Basic principles of school technology

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BASIC PRINCIPLES
OF SCHOOL TECHNOLOGY

REPORT
PATT-3 conference
1988

vol. 1 • FRAMEWORK FOR TECHNOLOGY EDUCATION

PUPILS' ATTITUDE TOWARDS TECHNOLOGY

RAAT/COENEN-VAN DEN BERGH/DE KLERK WOLTERS/DE VRIES (EDITORS)
BASIC PRINCIPLES OF SCHOOL TECHNOLOGY

VOLUME 1
This is volume 1 of the report of the PATT-conference that has been held from April 21-26, 1988 in Eindhoven, the Netherlands, and was organized by the Department of Physics Education of the Eindhoven University of Technology in cooperation with the Dutch Ministry of Education and Sciences.
In almost all countries of the world people are working on the development of a school subject in general education in which pupils learn things about technology. The name and the filling of the subject may vary, but it is the intention to teach pupils what technology means. This is understandable, because technology is very important in our modern society. Every day pupils get in touch with technology and its products. Technology as a subject in schools for general education has hardly any tradition. It is a new subject with which people have little or no experience. Therefore many questions still need to be answered:

- What are the learning objects of the subject;
- What are the learning contents;
- What initial or in-service training should be given to teachers for this subject;
- What are the material limiting conditions (equipment, classrooms)?

Another important question is: What are the pupils' ideas about technology? After all, pupils do not enter technology education unprejudiced. Because of experiences, among other things with mass media, they already have certain ideas of what technology is and they have taken an attitude towards it. What concept do pupils have of technology? What is their attitude towards it? It is essential for the development of technology to answer these questions to be able to pursue adequately the imperfections or inaccuracies in pupils' thoughts about technology and to promote that they get a balanced attitude towards technology: positive, but also aware of disadvantages and dangers.

Pupils' Attitude Towards Technology

The international research Pupils' Attitude Towards Technology (abbreviated to PATT) is concerned with the pupils' concept of and their attitude towards technology. For several years now, conferences have been held within the framework of this international research, at which results of research into the pupils' attitude towards technology are presented, and people discuss the developing of technology education in various countries. This publication is the report of the third international PATT-conference. All contributions are collected in these two volumes.

In this preface we give a short survey of the history of the research into Pupils' Attitude Towards Technology and the previous PATT-Conferences.
In 1984/85 a research was done in The Netherlands by Jan Raat and Marc de Vries among pupils of 13/14 years old to find out their attitude towards technology. They used as instruments a questionnaire with items of the Likert-type and essays. The results were startling: pupils appeared to have a narrow and distorted concept of technology. The concept of girls was even more narrow than than of boys and their attitude was less positive as well.

When the results were presented at some international conferences (GASAT 3, London 1985; ICSU-UNESCO, Bangalore 1985) it appeared that there was a great interest internationally to do this research in other countries as well. An English version of the questionnaire was prepared and arrangements were made to carry out a pilot study in 10 countries to find out whether the questionnaire that had been developed in The Netherlands could be used in other countries as well.

**PATT-1**

In March 1986 the first international conference, PATT-1, was held in Eindhoven, The Netherlands. There were 25 participants from 11 countries. The content of the conference consisted mainly of the presenting and the discussing of the pilot studies that had been carried out and the working on the adjustment of the instrument.

After this conference a new version of the questionnaire was published. This version consisted of a separate part about the pupils' attitude and another part about their concept of technology. With this new instrument researches were started in 16 countries to measure the pupils' concept of and attitude towards technology. By means of a PATT-Newsletter the partaking researchers and other interested persons were informed of new developments.

**PATT-2**

The international conference PATT-2 was held in Eindhoven in April 1987. There were 49 participants from 23 countries. An important part of the programme consisted of presentations of PATT-researches. In the second part of the conference there was attention for various aspects of the development of technology education: the contents of technology education, the pre- and in-service training of teachers for technology education, the policy regarding this subject and the investments that are necessary, and research in the field of technology education.
After the second PATT-conference again new countries joined the group involved in carrying out PATT-studies.

In view of the broadening of the objectives of PATT: not only to carry out and report PATT research, but also to find out what the consequences of the results are for the development of technology education, the name of the Newsletter was changed to TECH-ED-Newsletter.

**PATT-3**

This book is the report of PATT-3, which was held in April 1988, again in Eindhoven. There were 61 participants from 20 countries. One of the participants was a representative of the United Nations Educational, Social and Cultural Organisation (UNESCO), and he held the opening speech. The central theme of the conference was 'Basic Principles of School Technology'. With this theme the organising committee tried to reach common and unique basic principles in technology education in various countries.

With this purpose in mind 4 entries were chosen:

- **Frameworks for Technology Education** (examples of technology curricula and the description of its conceptual basis),
- **PATT-research, related research and its relevance** (what do pupils think about technology?),
- **How to make technology education attractive to girls?** (issue of small number of girls participating in technology),
- **The education of teachers for technology education** (what are the basic principles of teacher education?).

Participants have been invited to address their papers to these 4 subthemes. The submitted papers that were accepted by the organising committee have been taken up in two volumes: Volume I and Volume II.

The first report book contains papers referring to the first theme (Framework for Technology Education). The papers referring to the other three themes can be found in the second report book.

During the conference the four themes were introduced by keynote speakers. Summaries of each theme, together with the discussions about that theme, have also been taken care of.

For each theme the order of (1) keynote address, (2) thematic papers, and (3) summary can be found in the volumes.
Volume I
Apart from the introduction to the conference (by Raat and De Klerk Wolters) the first volume entirely refers to the first theme: Frameworks for Technology Education.
In his keynote address Vohra (UNESCO) gives a survey of frameworks used in technology education in various countries. Examples from practical situations that indicate frameworks of technology education more implicitly than explicitly, can be found with: Cheng Donghong (China), Claeys (Belgium), Kananoja (Finland), Natali (Italy), Fekete (Hungary), and Novakova (CSSR).
Frameworks for technology education are explicitly dealt with by: Blandow (DDR), Traebert (FRG), Edwards (UK), Page (UK), De Vries (the Netherlands), Otieno (Kenya) and Ogar (Poland).
More internationally oriented are the contributions of Dyrenfurth and Barnes (both USA). In his paper Dyrenfurth gives the results of an international comparison for different theoretical frameworks for technology education and literacy. Barnes provides a research based framework that has been developed in the USA. A practical example of Dutch School Technology in a real school context is given by Van der Velde, Van Engelen en Meyer.
A summary of the contents of the papers and the discussions during the conference is given by Page.

Volume 2
The second theme: PATT-research, related research and its relevance is introduced by three keynote addresses.
From their specific cultural context, Dugger (USA), Kapiyo (Kenya) and Szydlowski (Poland) each give a view of technology education in relation to PATT-research.
Reports of PATT-research are given by: Balogun (Nigeria), Dudziak, Grodzka-Borowska and Oleniacz (Poland), De Klerk Wolters (the Netherlands) and Rajput (India).
A proposal for a Large Scale PATT-study is given by Kapiyo (Kenya).
Reports of PATT-related researches are given by: Barbafleria Bardini (Italy), Moore (UK), Saar and Hendre (USSR) and Singh (India).
A summary of 'PATT-research and its relevance' and the conference discussions about this topic is given by Moore.
Important PATT-contributions can also be found in the contributions to the other themes (girls and technology and teacher education), see, among others, Rennie and Deijsselberg/De Klerk Wolters (TAS).

In her keynote address to the theme **How to make technology more attractive to girls** Rennie indicated a framework on the basis of which less positive attitudes towards technology of girls should be explained. She also indicates 'educational' solutions for the improvement of the present back-log of girls in technology.

From the Dutch MENT-project (Girls, Science and Technology) two contributions are given. Alting has interviewed a number of teachers in senior technical schools to investigate their ideas on sex equity in their schools. She derived recommendations for making the situations for technical schools better for girls. Brand discusses the guiding role of the MENT-project in a number of sex-equity efforts at technical schools. Mottier indicates to what extent young women are interested in existing 'frameworks for technology education'. Groenendaal and De Vries developed a 'girl-friendly' course on 'Medical Technology'. The rationale behind this course is described in their paper.

The possible role of hobbyclubs in this context is discussed by Nauta, Hylkema-Knottenbelt and Van Loon. Another approach is taken by Tremblay: Strategies for enhancing the girls' and women's position in manpower management.

A summary of this theme is given by Mottier.

The problems of the initial and inservice training are discussed in a separate subtheme: **The Education of Teachers for Technology Education**. Of course, the conference-theme 'Basic Principles of School Technology' does not only apply to the basic curriculum, but perhaps even to a greater extent to teacher education. There are two keynote addresses:

Harrison focusses on the question how the various school subjects contribute to school technology and the consequences for the education of teachers. Deijsselberg discusses the ways to give teachers a balanced concept of technology and how the Technology Attitude Scale (TAS) is being used in in-service training. The TAS, developed by De Klerk Wolters is taken up as a separate document in this theme.

Several national frameworks for educating technology teachers are discussed: Arp (West Germany), Bladow (DDR), Deri and Szücs (Hungary), Morrison (Scotland) and Türker (Turkey).
Two papers deal with technology teacher education at primary school level. Siegers, Raat and De Klerk Wolters deal with the Dutch situation (BASTEC-proposal) and Harvey a.o. describes at project level a solution for teaching technology at primary schools. Petrow and Atanasova give a general reflection on teaching methods to be dealt with in teacher education. The summary of this last theme was prepared by Dyrenfurth.

**PATT-4**

It has been decided to organise the PATT-4 Conference from April 13-18, 1989, with the theme 'The Education of Teachers for Technology Education'. Naturally, there will also be attention for PATT-research.

We refer to TECH-ED-NEWS, which is the newsletter by means of which the contact was maintained between two conferences in previous years as well.

We conclude this Preface,

by expressing our gratitude towards all those who have contributed to the success of PATT-3.

We hope that this report too will contribute to the development of the subject technology.

Jan Raat Eindhoven, June 1988
Rosy Coenen- van den Bergh
Falco de Klerk Wolters
Marc de Vries
# CONTENTS

## OPENING

1. Technology in the context of school education. General Frameworks, Faqir C. Vohra  
   Page 11
2. Introduction to the theme of the conference, Jan H. Raat  
   Page 30
3. PATT-research in 1987/1988, Falco de Klerk Wolters  
   Page 39

## FRAMEWORKS FOR SCHOOL TECHNOLOGY

4. School technology in China's rural area, Cheng Donghong  
   Page 49
5. Evolution and evaluation of technological education as a generally formative subject, Chris Claeys  
   Page 57
6. Technical work as an academic discipline in Finland, Tapani Kananoja  
   Page 76
7. Pupil/surroundings connection as an educational moment in self knowing and problem solving, Ilia Natali  
   Page 89
8. The dilemmas of technology education in Hungary, Janos Fekete  
   Page 98
9. Basic principles of school technology in our country, Hana Novakova  
   Page 108
10. The system of polytechnic education in the GDR, Dietrich Blandow  
    Page 116
11. Items of selection in the didactical process, Wolfgang E. Traebert  
    Page 136
12. Developing knowledge and skills through technological project work, Peter Edwards  
    Page 147
13. Technology education in the UK, Ray Page  
    Page 163
14. What should and can pupils learn in technology education, Marc J. de Vries  
    Page 182
15. Technology as a school subject: the Kenyan experience, Frederic Otieno  
    Page 189
16. Framework of technology education in Poland, Jerzy Ogar  
    Page 197
17. International perspectives on technological literacy, Michael J. Dyrenfurth  
    Page 202
18. A framework for studying technology, James L. Barnes  
    Page 209
19. Technology at a Dutch school, J. van Engelen
20. Technology education in the Netherlands: off the main road, Jenne van der Velde
21. Technology education at "De Pijler" comprehensive school, Tineke Meijer
22. Summary of the papers and discussions on the first theme: frameworks for school technology, Ray Page

VOLUME 2

PATT-RESEARCH, RELATED RESEARCH AND ITS RELEVANCE

23. Technology - the discipline, William E. Dugger, Jr. 255
24. PATT research and the relevance of PATT: perspectives from developing countries especially from Africa, Raphael Kapiyo 272
25. PATT - results and the relevance of PATT, Henryk Szydlowski 285
26. Nigerian pupils' attitudes and conceptions of technology, Taju Balogun 294
27. The teachers' and pupils' opinions about the school subject "Work and technology", Grazyna Dudziak 303
28. The investigation of the general high school students' attitude towards technology, Alexandra Grodzka-Borowska 309
29. The study of the concept "Technology" by the general high school students, Danuta Oleniacz 314
30. What do adolescents think of technology, Falco de Klerk Wolters 323
31. Projection of different gender and social setting over attitudinal difference to technology, Jaghmohan S. Rajput 337
32. Research into pupils' concept of and attitude towards technology and its impact for the Kenyan school curriculum, Raphael Kapiyo 357
33. The valuation in middle school: technical education Italy, Lola Barbafleria Bardini 364
34. A study of the relationship between teachers' activities in computer education lessons and pupils' attitudes towards computers, Jeff L. Moore 370
35. Physics and technology in students' opinion, Aivo Saar, J. Hendre 379
36. Scientific creativity test, Chhotan Singh
37. Summary of the second theme: PATT-research, related research and its relevance, Jeff L. Moore

HOW TO MAKE TECHNOLOGY INTERESTING FOR GIRLS

38. How can we make technology interesting for girls, Leonie Rennie
39. Making technology more attractive for girls: the teachers' view, Annita Alting
40. What can MENT do to make technology interesting for girls, Marja Brand
41. The concept of technology and the interests of young women, Ilja Mottier
42. Medical technology: a girl friendly course, Wilma Groenendaal and Marc de Vries
43. Technika 10 - Hobbyclubs for girls, Mieneke Hylkema-Knottenbelt, Margreet Nauta
44. Labor management strategies, internal labor markets and sexual division of labor, Diane Tremblay
45. Summary of the third theme: How to make technology interesting for girls, Ilja Mottier

EDUCATION OF TEACHERS FOR TECHNOLOGY EDUCATION

46. Teachers for technology, Geoffrey B. Harrison
47. Teacher training and the concept of technology, Willem Deijsselberg
48. Directions for use of the TAS in class, Falco de Klerk Wolters
49. Teacher training based on a general technology, Horst Arp
50. Teacher training in Polytechnical Education, Dietrich Blandow
51. The fundamental categories of technics and technics-teachers' training in Hungarian universities, József Déri
52. Technology education in Hungarian schools, Ervin Szucs
53. Technological education in Scotland, R. T. Morrison
54. Training teachers for technology education: a new goal in a number of Turkish projects of vocational and technical education, A. Vural Türker
55. Technology at primary schools, Henk Siegers, Jan H. Raat and Falco de Klerk Wolters

56. Primary science and technology, Robert Harvey

57. Problems and perspectives of teaching technology, Peter Petrov

58. International perpspectives on technology teacher education:
an analysis of the implications of PATT-III, Michael J. Dyrenfurth

LIST OF PARTICIPANTS

REGISTER OF AUTHORS
OPENING
TECHNOLOGY IN THE CONTEXT OF SCHOOL EDUCATION
GENERAL FRAMEWORKS

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Summary

Technology and its education are not new. They started with the beginning of our civilization. However, in the context of formal school education, it is only recently that the introduction of technology as a dimension of relevance has attracted widespread attention. Thus, the paper attempts to review the place of technology teaching in school curricula and timetables. It also considers, though in general terms, the content of technology and various approaches to teaching it in schools. Various related UNESCO activities in the field have been described.
TECHNOLOGY: FRAMEWORKS FOR SCHOOL EDUCATION

Why Technology Education?

Technology is not new. It dates back to prehistoric times but its influence on our daily lives almost everywhere has never been so powerful as in recent years. Increasingly, most of our issues and problems at all levels involve technological interactions. Together with science, technology influences the shape of things to come and guides the future destiny of mankind. It is so pervasive in our society and yet so sophisticated in some instances that images people have of it are varied, often incomplete or inaccurate. Thus, in linking technology with human progress an optimist sees a positive correlation while the pessimist a negative one. Accordingly, futurists offer both promise and gloom through its ever growing integration with the socio-cultural fabric of our existence. Whereas the modern technology has contributed tremendously to the quality of human life, it has at the same time created problems of over-population and environmental pollution. For example, fertilizers and pesticides have helped to increase our food production but at the same time they have polluted our water. Similarly, laser technology is revolutionizing surgery for the benefit of mankind, but when applied to "star wars" it can usher the nuclear horror into space and bring humanity nearer to its doomsday. Again, the application of microprocessor technology to agriculture, communication and industry may have profound impact on both the worker and his work, raising problems of social control and unemployment. Whether the technology emerges from public expenditure or private enterprise, it is not always clear as to whose interest it will serve. Anyhow, whatever the case, it is now with us to stay, making an ever-increasing impact on our future existence. Preservation and improvement of the quality of our life will ultimately depend on how far we are able to recognize, understand and learn to control the interaction between ecological and technological systems. Thus, technology is no longer a matter solely for professional technologists and their supporting technicians and craftsmen; it concerns all, men, women and children alike, both in their professional life and in their working careers. Those who are knowledgeable about the basic process and practice of technology can participate in decisions on its future orientation, while those lacking such understanding of technology will find themselves cut off from the fundamental part of all cultures. They will neither be
able to communicate about it nor be able to enjoy benefits accruing from its innumerable inventions and discoveries. It is therefore imperative that we become technologically literate to cope and live harmoniously with the changes arising from the consequences of technological developments.

What Is and What Is Not Technology

During the last decade technology along with its education has been the subject of considerable discussion among educators, teachers, economists, sociologists, administrators, planners and even politicians around the world. And yet, there is no universal agreement or even general consensus on what exactly it does involve. Much though it will help to have a universally acceptable concept of the subject, it may not be wise to dwell too long on the issue at this stage just to derive some internationally plausible definition. Later, by discussing some specific technology education programmes and activities around the world we may be able to achieve our purpose in identifying the major ideas underlying the subject. However, at present, it may not be misplaced to spend some time in considering what technology is and what it is not before we proceed to discuss it as an educational tool in the school curriculum.

Technology, of course, is not science, though the relationship between the two cannot be denied. It is also not mathematics, though often times mathematical skills are essential in the practice of technology. Likewise, it cannot be called history, though it has a history which can be taught or learnt without having to demonstrate or practise any of its components. Similarly, we cannot label it as social studies or political science because of its implications and impact on national economic growth and socio-cultural development.

Technology has a more complex nature and varied purpose. This makes it difficult to define it in very precise and concise terms. According to the Oxford Dictionary it is "science of industrial arts; ethnological study of the development of arts". This suggests breadth of technology in our culture. In the McGraw-Hill Encyclopaedia of Science and Technology, it is defined as "systematic knowledge and action, usually of industrial processes but applicable to any current activity". It can thus be said to deal with tools and techniques to carry out plans to achieve the desired ends. In a UNESCO document (1981), it is defined as the application of scientific knowledge to the general purpose of fulfilling an individual, community or
national need. This view is further strengthened by a statement of the U.K. Committee on Manpower Resources for Science and Technology. It reads, "In every technology the ultimate purpose is to exploit existing scientific and other knowledge for productive ends whether or not all the processes involved in the technology are currently capable of scientific explanation". Again, in the U.K., the Schools Council Project on Technology gave the following definition: "Technology is the purposeful use of man's knowledge of materials, sources of energy and natural phenomena". among other things, its essence surely concerns "the purposeful use". In a UNESCO Consultation Meeting (1984) held in Beijing the group also regarded technology as an application of knowledge for making purposeful or useful things. These definitions imply that practical work and intellectual effort constitute two of the basic components of technology.

Again based on the definition of Gebhart et al. (1979), the UNESCO Symposium (1985) agreed that "technology is the know-how and creative process that may utilize tools, resources and systems to solve problems to enhance control over the natural and man-made environment in an endeavour to improve the human condition". In addition to knowledge and practice, it reflects creativity, design and skills for the utilization of tools, materials, resources and systems for decision-making, problem-solving and environmental control as essential components of technology.

Technology as a Discipline

From the foregoing definitions, technology as a discipline in school education may be characterized by two closely integrated components of "theory or know-how" and "practice or do-how". Knowledge alone or practice alone do not qualify as technology. Thus, to perform well in technology-related activities, such as cooking, operation to remove an appendix, welding or designing a solution to a problem, a good mastery of both knowledge and associated performance skills is essential. Knowledge alone may qualify as science, social studies or mathematics and since technology uses all these and more, it may be defined as knowledgeable doing to achieve the human purpose. Thus it can serve as a new dimension for school curriculum renewal and relevance.

In another UNESCO meeting (1980), technology education was regarded as the study of products emerging from various manufacturing processes on one hand; and analysis of manufacturing processes through which raw materials
are transformed into usable products on the other hand. This education should, taking into consideration the endogenous techniques as constituting the initial environment of the child, be provided in the form of practical work at school or in the field in order to reconcile intellectual effort with manual skills in solving problems. In encouraging this, the design process and rational use of available resources should not be ignored.

In this respect, the definition of Wright (1981) seems more inclusive. It reads "technology education is the study of technology and its history, growth and future development as they relate to industrial organizations, materials, tools, processes, occupations, products and problems. It includes multi- and interdisciplinary academic and laboratory endeavours that help students explore their technological world, realize their responsibility therein and better cope with the socio-cultural changes caused by technological advance". Based on the foregoing discussion, the following points emerge as the most common deserving attention:

(i) Technology is concerned with meeting human needs or purposes;
(ii) It is the control of the environment;
(iii) The use of physical resources; and
(iv) It is a creative process of using human knowledge and skills (both physical and mental) to solve practical problems.

Technology as a Dimension of Relevance of Education

Education today is not so much for education's sake. It is now considered as an investment rather than a peripheral issue in achieving socio-economic growth and modernization. As such, the question of its relevance in all aspects and at all levels is given high priority in major programme activities and conferences on educational renovation. As a basic human right there is a constant demand on education to be general and available to all school-age children both in the formal and non-formal systems, at least for the first 8-10 years.

If school education is thus to become truly fundamental and productive, it should not be limited to providing knowledge alone by developing in them a better understanding of the world in which they live. Study and teaching of only the classical and literary subjects in schools will not equip our young citizens to live the life of tomorrow. Moreover, many of the changes occurring in the world today result either from the expansion of knowledge or through its application to the solution of human problems. The
introduction of technology as an integral component of modern education can help provide the balance to the theoretical white-collared education through exposure to manual and practical work and thus may help our children to cope with their lives in the changing world of technology. The move will also serve as a basis for development. General comprehension of technological principles and processes may also contribute to creating a favourable pre-condition for development. Through this children and adults alike may become aware of new challenges and thus may develop new capacities for harnessing local resources to control the environment for continued human benefit.

If technology as a growing and guiding element of our culture is denied to our children in their basic education, they may find themselves alienated from it and hence restricted in their ability to derive benefits from it to lead an effective and satisfying life. In brief, they may be technologically disfranchised in a world increasingly technological.

**Constraints to Technology Teaching**

It is encouraging to note that results of surveys conducted by UNESCO (1983, 1986) show that various education systems around the world have introduced or are on the point of introducing or developing the technological facet of general school education. However, efforts in many cases are rather marginal and the over-all situation far from being satisfactory. The reasons for this are complex. In many countries various aspects of technology are treated either as technical and vocational education, or wood-work, metalwork and industrial arts in special schools to develop skills for specific vocations or as art and craft including home sciences etc. to introduce children to manual work or work experience. This has been interpreted by many as contrary to what is called "liberal education" and providing little hope of freedom from the life of labour or little promise for upward social mobility for working class.

Being often regarded as a manual activity subservient to the role of science, technology education has acquired a certain disdain among pupils and their parents. This has hindered its popularity as a school subject.

Another point relates to countries with a capitalist economy. According to Prof. Layton (1986), "technology education, if it were to be developed much beyond a study of the principles of science applicable to the practice of a trade or industry, might expose to public scrutiny crucial aspects of
technique upon which the economic success of industry depended. In some countries, this fear about loss of trade secrets in a competitive industrial situation has ensured that, in so far as a version of technology penetrated the educational system, it remained remarkably 'pure'."

Other constraints hindering the development of technology as part of general education relate to the general inertia of the education system, lack of trained teachers, teaching-learning materials, financial resources, equipment and other physical facilities.

Proper understanding of technology and its operation involves such complex capabilities as "decision-making", "problem-solving", "creative designing". These, as Layton (1986) says, "may be teachable; at present they are under-researched aspects of human behaviour, and opinion varies on the means of achieving them".

Another significant point relates to the mode of introducing technology as part of general school education. Admittedly each option has its own difficulties and problems which must be considered carefully before adopting and implementing any one particular mode. Whatever the scope or approach for introducing technology in general education, there cannot be one particular brand of technology education which could be acceptable and applicable everywhere.

Recent Experiences

Each country has its own preferences and priorities which are dictated by its national development goals, available resources and facilities, socio-cultural requirements and the prevalent state of technological development. Let us now examine some of the recent national efforts in the field in order to determine how various aspects of technology have been integrated and manifested in the technology education frameworks as part of school curriculum around the world.

Canada

The province of Quebec has developed a one-year course, "Introduction to Technology for Secondary III Students" (both boys and girls). Based on ideas and experiences familiar to the pupils, the course comprises five main themes corresponding to broader areas of technology. These are:

(i) Technology in the life of man;

(ii) Building, construction technology;
Mechanical technology;
(iv) Electrical technology; and
(v) Technology in the world of work.
The first four themes cover the processes of design and production of technical products, while the fifth deals with industrial production of products from a pre-developed and tested prototype.
The main goals of the course are to provide the pupil, through the study of technical objects, with the basic knowledge (theory), skills, and attitudes that will enable him:
(i) To discover the technological principles of construction, mechanics and electricity through practical applications of these principles (practice) so that he can:
    a. understand the technical product,
    b. make intelligent use of the technical product,
    c. understand how the technical product influences the life of man;
(ii) To learn logical step-by-step techniques for problem-solving;
(iii) To learn the rudiments of graphic communication;
(iv) To use his inventive ability and sense of form and design in seeking technological solutions to practical problems;
(v) To practise techniques that are useful in everyday life in the process of constructing models:
    a. using common tools,
    b. using and transforming certain primary materials,
    c. putting into practice certain production processes,
    d. applying knowledge acquired in other disciplines (interdisciplinary approach);
(vi) To develop the capacity to reason and use critical judgement with regard to technical products and technology in general.
The course, however, does not describe learning situations or evaluation procedures. Nevertheless, it serves the teacher in planning his activities and in selecting an appropriate methodology for teaching them. In general, study of a technical product involves learning:
   (a) Why it is made,
   (b) How it is made,
   (c) Why it operates, and
   (d) How it can be produced.
Each technological study comprises two phases:

a. **The intellectual phase:** the design stage which requires logic and creativity as well as technological, scientific and mathematical knowledge; and

b. **the practical phase:** the production stage which requires imagination and initiative as well as manual skills, perception of form and detail, and a sense of organization.

**U.S.A.**

The course "Introduction to Technology" has been prepared by the New York State Education Department, Division of Occupational Education Programmes, in two parts, one each for students aged 12 and 13. The first part introduces students to the pervasive nature of technology and to the ways in which technological systems have been designed to satisfy people's needs and wants.

The content is divided into five themes:

(i) Getting to know technology;
(ii) What resources are needed for technology;
(iii) How people use technology to solve problems;
(iv) Systems and sub-systems in technology;
(v) How technology affects people and the environment.

Thus, through a study of resources which are common to all technologies, and a focus on how these are combined in technological systems, students are provided with conceptual tools that can be useful in solving technological problems with reference to biologically-related technology, information/communication technology and physical technology.

The second part is built on concepts introduced in the first part. It covers themes such as:

(i) Choosing appropriate resources for technological systems;
(ii) How resources are processed by technological systems;
(iii) Controlling technological systems;
(iv) Using systems to solve problems;
(v) Social impacts of technology.

Thus, this addresses additional generic technological concepts such as the methods that people can use to control technological processes, technological career opportunities and other personal and social implications of technology. Part II also requires the students to use the computer for accessing data.
The major part of the course is to be taught through hands-on "design and construct" experiences and is intended to develop the ability of students to synthesize and apply their new technological literacy to the solution of problems through design, development, operation and maintenance of systems related to different aspects of technology. As such the course is suggested to be taught in a technological laboratory, equipped with tools, machines and devices used at home and in the work place. This is to be supplemented with field visits.

The Netherlands

In order to introduce technology in general school education, a course entitled "General Techniques" or "General Technology" has been developed for pupils in the age-groups of 12-14 years. To establish the framework of the course, technology has been described as the field of activities of man based on an accumulation of knowledge, means and capacities (skills) through which people can adapt or control the environment to suit their needs and comfort without excluding their responsibility to the environment.

On the basis of eight starting points, over sixty educational objectives were formulated and arranged around three topics - materials, energy and information. The starting points include:

(i) The relation between man and technology;
(ii) Technology in the children's world of experience;
(iii) The five aspects of technology as covered by definition: i.e. knowledge, skills, means, adapting one's surroundings to one's needs, and responsibility for one's environment;
(iv) Historical perspective;
(v) Areas of life;
(vi) Division in subject matter;
(vii) Differentiation of subject matter to suit children's capacity and socio-cultural background; and
(viii) Self-concept elucidation - enabling children to realize their own possibilities and limitations.

The teaching/learning content of the course is grouped around four main areas:

(i) Residential surroundings;
(ii) Work and profession (occupation);
(iii) Leisure (contact with technology during leisure);
(iv) Environment.
These areas are to be related as much as possible to the life and experience of the children with special reference to technology in their everyday life with emphasis on:
(i) Basic knowledge and skills;
(ii) Materials and tools;
(iii) Socio-cultural impact; and
(iv) Designing and evaluating solutions to problems.

**Physics and Technology (P&T)**
This project has been developed by the Faculty of Technical Physics at the Eindhoven University of Technology. This demonstrates that elements of technology can be taught linked with science education and in this particular case their inclusion in the project serves as an enrichment of physics education.

The course has been developed as units around six themes:
(i) Making musical instruments;
(ii) Electrical equipment at home;
(iii) Communication;
(iv) Water at home;
(v) Do-it-yourself; and
(vi) Lighting.

They relate to the immediate environment of pupils.
Each unit is divided into six sections. The first deals with the physical knowledge (theory); the second with the practice involving design of simple objects and the solving of a "closed" project; the next two deal with the study of technical objects with reference to their design and operation; the fifth encourages reflection on the effect of technology on pupils' lives and on their professional possibilities; while the last concerns the recapitulation of elements studied during the earlier steps.

**Sri Lanka**
As an initiation to technology and the world of work in the context of general education the subject of "Life Skills" was conceived to replace the study of technical subjects in the school years 7 and 8. It was defined as "work and employment oriented skills which enable the child to develop an awareness of and appreciation for work and employment as an integral part
of daily life. They are composite of knowledge, attitude and psychomotor skills which are fundamental for successful participation in work and employment, for the benefit of the individual, the community and the country as a whole. The course was developed within the framework of the local socio-cultural environment, as well as the prevalent level of technology in the country.

The content of "Life Skills" is based on activities drawn from the pupils' environment, including home, community, work place, leisure and familiar occupations or vocations. It is presented for learning as far as possible in the form of hands-on exercises with a view to enabling children to:

(i) Acquire skills such as practical (involving the use of tools), investigative (including decision-making), and those of problem-solving and communication;
(ii) Develop an awareness of the world of work, understand the design and production processes; and
(iii) Become familiar with a range of vocations/occupations including their associated skills.

Bulgaria

In Bulgaria, technology education as part of general school curriculum is taught through unified polytechnical education. It enables pupils to acquire theoretical knowledge and practical skills with emphasis on learning about work involved in various sectors of the national economy. Three distinct stages can be recognized. Thus, in grades 1-3, the foundations for all-round personality development are laid, encouraging understanding of useful jobs through "work and creativity". In grades 4-7, children acquire scientific knowledge and a wide range of skills and operations related to agriculture, industry services, etc. During grades 8-10, the first year is devoted to practising skills related to six areas of study, namely, technical drawing, metalwork, practical electricity, woodwork, textiles and agriculture. The following two years (i.e. grades 9 and 10) offer a choice between general theoretical training and mastery of specific practical skills with reference to industrial production, automobile mechanics, general mechanics, etc. Here, the learning content seems to lack the disciplined structure of technology, though it does cover some essential aspects of technology as such; the main emphasis clearly being on productive work and preparation for vocations through general education.
United Kingdom

The British Education appears convinced about the place of technology in the school curriculum. However, some see it as a single subject in its own right; others consider it as an aspect for enrichment of science or other disciplines of general studies; and yet others regard it as a cross curricular activity to be taught through almost all subjects. In some cases it may be offered as an alternative or addition to science. As a single discipline, it is offered as a structured course based either in science, technical, or "craft design and technology" department or involving combinations of these departments. As such it is often taken as an elective subject rather than a core one; frequently in place of physics. Each mode has its own advantages and disadvantages. However, various initiatives for the purpose include:

(i) Modular courses;
(ii) Control technology;
(iii) Electronics;
(iv) Applied science, engineering science and design;
(v) Design based courses;
(vi) Technology for age groups 8-13 years;
(vii) Technology awareness; and
(viii) Other miscellaneous technology courses.

According to Black and Harrison (1985), there is, therefore, considerable confusion about the place of technology in the school curriculum. Partly it may be due to the decentralized nature of the school education. Thus, several groups of teachers representing general education, handicrafts, technical and vocational education, "craft, design and technology", etc., working independently, have contributed to the development of technology as part of the school curriculum in the country.

Of the 90 schools visited by the team of Her Majesty's Inspectors (HMIs), experienced in "craft, design and technology" (CDT), about two thirds had no written definition of technology in their schemes of work or syllabuses. Some, however, adopted the definition originally offered by the Schools Council Project on Technology: "Technology is the purposeful use of man's knowledge and natural phenomenon (HMI-DES, 1982)". In developing the Modular Courses to the common purpose, process and product of technology, it was agreed that, "technology is the process by which people cope with their environment. It is therefore a problem-solving mechanism which draws on the knowledge and resources available to us, while working within the
constraints that the knowledge and resources place on us" and accordingly, the model shown in figure 1 was adopted.

Figure 1. A model of Technology adopted by the Modular Courses in Technology Project.

In "Place of Confusion", Black and Harrison (1985) perceive technology in terms of human capability and hence have suggested another model of technology education (figure 2) based on three main interacting elements of resources (knowledge, concepts and skills), technology tasks and outcomes (full technological capabilities).

Figure 2.
According to Edwards (1987), the Assessment and Performance Unit (APU), based on the study of technology across CDT and Science, concluded, "technology capability is seen as that which enables a person to enrich the quality of life by using technological skills, knowledge and value judgements in the development of man-made environments and man-made things". This expresses the same elements as HMI deem essential to wholesome education. HMI further suggest that these elements should be developed through all areas of learning with a view to reinforcing the national policy and thinking for the inclusion of practical and technological work in a number of school subjects". Based on APU's conclusion, Edwards presents figure 3 for consideration.

**Figure 3.**

**UNESCO Pilot Project**

As part of UNESCO's programme in science and technology teaching for 1981-83, a pilot project on "Technology in General Education" was initiated with the participation of Australia, China, India and the Philippines. This was then extended to include Brazil, Finland, Greece and Mauritius. Based on the analysis of existing school science curricula in the participating countries, it was intended to give selected topics in science education a practical and technological bias, so enabling students to achieve better understanding of the surrounding objects and the environment. The overall conceptual scheme provided for both theory (knowledge) and practice (skills) with emphasis on application of both in designing suitable solutions to confronting everyday problems. Thus, the project aimed at developing technological literacy through school science education on the following considerations:
Science is already an integral part of school education in most countries. It is more economical to re-orientate an existing subject than to introduce a new one in the school curriculum.

It is too simplistic to think of science as theoretical and technology as practical or applied. Both are needed to understand the modern world.

Science and technology represent two basic areas of human activity which while different are inter-related and mutually interdependent. The former relates to man's natural desire or curiosity to know, understand or to explain, while the latter to find ever new ways to satisfy human needs. Thus, to do something better one needs to know more. Similarly an improved technology can help extend the frontiers of scientific knowledge.

Technology alone is often associated with manual work and has acquired certain disdain.

The combination of science and technology in education can bring together a range of knowledge, attitudes, methods and skills which have great bearing in solving problems to improve the quality of life. The selection of topics and activities had immediate relevance to students, being drawn from their familiar surroundings. They included designing of swimwear, propagation of plants, solar energy, combustion, household electricity, electrical appliances, water supply, an electric engine, compost making, bicycle maintenance and repair, constructing and operating a biogas plant, etc. In preparing the teaching-learning materials on these, the participating Member States considered various objectives, such as: to make education more realistic and relevant to the life of students; to prepare students for life in modern culture of science and technology; to train students in the constructive use of both the head and hands; to develop both intellectual and practical skills, etc.

Conclusion
Modern life may not be totally due to technology, but today an average person seems more conscious of its influence on conditions surrounding his life. To be educated under these circumstances implies not only knowing the three Rs and ancestral culture, but also requires an understanding of technology and the working principles of its objects around us. It is to acquire some practical common sense about living in a world increasingly technological. As indicated earlier, many countries are therefore seriously thinking of technology as an essential component of school education. There
is no single exclusive approach for the purpose. Based on available experiences, five main strategies may be recognized:

(i) As independent projects or isolated activities without any link to any particular subject or examination;
(ii) As a single subject comprising a structured course;
(iii) As linked to science education or other subjects for their enrichment and relevance;
(iv) Through general study programmes emphasizing awareness and appreciation of technology as a socio-cultural factor in life;
(v) As a unifying factor across various curricular subjects contributing to various objectives of technology teaching.

These approaches are not necessarily contradictory but complementary to each other. The question is not simply to ask what technology or what mode for its inclusion in school education is to be adopted or accepted. Among other things, the selection of technological elements of school curriculum must relate to the prevailing socio-economic framework and cultural environment of the country as well as to its development goals. There are seven main categories of resources, namely, people, information, materials, tools and machines, energy, capital and time -- which are basic to any technological development and, hence, technology education must be planned and structured within their provision and availability.

Technology has certain constituents of pedagogical value which should be integrated into technology education whatever its form, scope and mode of linking with school curriculum. These, according to APU (1982), include "skills of investigation, invention, implementation, and validation, in relation to a designated product; the knowledge base of understanding about materials, energy and control; and the value dimension -- economic, technical, aesthetic and moral". Furthermore, technology is concerned with the identification of human needs and the endeavour to satisfy them through the application of knowledge, including laws and principles of science, and by using skills, both mental and physical, resources, materials and energy. This involves decision-making and creative activities, with due regard to socio-economic factors, cultural constraints and moral values. It concerns solving problems where there are no right or wrong answers; only good or bad solutions. Technological solutions and their testing also demand approaches and techniques related to systems analysis, planning, communication, execution, etc., which are more than pure science or craft.
Since technology can be both good or bad, it can either improve or pollute the environment in which we have our being. As a fundamental part of our culture, technology education should, therefore, aim at developing an understanding and appreciation of technological possibilities and limitations in order to assist our present and future citizens to make intelligent decisions and to exercise control over its development. Through practical exercises, it should also explain how decisions are made and conflicting factors are resolved, instilling in pupils at the same time a keen sense of environmental and social responsibility.

The all-pervasive nature of technology in our daily life demands that its teaching should be interdisciplinary, drawing on knowledge of other school subjects such as mathematics, science, economics, social studies, etc. Students should also realize how various technologies may affect them and their work and what new career opportunities they may create.

If the technological component of our fundamental education is to be relevant, its curricular content should relate to real life situations derived from the socio-cultural and economic environment of the learners, and should be appropriate to their needs and abilities. The various activities chosen should interest both girls and boys and, in a thoroughly practical manner, involve them in solving a wide variety of problems related to design and construction.

In considering the technological content of general school education, the major concern should be not so much for the education of the professional technologists, technicians, etc., but for the majority of individuals who are going to live as non-technologists in an increasingly technology-based society. Thus, technology teaching need not focus on high-tech, complicated processes included in the courses designed for specialist technicians and engineers. There is no way that individuals living in a modern society can assimilate the total technological information that supports daily life. What can possibly be developed is a general technological literacy that will allow people to function intelligently within the complexity of their technological environment.

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INTRODUCTION TO THE THEME OF THE CONFERENCE

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Summary

PATT-Conferences consist of a mixture of research in technology education and examples of technology curricula from all over the world. We attach great value to the linking-up of research and curriculum development. Even more than in the previous years we shall try to make this link during PATT-3.

In the introduction there will be attention for the following aspects:
1. technology education as part of general education, especially for 12 to 15-year-olds;
2. research into and curriculum development for technology education;
3. aim and meaning of PATT-research;
4. explanation as regards the contents of the PATT-3 themes, this also with respect to the submitted papers;
5. account of the structure and organization of the conference;
6. PATT in the years to come.
BASIC PRINCIPLES OF SCHOOL TECHNOLOGY, THE THEME OF THE CONFERENCE

'Basic Principles of School Technology', that is the theme of this PATT-3 conference. When we are discussing technology in education, school technology, or simply technology, we all know that it is essential that we get an answer to the question 'what is technology?'.

Now, when we are discussing school technology the question 'what is technology?' is not really a question that can be answered in an hour or in three days for example.

Various answers are possible. Answers that do not always need to be conflicting. There are also times that we have to make clear choices when giving an answer. In his opening speech, for which I thank him very much, Dr. Vohra already clearly indicated a certain development of what could be understood by technology, with relevance to school technology. He also gave some clear examples of this.

The theme of the conference is 'Basic Principles of School Technology'. During the days of the conference we hope to have extensive discussions about this.

What makes this conference on 'Basic Principles of School Technology' so special? That is of course first of all the fact that colleagues from so many countries who are all involved in school technology meet for the first, second or third time. We are anxious to hear about the developments in places that are so far apart and where the situations are so different. And time and again we discover that many basic questions are the same, and also that the same or comparable answers are obtained.

A second factor is that we are directly and sometimes indirectly involved in education for young people. Whether we are researchers, or curriculum developers, or teacher trainers, or whether we are trying to design the policy for education, in all cases our ultimate concern is the education the way it is provided to young people in a class or in a group.

These days we shall not talk about philosophical questions concerning a certain theory, nor about the historical development of the art of painting. You will not hear me say that these subjects are not interesting. But in my opinion involvement in direct education calls up a different atmosphere. This PATT-3 conference is about the new technology education. Many young
people all over the world are interested in it. We know that good technology education is important to them. All discussions on researches, curricula, teacher trainings and policy are ultimately focused on the optimalizing of technology education. Therefore we consider it important that during the conference we can pay an extensive visit to a school at which technology education is implemented in a fascinating way. On Saturday we shall visit "De Pijler" Comprehensive School for several hours. There we shall not only meet the principal of the school, but also teachers and pupils. We are very sorry that Mr. van Engelen, principal of the school, could not be present at this opening session.

However, I think that there is a third factor that particularly contributes to the fact that we are at the beginning of a fascinating, interesting and even engaging conference. It is a fundamental aspect of our society that we live in a time of fast, of very fast technological developments.

These technological developments have a great impact on the economy and also on the labour market. Modern technology influences the arms production. Because of technical developments we are faced with a great responsibility regarding the environment.

Technology influences health care. We have means of transport available that would be inconceivable only a century ago. The same applies to communication. Just think of the fact that we are present here from so many different places. And later today each and every one of you can simply call home from your hotel room to say that you had a safe journey (but you will have to pay for this yourself, of course).

Technology influences all aspects of society. Technological developments have a great impact on society.

The question is now: how should education react to this? I can split up education into general education and vocational education. And I shall confine the question to: how should general education react to the fast technological developments of our time?

I shall not discuss this question in general; this is not the occasion to do this.

I note that in many countries people are paying attention to school technology in general education.
Because we, the way we are gathered here, know something about technology education, we also know that this calls up many questions. Because school technology is a new subject. It is a subject without tradition.

Particularly the fact that we are gathered here as colleagues, who all have a function in education, to exchange and test opinions on developments in the new subject Technology places us at the beginning of an extremely fascinating congress.

One could say that in a number of ways school technology is similar to 'craft', to 'doing things with your hands'. But school technology is as different from the subject 'craft' as the practising of modern technology is different from 'being active in a craftsman-like way'. It is related though. But it comprises much more. In some aspects school technology is similar to physics, and also to chemistry and biology. But it is also different from those subjects. And not a little bit.

So what is it really?

We know some answers. But there is still a lot of discussion about this. And that is exactly the theme of this conference. What are the principles, what are the basic principles of school technology?

If we offer school technology to pupils we have to make a certain selection from the multitude that can be offered. To be able to make this selection we need certain criteria.

These criteria are closely related to the concept we have of technology and of school technology.

There still is the question of: what is the theoretical concept of school technology? We, who are concerned with school technology, have to try to develop a fairly generally accepted theoretical concept. I think that this will determine to a great extent whether school technology will take up its own position in the educational system.

The PATT-conferences originated from the research into Pupils' Attitudes Towards Technology. What is the attitude of pupils towards technology? And also: what concept do pupils have of technology?

Drs. Falco de Klerk Wolters who is going to speak next will discuss this in greater detail.

At first the attention was mainly focused on pupils of about 12 to 15
years old. The education to pupils of this age group is rather special. These pupils have acquired the basic skills of reading, writing and arithmetics. All over the world there is a tendency to teach pupils more in the period of about 12 to 15: mathematics, science, a foreign language, social subjects like geography and history, to develop their artistic abilities further (drawing, music), to teach them to improve their talent for a certain sport. But all this still as far as possible in general education. It is important to introduce the new subject technology at this stage of their school career, or to ask for special attention for technology in another way (I refer once more to Dr. Vohra's lecture).

I think it is important that during this PATT-3 conference we should concentrate on school technology for pupils of about 12 to 15 and as part of general education.

And yet I would like to take a small trip. Education reacts to the fast and much comprising technological developments not only by paying attention to technology in general education for pupils of 12 to 15 years old. There is also some interest in school technology at elementary education; education for pupils of about 6 to 12. I do not think that there are many people who think that technology education should be given as a separate subject to such young children. It is far more important for young children to acquire the well-known basic skills that I mentioned before: reading, writing, arithmetics; social skills. But then there might also be some attention for technology. And I am one of the people who hold the opinion that this indeed should be the case. An important reason for this is certainly that it may be possible this way to give girls a certain positive attitude towards technology and a positive idea of what technology is. We know from research that it is essential to pay special attention to the attractiveness of technology education for girls too.

Another aspect is the developing of school technology for pupils of about 15 to 18 years old; I am still talking about technology as part of general education. So thereby I think of the upper part of secondary general education and of the last 2 or 3 years of pre-university schools. Discussions on the implementation of school technology for pupils of 15 to 18 years old are still at a very early stage. Important questions are: if one
thinks of a new subject, at the expense of which other subject will it be introduced (will there be less science, e.g. less physics, less chemistry or biology; or less mathematics; or less attention for social subjects like geography and history; etcetera)? Does a new subject school technology offer enough to ask time for a separate subject? Or is it better to pay attention and time to this in another way (e.g. in physics, chemistry, biology, economy, social studies)? At the moment I cannot give a balanced answer to his question.

I do think it is important to pay special attention to this.

It is also an established fact for me that school technology for pupils of 15 to 18 years old at pre-university schools would contribute, among other things, to a discussion on the 'basic principles of school technology'.

After these more general remarks about the developments in school technology I would like to say some things that are more directly related to this PATT-3 conference. I shall do this under the headings that were also indicated in the pre-congress book of March, 1988.

1. On technology education as part of general education, especially for 12 to 15-year-olds I already made some remarks.

2. Research into and curriculum development for technology education.
   It is essential during the introduction of a new subject school technology to give a lot of time to curriculum development.
   But in this respect several questions come up.
   By the way, this does not only apply to curriculum development. It also applies to other aspects of school technology.
   That is why it is important to give time and attention to research into technology education.

3. From the point of view of the history of PATT the PATT-research has an important position, in our opinion, in research into technology education.
   In our opinion the aim and meaning of the PATT-research is very much determined by the extent to which it contributes to curriculum development; and also to teacher training.
   It is a fascinating aspect of PATT that it brings together colleagues
from many far countries to discuss the results of common research. I think that it is also a special value of PATT not only that it draws the attention to what pupils think of technology—and of education in general; they will be the ultimate consumers of education, and also of school technology—, but also that we make a joint effort to do this difficult kind of research in a justified way, and also to try to obtain such results that international and cultural comparisons are possible. Everybody who knows something of comparative international studies in education will also know that these studies are important, and also rather difficult as regards the obtaining of valid results that can actually be used.

4. The structure and organization of the conference.

During the conference will focus our attention on four themes: first of all: 'frameworks for technology education'. This is the main theme of the conference. The success of technology as a fully fledged school subject will depend on the theoretical concepts and/or paradigms at its basis. Which can be distinguished and what is the relation of these possible differences with cultural factors? The link with the second theme: PATT-research seems obvious. After all, theoretical concepts have to be translated to the living environment and way of thinking of young people. This last aspect is a subject of research of PATT. In the programme we can see that the two themes are somewhat mingled.

The third theme: 'How to make technology education attractive to girls?' is extremely relevant. In some countries the experiences with girls and technology education are unfavourable. How did this happen? What can we do about it? This theme is very suitable to be dealt with in workshops. Various aspects such as 'girl-friendly course material' and 'technical hobby clubs' will be discussed.

The fourth theme that will be discussed on Monday will be given special attention because probably the developing of theoretical concepts mainly takes shape in the teacher training.

It is the structure of this workshop that we have a number of paper sessions in which the most important points of a paper are presented in 5 to 10 minutes. This may be somewhat difficult for the person who
presents his or her paper. However, the main advantage of this is that this way there will be ample time for discussions and our attempt to come to certain conclusions. Besides, this way everybody who has written a paper will have the opportunity to give a presentation, even though it is a short one, that is attended by everybody. The paper sessions are plenary sessions. We printed the summaries of most papers in the pre-congress book and at the beginning of the conference you received the full texts of most presentations as well. The idea is that you read in advance as many of the papers as possible. Particularly the papers that have your special interest. At the end of each paper session there will be a short moment to enable you to ask informative questions.

After the paper sessions there will be discussions in groups at various times in the programme of the conference.

We propose to have in principle 5 discussion groups, of 10 to 12 persons each. We also suggest that the five groups will consist of the same people as much as possible, at least for Thursday and Friday. We took the liberty to make a division for the groups already.

The idea is that the groups discuss first of all the concrete contents of the papers, and then also certain questions concerning the main and sub-themes of the conference. We made certain suggestions for this which will be handed out later.

In the middle and last part of the conference certain themes will be discussed in parallel sessions. This is the case on Sunday evening and on Monday.

The preparation committee hopes that by introducing this structure we have made the framework for a useful conference. We think, that there will be enough room for conversations of a more informal nature. By organizing an excursion on Saturday afternoon, and by keeping Sunday morning free we hope to have reserved enough time to relax and have a good rest.

For the last day of the conference we planned recapitulations that will partly be prepared by several participants in the days to come.

6. PATT in the years to come.

Now all I have to do is draw your attention for a moment to the question about the development of PATT in the years to come.

PATT-research is going through a certain development. Important aspects
of this will be mentioned by Falco de Klerk Wolters after my introduction. I shall only indicate the main points:

- **running PATT-research**, in which about 20 countries are participating at the moment. This research is relatively small-scale in nature. It requires for each participating country about 3 months of full-time work from a researcher with some experience;

- **the large-scale PATT-research**. Apart from the Netherlands this research is carried out in 2 or 3 other countries;

- **the developing and using of a PATT-instrument on the level of use by a teacher** in his or her own class.

The annual PATT-conferences, of which this is the third, rather quickly resulted in international technology conferences at which attention is given to PATT-research, but where more and more attention is paid to school technology in general: PATT- and related research, curriculum development, teacher training. We concentrated on school technology mainly for pupils of about 12 to 15 years old. At this conference there is a special theme devoted to elementary school technology.

At the moment the UNESCO is also playing a part in the development of these conferences. We think this is very important.

In our opinion there will most certainly be a need for international conferences on the development of school technology in the years to come. It is not necessary and perhaps not desirable either that they will still take place in Eindhoven, in the Netherlands. That is why we are thinking of having PATT-4 in Nairobi, Kenya -if possible in 1989- and PATT-5 in Budapest, Hungary -if possible in 1990-.

The PATT-research originated from the project Physics and Technology by Marc de Vries. He is willing to act as secretary/treasurer, and as such to form a nucleus of the preparation group. He also thinks he has the opportunity to continue the publication of Tech-Ed-News. This gives a possibility to communicate. As far as time is available Falco de Klerk Wolters is willing to play a part in this as well; the same applies to Rosy Coenen-van den Bergh. When I am called on for advice and support I am, in principle, also willing to give this. During the coming days we hope to have some time for a possible preparation of PATT-4 and PATT-5.
PATT-RESEARCH IN 1987/88

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Summary

It is the aim of PATT-research to investigate the concept that pupils have of technology and their attitude towards technology. After the second PATT-Conference the research went in three directions:

- **the traditional research**: research by means of the existing questionnaires: attitude and concept questionnaire;
- **small scale studies**: research by means of short questionnaires that can be processed by the teachers themselves and/or small scale qualitative research by means of essays and interviews;
- **large scale studies**: researches with representative samples.

In the introduction a short explanation is given of these three directions. The most important developments of the past year are discussed.
PATT-RESEARCH IN 1987-88

Introduction

Ladies and Gentlemen,

In my contribution to this afternoon I shall give a short survey of the PATT-research in the past year.

If we look at the theme of the conference, 'Basic Principles of School Technology', and then also at the programme, it might give you the impression that PATT-research is dying a natural death because the scale is turned from research in favour of curriculum. However, this is not true at all. I hope to be able to convince you of this today.

We do want to emphasize a more direct (and more solid) relation between PATT-research and Technology-curricula. In other words, apart from the research question 'what is the attitude of pupils towards technology' the PATT-researcher also ought to answer another research question, viz. 'in what way can we use the results and how have they been used so far?'.

In the past PATT-year several interesting developments have taken place. These will undoubtedly be discussed in detail during the conference. Here I would only like to touch lightly on these developments, particularly with the aim of giving the participants at the beginning of this conference a certain survey of the direction the PATT-research has taken.

Those of you who have read Tech-Ed-news in the past year know that PATT-research has gone in three directions:
- 'traditional PATT-research',
- 'small scale PATT-research',
- 'large scale PATT-research'.

I shall explain these three directions and indicate which contributions were given by researchers in the past year. I also do this in view of the programme for Friday.

However, first I would like to say something about the PATT-instruments and their theoretical basis.
Theoretical Basis PATT-Instruments

It is the objective of PATT to find out what attitude pupils have towards technology. As a basis for the measurements we use an attitude instrument and a concept instrument.

It appeared to me that the notion attitude causes a lot of confusion. Therefore an unambiguous definition at the beginning of the conference is not un-called for.

The simplest definition of an attitude (as regards the object technology) could be the following:

'A certain negative or positive feeling towards technology based on certain knowledge of and ideas about technology that may lead to a certain behaviour with reference to technology.'

An attitude consists of an affective component, a cognitive component and a behavioural component. In the PATT-research two of these three components are measured: the affective and the cognitive component. We know by now that there is a positive relation between the two. This is important information when we are talking about changes in attitude and curriculum development.

For the affective part of the attitude towards technology we use the six scales:
- INTEREST IN TECHNOLOGY,
- ROLE PATTERN IN TECHNOLOGY,
- CONSEQUENCES OF TECHNOLOGY,
- DIFFICULTY OF TECHNOLOGY,
- SCHOOL AND TECHNOLOGY,
- CAREER AND TECHNOLOGY.

Although these six scales are called the attitude instrument it only measures the affective component of the attitude towards technology.

To measure the cognitive part of the attitude towards technology we mainly used a concept instrument. A questionnaire based on characteristics of technology the way they have been defined by Marc de Vries:
- TECHNOLOGY AND SOCIETY,
Apart from with this written questionnaire, the cognitive part of the attitude towards technology, also called concept (image!) of technology, can also be measured with more qualitative methods like interviews and interpretations of essays and drawings.

Until now all these methods have been used in the PATT-research. So far the theoretical basis of PATT-research. I shall now discuss in greater detail last year's PATT-research.

**Traditional PATT-research**

With traditional PATT-research we mean research with the existing attitude and concept questionnaires that were discussed at PATT-2. At PATT-2 these attitude and concept questionnaires have been evaluated. It was decided to leave these instruments intact as far as possible, to retain the longitudinal aspect of PATT, this in spite of some fundamental difficulties.

In the past year too research has been done with these instruments in various countries.

In Eindhoven we processed the data from Finland and Kenya by means of SPSS. We hope that the results will be reported by Tapani Kananoja from Finland and Raphael Kapiyo and Frederic Otieno from Kenya.

In cooperation with Henryk Szydlowski, Aleksandra Grodzka-Borowska from Poland used the attitude scales among 400 pupils of 16/17 years old of Polish High Schools.

In Hungary, Portugal, Spain and Nigeria too people have been working with the instruments. Unfortunately we did not receive any information about the progress of these researches.

It may be noticed that the PATT-instruments are used regularly without the group in Eindhoven being notified of this. This happens even in the Netherlands. The fact that the instruments are used, even beyond the
PATT-circuit, is of course a favourable development. It shows that the instruments are considered to be useful. Yet it must not be forgotten that the instruments are more reliable for pupils in western countries than in eastern and developing countries.

An example of the use beyond PATT can be found in Australia, where in the framework of an official Ministry project research is done among students in Victoria (by Peter E. Clarkson). An entirely different application can be found in New Jersey (USA), where the questionnaire is used as an official assessment instrument for a new technology curriculum (John Hutchinson).

Small scale studies

New in the PATT-research are the small scale studies. What do we mean by this? By small scale studies we mean research by means of a condensed version of the PATT-questionnaires, the so-called Technology Attitude Scale or TAS. But also qualitative research by means of interviews or essays whereby the results can be processed without a computer are part of this type of research.

During PATT-3 we shall see two good examples from Poland of the last-mentioned aspect. First an extensive essay-study on the technology-concept of High School students, carried out by Danuta Oleniacz in cooperation with Szydlowski and Dudziak. Secondly a study by Grazyna Dudziak in which it was investigated by means of interviews what views teachers and pupils have on the school subject 'Work and Technology'.

The Technology Attitude Scale has been developed in Eindhoven. The TAS is a questionnaire that can be used by teachers in class to find out what the pupils' concept of and attitude towards technology is. A detailed account of this was given in Tech-Ed-News No. 2. The questionnaire consists of 26 attitude and 28 concept items. In the developing we started from data from Denmark, Finland, Kenya, Poland, France and the Netherlands.

The material that is offered to teachers consists of:
- a manual with a description of the instrument; instructions for
administration and processing and furthermore standard scores to compare the class' or groups' scores with,
- the questionnaires,
- answer models and score forms that quicken the scoring.

At the moment the TAS is being evaluated in the Netherlands. This is done in consultation with Willem Deijsselberg who, during inservice training for technology, makes teachers acquainted with the measuring of the attitude towards technology. We would like to know whether the TAS is indeed an easy scoring instrument that yields useful information for teachers. As yet the TAS has not been used abroad.

In a workshop on Monday evening we shall discuss the possibilities of the TAS for international use. With this aim in mind we translated the TAS into English.

**Large scale studies**

With large scale studies we mean researches that are more representative in nature. They are characterized by a broad design. Apart from the PATT-questionnaires additional scales and composed independent variables are used as well. Large scale studies are started or carried out in:
- Blacksburg, Virginia (USA) by Bill Dugger, Sharon Brusic and Marc de Vries,
- Bhopal (India) by J.S. Rajput, S.C. Pant and K.B. Subramaniam,
- Nairobi (Kenya) by Raphael Kapiyo,
- Ibadan (Nigeria) by Taju Balogun,
- Eindhoven (the Netherlands) by Jan Raat and Falco de Klerk Wolters.

It is our intention to pay attention to large scale studies on Friday evening.

Several plans are described in the coloured booklets you received this morning.

A month ago a large scale study was started in Virginia. At the moment Marc de Vries and Sharon Brusic are developing an instrument to measure the attitude towards technology of pupils of 13/14 years old. This research will be based on the PATT-instruments and -methodology. The
nice aspect of this research is that 'Technology Education' is taken along as an independent variable. Therefore the research started with the drawing up of an inventory of the contents of the technology-lessons. It is expected that the research will last for one year.

As part of a three-year state level study of pupils' attitudes towards technology of Madhya Pradesh Rajput carried out a study into the differences between more than 1100 boys and girls in towns and rural areas. It is striking that there are hardly any differences between boys and girls, and geographical location and/or social settings do not appear to lead to the expected differences either. In all layers of the population people have an extremely positive attitude towards technology, which Rajput relates to the difficult natural circumstances of India which urge people to adopt a certain positive attitude towards technology.

The results of this interesting study and also further plans for the large scale study in Madhya Pradesh will be discussed in a workshop.

We are also looking forward to the first results of a multi-stage research project at a national level in Nigeria. The research will be led from the University of Ibadan by prof. Taju Balogun.

In Kenya a research plan has been drawn up for a national attitude research. The research will be led by Raphael Kapiyo from the Appropriate Technology Centre of the Kenyatta University of Nairobi. If financial means are available this two-year project can start.

The attitude research in the Netherlands has reached a final stage. Three age groups are involved in this research. By now attitude measurements have been carried out among pupils of 13/14 and 16/17 years old. We are now preparing a measurement among pupils of 10-12 years old. Apart from questionnaires drawings and interviews are used as research instruments for this age group.

On Friday I shall report the recently concluded research among 16/17-year-olds.
Related research

It is a tradition at PATT-conferences to pay attention not only to PATT-research but also to related research. For this year there are three items on the programme.

1. Saar and Hendre from the Soviet Union report an extensive research into the attitude of 14 to 17-year-olds towards physics and technology.

2. The study by Jeff Moore into the relation between classroom activities of teachers of Computer Studies and the attitude of pupils towards computers, is relevant to Technology Research and therefore it was added to the theme related research. It appears to be possible to draw up an inventory of classroom processes by means of a simple checklist. From the results it becomes evident that there is no relation whatsoever between the activities of a teacher and the attitude of pupils towards computers.

3. A third item that will be given attention during PATT-3 is Singh's Creativity Test from India. It is a 29-item test that might be highly valuable in a PATT-design. On Friday evening a special workshop will be devoted to this theme.

Ladies and Gentlemen,

It will have become clear to you that in the past year again thousands and thousands of pupils all over the world responded to statements like 'With reference to technology I mostly think of machines' and 'I like to read technological magazines'.

A next step in the educational research process is to make a direct link between the results and the everyday practice in education. On Friday three keynote speakers (Bill Dugger from the USA, Henryk Szydlowski from Poland and Raphael Kapiyo from Kenya) will give a contribution to this issue from their own cultural background.
FRAMEWORKS FOR SCHOOL TECHNOLOGY
SCHOOL TECHNOLOGY IN CHINA'S RURAL AREA

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Summary

School technology in normal schools of China's rural area has some characteristics as follows:
1. It takes the major form of after-class activities. Pupils attend one or more amateur's groups such as planting, breeding, seedling, machine repairing, electrical appliance repairing and tailoring, etc., according to their hobby and strong point. They learn some useful skills and technical knowledge under the vivid direction of their teachers and instructors.
2. Closely linked with the problems of social economic development and the well-being of the local community, the activities of school technology are highly diversified.
3. Relying on the local community to make up for special teachers' shortage, the associations for science and technology at country level and the societies of special agrotechnique in the countryside play an important part in recommending agro-technicians and talent people as instructors of school technology. Besides, the Association of Youngsters Science Instructors has organized a variety of training courses, enabling the science instructors to up-grade their knowledge in technology.

The activities mentioned above have enabled pupils to remove the mystique of technology from their minds. They have realized the important role which technology plays in changing the present conditions of the rural area, become confident in promoting the development of their hometown through technology. A strong desire on the learning of technology has therefore emerged. After graduation, they will become the mainforce in the popularization of science and technology, bringing about a great advance in the local economic development. So, such activities are greatly welcomed by the pupil's parents and the local community.

This paper first gives a brief perspective to the status quo of primary and secondary education in China's rural area, and then introduces emphatically the characteristics, means, and effects of the school technology which mainly take the form of after-class technical activities.
SCHOOL TECHNOLOGY IN CHINA'S RURAL AREAS

1. Introduction
There are a billion people in China, 800 million of which live in the rural areas. This is an important fact that we have to face whenever we study anything, school technology is not an exception. The development of agriculture is the crux to raise the people's living standard. But in China, cultivated land is decreasing by 467 thousand hectare while the population is increasing by 10 million every year. To solve this problem, thousands of new peasants are needed who are well-educated and equipped with advanced technology. Through a lot of efforts, the general education has developed greatly in China's rural areas. In 1987, there are 744 thousand primary schools with 104.6 million pupils, and 68.3 thousand secondary schools with 30.6 million students in China's rural areas (below the county-level). However, about 30% of primary school graduates, 70% of junior high school graduates and 90% of senior high school graduates have not the opportunity to go on with their school education. They go back to their home villages to do farm work. If they are given technical education before graduation, which will help them form positive attitudes towards technology, and build their confidence in changing their hometown by technology, they will become a mighty force in popularization of science and technology. Their role in the development of China's rural areas cannot be overestimated. Therefore, school technology is of special importance to China's rural areas.

Unfortunately, the general education in China's rural areas was run in another way. In science and technology education, it laid particular stress on science courses such as mathematics, physics and chemistry, while neglecting the technical education and the contents which reflect local conditions and suit the local needs. The graduates who went back to their villages found it impossible to use the knowledge they had learned. On the other hand, the peasants did not appreciate this kind of graduates, either. The Chinese government pays great attention to this problem. In recent years, it has pointed out very clearly that the education in the rural areas must serve the local economic construction, and set up various agrotechnique or vocational schools. But because of the influence of the traditional ideas, and the restriction of syllabus, teachers' training and practice places, it takes a lot of effort to realize the target in the formal
education. So, after-class technical activities, as a supplement to, an extension and development of the classroom courses, become an effective means of the school technology in China's rural areas.

2. Aim of After-class Technical Activities in Rural Areas

After-class technical activities refer to various activities of technical interests conducted by the students with the guidance of their instructors and in their spare time. They mainly take the form of amateur's groups and involve such useful techniques as growing crops, breeding, fruit growing, vegetable growing, repairing machinery, electricians, gathering, sewing, etc. The aim of the technical activities mentioned above, is, through participating in activities by students themselves, to broaden their outlook, forster their interests in technology, to help them form positive attitudes towards technology, and to help them develop their abilities in learning and mastering advanced techniques.

To help the students of rural schools form positive attitudes towards technology is meant to let them realize:
1. The advancement of the technology is the most effective way to put an end to the backwardness of the countryside;
2. The applied techniques of the rural areas are no mystery, rural students can master them so long as they make the right choice and adopt the appropriate method;
3. It is necessary to take the local conditions into consideration in using and spreading an advanced technique.

There are several means for the school technology in rural schools. They are mainly natural science courses, technique courses, and after-class technological activities. The natural science courses not only lay a solid foundation for learning technical knowledge, but also provide information about new technology and the history of the development of technology. The emphasis of the technique courses is to improve students' attitude towards labour, as well as learning some skills. The difference between after-class technical activities and the two others mentioned above is that it provides the students with an opportunity to learn and practise applied techniques which the natural science courses cannot, its content has more variety than the classroom courses, so it is more initiative and creative; it pays more attention to fostering students' technical abilities which are one of the most important qualities that the constructors of a new countryside
should possess.

3. Practice of After-class Technical Activities

Although without a long history, after-class technical activities spread very fast in rural areas. It has already been launched successively with the support from the education authorities in almost all provinces, autonomous regions and municipalities of mainland China.

1. Forms.

They mainly take the form of "amateur's groups", which students could join according to their interests and abilities. The amateur's groups put the practice bases on their own little farms, feed lots, vegetable gardens, repair workshops, laboratories, and engaged in their activities in their spare time under the direction of their instructors. This form is easier to be accepted by the students because it is lively, flexible and elastic.

2. Emphasis is Mainly on the Applied Techniques of the Local Development but also on Introducing Other New Techniques.

Although the popularization of advanced techniques will broaden rural students' outlook and help them understand the importance of technology in a modern society, it is not enough. Students will really realize the positive role of technology after they are given some real examples.

China's rural areas are uneven in development, huge differences exist not only between the coastal and inland areas, but also between plain and mountain areas, between lake and forest areas, even within a province. So, to launch the after-class technical activities in the rural areas, it is important to keep the contents in line with local conditions, select the most proper applied techniques to be introduced to the students.

For instance, Tonjiang county is located in the mountain area of Sichuan Prov., the population of this county is 600 thousand. Every year, there are 5 thousand graduates from junior/senior high schools going back to their hometown to do farmwork. The education authority of this county organized many after-class amateur's groups in the field of forestry, fruit growing, breeding, producing and processing of edible funguses, electrician, electric appliances repairing, photography, etc., according to the needs of local economic development and the different conditions of each school. The total number of students who attend the "groups" are more than 12,300. The
groups of seedling not only learned the technique of gathering tree seeds, seedling, and transplanting, but also raised about 80 thousand seedlings, which were provided to the local community and their schools. After graduation, many of the members of the seedling groups became special households of the forestry. Edible funguses are specialities of this county, the members of amateur's groups of this field mastered the whole technique from inoculating, culturing to processing under the direction of their instructors. They became the backbone of local edible funguses production after graduation, some of them were appointed counsellors. Because the amateur's groups select their objects in the practical production, the new techniques which students learned in the group could quickly be applied in the farm work of their families and produce effective results, so the activities are welcomed by the parents and local communities. On the other hand, students receive concrete technical education in the processing of learning and spreading new techniques when they have seen for themselves how badly the local communities are in need of new applied techniques and what development the techniques improve the agroculture construction of their hometown.

3. Relying on the Local Community to Make up for Special Teachers' Shortage and Set up Practice Bases.

Since the contents of after-class technical activities are closely linked with the local development, the activities get the support from local community as soon as they begin. Associations for science and technology and various societies play an important part in making up for special teachers' shortage. They not only have organized a variety of training courses enabling the science instructors to upgrade their knowledge in technology, but also recommended agrotechnicians and talent farmers as part-time instructors of school technology. Schools which have not practice bases of their own put their practice bases in research institutes, productive enterprises, or farms where the masters are appointed as part-time instructors.

As an example, Tianfu Middle School in Wunjiang County, Sichuan Prov., has appointed senior lecturers from agro-technical colleges, technicians from county's Animal Husbandry Bureau, and specialized peasants as part-time instructors since 1985. Together with the instructors in the school, they lead the students to launch technical activities in many fields. Students
learned how to measure pig's temperature in the feed lots of pig-raising specialized households, and learned how to recognize insect pests in the fields. They were eager to join in, and enjoyed the activities very much.

4. Social Effect of After-class Technical Activities
They have brought great social effects and are reflected in 3 aspects:

1. Nurturing large number of primary technicians for rural areas.
The structure of education in China's rural areas is not proportional. In 1987, there are totally 1.19 million students studying in the vocational schools below the level of county. Among them, only 618 thousand students study the subjects of agriculture and forestry in senior-high vocational schools. That means, that among 30 million rural high school students, only 4% of them have the opportunity to receive vocational education. So, normal primary and secondary schools have to carry on the major task of training a great number of primary technicians that rural areas urgently need.

Most of the students who attended after-class technical activities in the schools have a positive attitude towards technology, have the desire and the confidence to reform the present by technology. They have been trained in certain basic technology, their ability of learning and mastering new techniques has been improved. After the exercises of practice work, they will become the key members of rural construction in various fields.

Changle Middle School is located in the poor hilly country of Miluo County, Hunan Prov.. It began to carry out after-class technical activities in 1980. Since then, it has sent many talented students to higher-level schools (universities), and trained a great deal of qualified new farmers as well. Fu Ming was a member of the Biology Amateur's Group. After graduating from junior-high in 1982, he achieved many successes in feeding chickens and rabbits, planting fruit trees, doing experiments in rice-seedling, studying the method to prevent and treat cotton diseases and insect pests. The villagers called him "scientist" to express their appreciation. Another graduate Wang Ping was a member of Electronics Amateur's Group when he was a student in this school. Now he is running a small repair shop of electrical appliances in the little town, which provides service to the local people and brings him a fortune to develop.
2. Spreading Advanced Techniques to Rural Areas.

Schools are where knowledge is most concentrated in rural areas. Through the development of various after-class technical activities, they are now not only the centers of culture and knowledge in the rural areas, but also becoming centers of techniques. Students get the opportunity to learn many new techniques which are quite different with the traditional farming. Then, they bring new techniques to their homes. Farming Technology Group of Xinggezhuang Central Primary School of Baodi County, Tainjing Municipality, has already established contact with many agriculture research institutes and agriculture colleges, where they learned advanced techniques and introduced new varieties of vegetables and crops. The Group planted the new varieties in their own experiment garden. The villagers were convinced by the advantage of new techniques, and asked the Group for seeds and advanced agrotechniques.

3. Changes in Students' Attitudes.

A. Attitude towards Technology

The environment around the rural students makes them feel the mystique of technology. After-class technical activities broaden their outlook, and their understanding of certain applied techniques is clearer than ever before, which helps clear away the mystery about technology. They have to use science principles which they learned in the classroom to solve or explain the technical problems they met during the activities. This helps them understand better the relationship between science and technology. On the other hand, after attending a whole process of spreading an advanced technique they have realized that only by fitting the local conditions could the introduced techniques produce fruitful results. The members of Bio-technique Amateurs' Group of Huai Yang Middle School, Henan Prov., got very much interested in the techniques of wheat breeding. Many of them who are now studying in universities have selected bio-technique as their career.

B. Attitude towards Countryside

In the past, many students thought that the rural area is too undeveloped to develop it. In the after-class activities, they were convinced by the great power that technique has. Even a very simple applied technique which they learned in the amateurs' groups could bring profit or convenience to
their families or neighbours. Many families have already become well-off as a result. The facts help them see the bright future of the countryside, and the means towards such a future.

C. Attitudes towards their own Future

Is it possible for educated young people to display their abilities or talents in the rural areas? In many places where after-class technical activities are in practice, students are often praised by their parents and local people after they have solved some actual problems in their production or everyday life. These positive feedbacks satisfy the students' sense of self-respect and honour. They gradually realize that the new peasants who have the knowledge of modern science, technology, and culture are desired in the countryside, and their talents can be brought to full play there.

Though after-class technical activities have been carried out in many rural primary and secondary schools as one of the means of school technology, there are still some problems that have to be studied and resolved, such as the scale of popularization of this activity is not vast enough, many schools have not started them; how to link after-class technical activities with vocational education and continuous education for adults, etc. Nevertheless, since the direction of their development is the same as the trend of education reform, their content is in keeping with the desire of society especially the rural areas, following the popularization of science and technology in China and development of school technology in the world, after-class technical activities are bound to be prospered in the primary and secondary schools of China's rural areas.

References


* Articles mentioned above are all in Chinese.
Summary

Technology is one of the formative components that were from 1970 onwards gradually introduced as a generally formative subject. The target population consists of boys and girls of 11-13 years old (first 2 years of secondary education). At the moment we have 17 years of experience. Up to the present Technological Education is a compulsory subject for approximately 85% of this Belgian age group. Technological Education includes 3 aspects: insight, psychomotorism and human consequences, which are regarded as a unity in this teaching of real life. For this purpose a process for problem-solving activities was set up, in which 5 stages are distinguished: need-problem, brainstorming around possible solutions and a selection of the best solution, realization with its organizational and purely manual aspects, an enquiry when the solution is put to use, and finally a broad evaluation.

After some years objectives, the ones exceeding the subject and specific ones, methodical suggestions and conditions were described in detail in a vademecum in which the view of the subject was clearly put down as well.

In our Technology Education we evolved from a frame-curriculum (1970-1975) to a thematic more or less open curriculum (1975-1988) and now we set up a rather closed thematic curriculum that will probably be introduced in September 1988 in all Catholic schools in Flanders. This, however, is allied to a reduction of the hours: in the first year from 3 to 2 hours, in the second year the 2 hours are retained.

Several of the 7 themes will be retained, be it that they will be adjusted as regards objectives and contents. These themes are: Communication (1), Energy (1 + 2), Living (2), and in both years Information Technology. There is an option to choose other themes, such as industry, food, textile and bioengineering for 2 to 4 hours a week.

Difficulties that were experienced from the introduction of Technological Education up to the present were mainly in the organizational and didactic-pedagogical field.
EVOLUTION AND EVALUATION OF TECHNOLOGICAL EDUCATION AS A GENERALLY FORMATIVE SUBJECT
- Catholic Education
- Dutch language area (Flanders) of Belgium

General view

Introduction
As a component of present-day culture technology has started to dominate daily life to a great extent. Technology creates new means of existence, it creates culture. In the Vademecum 4 "T.O." (=Technological Education, 1978) we describe it as follows: "culture originates and 'takes place' in the relations focused on humanization between people and the human being and nature".

What is important in the analysis of our present-day culture is the indicating of several components without wanting to acknowledge a hierarchy in it. These components (ethical-religious, exact-scientific, social-scientific, musical, verbal-literary and technical-technological ones) all found their formative aim and package in the education for all, except for the technical-technological component.

In 1970 the renewal in Belgian Secondary Education started and it was going to change all this.

The most important objectives of the renewal were the postponing of the choice of a particular study, until the age of 14, a gradual choice of study with the possibility of options, and the breaking of the social barriers by offering not only think- but also do-activities to all pupils. It would be obligatory for all 12 to 14-year-olds to take 2 hours of Latin for one year and Technology Education for two years.

This renewal gradually started in a limited number of schools and two years ago it had grown to comprise about 85% of all Belgian schools and about 50% of the Catholic schools in Flanders.

Technological education in the renewed secondary education
So far Technology has been a theoretical subject about the history of commodities and materials or the subject was approached from a technical point of view, which means practical work while the correct techniques are drilled in.
This outlook had to be widened: not only the head, not only the hand, but also the heart is involved: insight, psycho-motorism and human consequences, 3 aspects of each technological activity of the human being. Then Technology is a subject in which one starts forming until a critical-creative integration in the technological aspects of our dynamic society and culture is realized.

Aspects of the technological activities
First an explanation of the technological activities of human beings:
- the insight in scientific regularities is only related to their organization, manipulation and instrumentalization for the benefit of the human aims. This insight may be intuitive but it is more likely that it is scientific. Besides, it must be dynamic and creative,
- the psychomotor activity has a broader meaning than manual dexterity or craft. The 'intervention' results in organizing, manipulating, instrumentalizing. It has to be extremely flexible and creative,
- the technological realizations have often surpassed man's expectations. some examples: disruption of a biological balance; ugly and inhuman residential quarters; arms race...,
An ethical and aesthetical interrogation is pressing on during the solving of each technological problem.

Technological process
The diagram below is meant to clarify our view of the origination of a new technological structure (see diagram next page).
It is not necessary in the discussion of a technological subject or theme, to discuss the same stages each time in the same sequence.
One could equally well start from the analysis of an existing technical structure (stage 3). The evaluation will be partial and permanent, and in the end it will be global.
And yet - my first personal input - this technological process is not elaborated so well at all as that of our American friends.
Our stage 2, brainstorming is also insufficiently elaborated.

Why psychomotor activity?
In many circles people do want to give the insight into and the aesthetical approach to technological structures but they are scrupulous as regards
psychomotorism. This will then lead to, or run off to, a kind of "verbal" technology.

In our Vademecum 4 we quote arguments from various points of view to defend psychomotorism:
- main argument: in technology the capacity to think-in-action is developed, the break between theory and practice is mended,
- social argument: gaining working experience "together",
- psychological argument: at the age of 10 to 15 the "thinking-in-action" is more natural than the abstract thinking and it will stimulate the aptitude to act,
- pedagogical argument: forming the entire human being and relate the forming to the entire reality,
- cultural-philosophical argument: man may not be alienated from his own cultural expressions, whether material or immaterial, so neither from his own technological realizations.

Why a subject?
As long as the professional expertise model is at the base of our system of education the offered formation will be split up into strictly separated subjects, each with its own hours, its own teacher training institutes and appointments of teachers, its own didactically equipped classrooms. This is imposed for all formative components, also for the technical-technological formative component, the only, by the way, for which this was not yet the case. Technological Education may not remain a rejected instrument in an orchestra that is already put together.

Prof. C. de Keyzer from Louvain University, one of the oldest universities in Europe (1425), in his introduction to the Vademecum 4 anticipated resistance to the point of view and the subject Technological Education from the side of technologists who are experts in the subject, and from natural scientists, one group because they keep thinking too strictly in their subject-field, and the other group because they have the illusion that technology is "only" an application of natural sciences. This last aspect he calls the most dangerous resistance because it is based on a 3-fold logical error.
"First of all people assume that the turn from retrospective to prospective thinking is so simple that it will just happen of itself (whereas they prove
the persistency of one-sided attitudes by their own attitude). Secondly people think that mere science is more noble than technological and "befouling" thinking, not knowing that they are suffering from the historical illusion of the hierarchical distinction between theory and practice. Thirdly people think that the relationship between science, technique and technology is still the same as it was in the 18th century. At the moment science is as much applied technology as the other way round."

**Objectives**

Supra-subject objectives were formulated, divided into Objectives referring to skills (a.o. gathering, processing of information), attitudes (a.o. ability to act in a problem-solving way, to analyze), preparation for later life and profession (a.o. insight into the relation between education and society). The general objectives touch on the 3 aspects of technological acting. More concrete objectives for the subject were also divided into insight (a.o. into the technological process), skills (a.o. drawing up and carrying out strategies for action according to the stages of the technological process) and attitudes and values (a.o. advertising, critical questioning of over-consumption).

**Method and conditions**

The teacher will have to take into account the pupil's entering situation. Within a group of pupils the socio-cultural origin may be very different and this may determine the entering attitude toward the technical-technological component. One is urged to use an active teaching method and a "do-approach". For this purpose one will start from concrete assignments. It is a condition for the improving of the technological formation that the entire (school) community has a positive disposition towards this new subject. Teaching time will have to be provided, and sufficient didactic materials will have to be present and the teachers will have to be proficient for teaching this new subject. A classroom for the subject will have to allow polyvalent work: a think-and do-corner for "light" work, a corner with work-tables and, for example, bench-vides, a media-corner, a corner for self-control and, if desired, for
self-reporting, notice-boards, sufficient electricity, gas and water supplies, tool boards, sufficient storage room for didactic material and pupils' work, good lighting, airing possibility, heating, sound isolation.

Teachers of Technological Education have a specific expertise in their subject but they will also have to take inservice training in other technical fields. They must be able to offer their pupils assignments in which extremely varied techniques play a part. They will have to master the necessary insights themselves and organize the pupils' activities so that pupils can work efficiently and effectively.

So on the one hand there is the problem of an adjusted training for teachers-to-be, and an inservice training and guiding for teachers who are already employed. After all, this subject requires an all-round mastering of technical domains and a high flexibility.

On the other hand the contents will have to be chosen so that the pupils will be confronted with technologies based on various sciences and originating from various sectors of the socio-economic life and from the various professions. Besides, the contents will have to be discussed in a process-based way.

**Evolution of hours and contents or domains of learning**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1st year (12-13)</td>
<td>2 hours</td>
<td>3 hours</td>
<td>2 hours</td>
</tr>
<tr>
<td>2nd year (13-14)</td>
<td>1 hour</td>
<td>2 hours</td>
<td>2 hours</td>
</tr>
</tbody>
</table>

**a. Provisional curriculum**

In the initial stage of the renewal that was followed by about 10% of the schools in Catholic Flemish Education, the curriculum consisted of 5 typed pages with several objectives, didactic guidelines and the enumeration of a number of categories of objects that could be chosen.

"Technology" consisted of a technical analysis based upon a tripartite dialogue with the object: - what is your purpose, - how were you made, -
what were you made of?
Principles and materials were studied.
Some examples were: corkscrew, pendulum, inflator, thermometer-bottle, tap.
Constructions were made by means of Fischer construction kits.
The concept Technology - inspired by the ideas of Ives Deforge (France) was here still rather narrow: analyzing do-activities (disassembling, assembling experimental research) in a scientific setting.

b. Curriculum framework
From an evaluation and numerous discussions a vision originated that was put down in the Vademecum 4 (1978) and the following curriculum. Themes were at the centre of this curriculum. It was a curriculum framework (1981) the filling of which was, for the greater part, at the teacher's responsibility.
In this "open" curriculum the contents of learning were divided into 7 themes: Communication, Energy, Textile, Food, Living, Buying and Selling, and Care.
An account was given of each of these themes, together with objectives and possible contents. For each theme one preparation of a lesson was written out in full. The teacher of Technological Education was supposed to divide the 7 themes over the 2 years on his/her own initiative. Technological Education - a subject obligatory for all - was still described as a test-activity in which the think- and do-process was emphasized. The "process" evaluation in the course of learning was the central issue. The ethical component had to be discussed more explicitly.
In the curriculum a guideline was provided for the designing and elaborating of a "rank plan". This consists of a diagram for filling in, in which all themes, aspects, types of science, fields of profession, basic skills and techniques, and - extra - some points of attention came up.

c. Renewed curriculum
At the moment we are facing a new revision of the curriculum for Technological Education.
Not everyone did fully understand the assignment and the challenge to work with the thematically relatively open curriculum.
In the new curriculum that will be introduced in September 1988 the teacher will be given less freedom and more explicit guidance.
The number of themes is reduced from 7 to 3 and time is provided for an additional subject that will be optional for the time being, namely Information Technology.

So, new in this curriculum are:
- the themes the teachers are obliged to discuss,
- the indication of the year in which the themes have to be discussed,
- the maximum time that may be devoted to this,
- the content that is laid down for each theme,
- the entire technological process that is emphasized. For each stage of the learning process assignments have to be carried out,
- the 3 aspects insight, psychomotion and human objectives are explicitly elucidated in each lesson (in each lesson thinking and acting should take place in an integrated way),
- since at that age one is dependent on a simple structure for the realization, a more complicated structure will be analyzed in each theme,
- the realization stage in the technological process is written out in 5 steps:
  - analysis of the assignment,
  - determining of the means with which the assignment can be carried out,
  - carrying out the assignment according to a self-made plan and working method,
  - drawing up and applying a suitable test method,
  - judging a product on its qualitative finish.

Survey of the contents of the new curriculum

<table>
<thead>
<tr>
<th>Year</th>
<th>Themes</th>
<th>Hours (†)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Communication</td>
<td>20 hours</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>20 hours</td>
</tr>
<tr>
<td></td>
<td>Information Technology</td>
<td>20 hours</td>
</tr>
<tr>
<td>2nd</td>
<td>Living</td>
<td>20 hours</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>20 hours</td>
</tr>
<tr>
<td></td>
<td>Information Technology</td>
<td>20 hours</td>
</tr>
</tbody>
</table>

A-modules and B-modules

The aforementioned themes belong to the A-module.
The A-module is obligatory for all pupils in that age-group and falls within
general formation.
Apart from the A-module - 2 hours a week - the school direction may provide an additional number of hours for the subject Technological Education. This may vary between 1 and 4 extra hours.

If one opts for only one more hour the provided themes will remain those of the A-module and they will be discussed in greater detail.
However, if one opts for 2 to 4 more hours one makes a selection from the curriculum for the B-modules.
These are: bioengineering, trade, industry, textile - clothes, food.
If we want to characterize and distinguish the two modules the result is as follows:
A-module: the technical activities are a means for technological thinking-habits and the building-up of strategies for action,
B-module: the technical activity is supported by insights and critical questioning, but the central point is carrying out an assignment in a systematic, logical way.
The introduction of a B-mode should be carried out as follows:
for 2 hours a week: selecting one module from the 5 provided modules,
for 4 hours a week: selecting two modules from the 5 provided modules.

Integration of A-modules and B-modules
This may be done for certain parts of the subject matter for tuition. It is desirable that it is taught by one teacher. It is possible to keep the A-module and the B-module side by side or to work with complete integration. This last method has some advantages:
- shorter period of time which will enable the pupils to experience one particular theme more as a coherent whole,
- better execution of tasks and interest on the part of the pupils,
- less danger of a form of disguised vocational training or a systematic theoretical course (e.g. trade).

Filling of the A-modules as regards contents
- Communication: 1st year: - process and elements
  - senses and sensors
  - signals, symbols, codes, language
  - forms and means
- storage of information
- technical structure, e.g. telephone
- working in a process-based way towards execution
- drawing
- information leaflet
- values and norms

- Energy: 1st year: - electricity and the own living environment
  - electrical conversions
  - basic principles: cycle, conduction, circuits, symbolism, diagrams, polarity
  - study of elements: switches, flexes, plugs, lamps and luminaires, sources
  - materials, price, durability, aesthetics
  - problems: short-circuiting, bad contact
  - realizations by means of electricity or analysis of an existing cycle in an object

2nd year: - sources - forms - carriers
- application in a home, in industry
- conversions - profit
- savings - utilization
- usefulness and transport
- production
- environmental problems
- construction or analysis of equipment
- lighting of a house
- electric voltages
- manual - control manual
- safety - environment

- Living: 2nd year: - function and concept of a house
  - evolution
  - culture - climate - relief - building materials
  - living and designing problems
  - legal norms for building
  - human factors
  - orientation and planning of a house
  - reading and drawing of plans
Why Information Technology?
We can describe this in 4 points:
- acquaintance with the building-blocks of information equipment
- making conscious of the many possibilities offered by information technology
- demystification
- stimulating and practising the problem-solving way of thinking.

In the experimental stage the schools are for the time being more or less obliged to follow the manual that was drawn up centrally by a working group in Brussels.
It is characterized by the study of one well-defined module-set, viz. an experimental scientific approach to the elements in the module. Only for
the applications the ever returning technological thinking is involved. Diagnostic and summative tests are provided too.
The teachers take inservice training courses and they are obliged to return the completed evaluation form to the working group in Brussels after they have worked with their pupils.
On the basis of this proposals for adjustment as regards content, order, framework of assignments, formulations etc. will be studied and carried out.

Evaluation

Outline of the general situation

Although the ratio of the renewed school (Type I) and the categorial schools (Type II) in Flemish Catholic Education was 50-50, the opposition to renewal was growing more and more. Never before did directions, teachers and parents' committees of Type II use so many empty words and slogans to topple the renewal. The press eagerly used the discord in once so powerful, unanimous Catholic Education to the disadvantage of the renewal. After all, a "unity-structure" within Catholic Belgian Education was being prepared for some years.

"Multilateral schools" wanted to keep their status symbol, elitist formation, at all costs, and avert the technical-technological formation from their education.
The "technical schools" wanted a thorough professional education: drills in manual skills. Elitist school boards, supported by P.M.S. counsellors (psycho-medical social centres, attached to each school) reduced the renewed education gradually but certainly to second-chance education: a last resort for the unfortunate child with its miserable school record.
However, renewed education was not only a structural renewal. Also in the didactic-pedagogical field pioneer-work was done. Teachers at these schools did not go on relying on their own training. By means of provisions for education and a flexible formation of attitude and motivation many pupils were lead to achievements that used to be "beyond their abilities". The entire conflict did bring with it shifts in the pupil population to the benefit of the "multilateral schools".
The economic savings eroded bit by bit the essential pedagogical advantages of the renewed system of education. This did not only demand extra energy of the teachers (not in school hours, not paid for: form councils,
pedagogical meetings, professional meetings, office work, postponed lessons), but it was also at the expense of the teachers' jobs. Quite a lot of colleagues have to commute as 'migrant workers' for some hours to categorial schools where they and their child-friendly methods are not always received with open arms.

If they went to the so-called élitist schools they would only too often come across textbooks from the 60s, equally dated teaching methods and objectives that are now rendered out of date: quantity at school, digesting at home or with a private teacher, or else dropping out = going down one form.

It should be noted by the way that pupils from the renewed system score equally well at university level as pupils from the categorial schools.

**Difficulties with Technological Education**

In the course of the renewal the fact that Technological Education is an obligatory subject for all pupils is a thorn in the eye of many people and it is one of the grateful targets for questioning the entire renewal in a negative critical way.

This criticism was partly justified. There is often a distance between theory and practice, this occurs even with the 'established' subjects.

The difficulties were situated round:
- inservice and initial teacher training
- didactic material and infrastructure
- objectives and contents

**The problem of qualifications and qualified teachers**

For this subject there was no specific teacher training. Every teacher with a technical training could give the subject Technological Education. From 1978-1980 there was teacher training as well as the 7 themes. From their specific training teachers would exchange inservice training by mutual contact within one region or later on within their own multilateral school. There were regular meetings on a voluntary basis, on the one hand because of the great need, on the other hand because of the enthusiasm for this interesting subject.

There was an abundance of points on the programme: practical-technical inservice training, purchase of and working with the essential didactic material, designing lessons and tests, discussing working methods and results,
drawing up objectives, discussing possible reports, attending colleagues' lessons. Report of each meeting were sent to Brussels and we were regularly convened for general (evaluation) meetings chaired by an educationalist or a specialist in the subject.

After some time inservice training courses were set up in various places by various didactic centres. Members of the curriculum committee and/or authors of course books cooperated in this.

At many schools the directors thought it would be a good thing for many teachers to take a few hours of Technological Education. They forgot, however, that a new subject requires an extremely large amount of energy and time and that most of the time teachers with the same training for their subject were day-dreaming until they and their problems were taken care of elsewhere in a wider circle.

In 1980 inspectorates were appointed for each diocese and the inservice trainings were structured "from the top". Teachers of Technological Education were assigned to other working groups and at first this official initiative killed a lot of voluntary work and freedom to move.

And yet the task of the inspectorate must be very frustrating. The difficulties below will explain this. Whereas Technological Education was at first taught by teachers with a technical training, it was changed to a subject that could be taught by anyone who was a qualified teacher, for example teachers of mathematics-sciences. But that was not the end of it. In the last few years the economic cut-backs caused a lot of shifts and surprises and the subject Technological Education evolved from an engaged subject to a filler subject. This resulted in a continually changing group of teachers of Technological Education and the teachers came from all lands of disciplines. A systematic inservice training was an almost hopeless task.

About 1980 at certain teacher training institutes a number of hours fell vacant to Technological Education. This would give the teacher-to-be the qualification to teach this subject. A good initiative that is of little or no practical use: it is extremely difficult for the young teacher to find a job and with the regulation that any qualified teacher can teach Technological Education there will seldom be hours of Technology Education vacant for young teachers.

Recapitulating

Inservice training was: - on a voluntary basis,
- sporadic or regularly,
- in organized or accidental groups,
- with or without guidance from inspectorates,
- with the moral support of the central board of directors.

The greatest hindrance was the continually changing group of teachers.

2. Didactic equipment

The specific aspects of the subject Technological Education required a suitable classroom for the subject and an investment for didactic material, but at many schools the budget was not sufficient, if there was a budget for Technological Education to start with!

(1) A separate budget for each subject may be a noble aspiration but sometimes it was like a white crow. The uncertainty as regards contents, adjustments and changes even facilitated this look of planning.

(2) Furthermore, Technological Education was still a technical-practical subject with a negative hereditary charge for many people.

(3) We should not forget that Technological Education - generally formative subject for all - was launched in a time that science-classrooms and language laboratories had to rub up the image of the school in Belgium. Thus little or no money was left for other subject-related classrooms. Sometimes it occurred that teachers had to finance the essential didactic material themselves. More often it occurred that discarded and far-off classrooms were refurnished, which did not always imply a negative appreciation. Here and there basements were freed from water and mould. There were rooms that were insufficiently equipped but there were also wonderfully equipped classrooms which matched the description in the curriculum completely, in which one could work focussing entirely on the objectives and the pupils. Now, with the introduction of Information Technology many schools are again facing a considerable financial expense.

"How" one was going to provide the classroom for the subject with the necessary didactic equipment related to one's view of the formation of attitudes that can be passed on optimally in this subject: the teacher who drills or prompts or the counsellor who has his pupils searching and working.

The course of minimal or inadequate didactic equipment may be found
in:
- lack of vision on the subject,
- insufficient appreciation,
- insufficient financial means,
- uncertainty about the evolution of the subject,
- regular changing of teachers and chosen contents within one theme.
This last factor is largely eliminated by the new curriculum.

3. Objectives and contents
Only if one has a clear vision of the subject one can convert it to objectives, and in function of these one can determine the contents that are most representative of the objectives. This implied more than a change of mentality:
- correct conceptions of and distinction between Technological Education - technology - applied sciences,
- distinction between general formation and training for a specific subject,
- expanding and exceeding one's own expertise in the subject,
- realizing the importance of process-based working as opposed to being focused on a product,
- getting familiar with other working methods.
Means for this were:
- studying pedagogical, didactical works such as the Vademecum 4 for Technological Education and the curriculum,
- enter into the confrontation with colleagues from other training institutes.
Difficulties were, among others:
- lack of time and energy,
- sometimes not knowing or knowing too late where to go,
- in certain cases it could happen that a teacher in his/her assignment for a new year read that she/he was supposed to give some hours of Technological Education,
- defective equipment,
- a not so good course book,
- negative mentality of the environment,
Solutions

Obvious is:

- good counselling on behalf of the authorities
directions: moral counselling,
inspectørates: didactic, pedagogic counselling,
didactic centres: technical counselling,
pedagogic centres: coordinating counselling,
- an entire network of clearly organized organs to which a teacher or a
group of teachers can at all times apply for help,
- efficient worked-out programmes for inservice training that can no longer
give the impression of:
  - the counsellors that have to work (put in hours) so they organize,
  - the teachers that have to form the public for the counsellors.

Policy

For many years Brussels thoroughly controlled the supervision of the renewal
and the intervening and helping wherever necessary.
A whole group of extremely dynamic counsellors were working on the basis
of an idealism and an enthusiasm that was heartwarming.
But when the time came of concessions to the principles and of
dispensations for all kinds of jobs, of people who preferred to build their
own career instead of making a radical effort, of people who were
manipulated, the devotion of some people diluted and the faith and
certainty of the group of teachers in their counsellors and Brussels
decreased. The soul was locked up and in the outside world there was not
a week in which a newspaper did not publish a scorching or demolishing
article on the renewed system of education. Only by a continuous fight one
was able to keep one's head above water.
A lot of enthusiasm and effort remained but it was just like in the days
of the catacombs: the good things did not see the light of the press.
A likely mistake is the fact that the renewers did not rush to the
typewriters often enough and particularly that Brussels changed its clear
attitude in favour of renewal to indistinct and ambiguous attitudes that
even made the confusion grow. It is a positive aspect that after years of
confrontation and discussions on a high level a consensus was reached: a
unity structure that has to start in September 1988 in all Catholic
secondary schools in Flanders.
Both types of schools -categorial and renewed- will have to make concessions as regards structure and curriculum contents. But what cannot be taken away from us if the spirit of renewal that crosses the boundary of structure.

Because of this openness the adjustment of our teachers will no doubt be much more smoothly. We are not afraid to work and to change either. We do not need to feel ashamed and "unsuccessful". After all, in Belgium in the 20th century no renewal in education lasted as long as the one of 1970.

Conclusion
The outline of the problems and difficulties we are facing in the professional and organizational field proves once more the essence of
- sufficient funds for education, who invests in education invests in the future of his/her country,
- efficient use of energy.  
  Too often teachers are called together for meetings on inservice training for things they can do independently at home. It is more useful at meetings to compare acquired knowledge and experience with that of colleagues,
- broadening of the horizon.
  Creating possibilities so that teachers of Technological Education are acquainted with the view of the subject in other countries.
  Obviously such confrontations ought to be supported and organized on policy level.
Summary

The nature of a new school subject is determined by different factors. One natural frame of reference are the traditions of the school and the society. In countries, where general education is more theoretical, cognitive, it would not be so easy to guarantee the decision makers the importance of a new, practical aspect of education.

Teacher training is often connected with research. Through it there are possibilities to make sure, that the new kind of education is finding the right track.

An analysis made about the propositions or realisations for Technology Education by 12 countries or international organisations reveals, that the origin is most often the practical activities, crafts, in school.

Technical Work Education in Finland is interpreted as a many-faceted subject area with connections with both theory and practice. Activity approach and problem solving method are emphasized.

The contents of Technology Education should be relevant to the Technology of the country. However, the whole of the History of Culture should be the reference area.

Technological education should be technologically many-sided and educationally balanced.
TECHNICAL WORK AS AN ACADEMIC DISCIPLINE IN FINLAND

Connected with my paper from 1987 I would shortly describe the situation in Technical Work research as it is in Finland today. The following is an abridged and modified version of a bigger research "Work, Skill and Technology: Activity Education and Education to Work in General Education" (Kananoja 1988).

As in many countries there are some problems in conducting research in elementary technology education. It has not been a popular or easy object for research.

The subject area may have been experienced to be too large. As such it is difficult especially for an outside researcher to find out the essential starting points or relevance.

The qualifications required for a researcher are not the same as qualifications required to be a practical teacher who, however, might be the expert to know the idea of the many-facetted subject.

The tradition of the subject in most countries is very short compared to e.g. science, mathematics, and languages education.

Education to work has often been connected to education of the working class of the society. As such it has not been experienced as important as the academic subjects.

There is no covering research in Finland about a School subject named Technical Work Education so far. Recently some efforts have been made.

Teacher Training Institutes work on academic level. According to the Teacher Training System the R&D of the subject is supposed to be made at the TTI's.

Every newly educated Technical Work Teacher has the grade of Master of Education. So the natural bi-product of that has been to concentrate more or less on Educational Science when researching
the subject.

Common for the approaches has been:
- The researcher has been training the teachers for the old-fashioned Technical Crafts, woodwork and so on as a general educator, and is not aware of the idea of the broad and modern Technology Education.
- The researcher is trying to find out the paradigmas from too far and/or one-sidedly.
- When using the philosophical approach the Philosophy of Technology has, however, not been used.
- The researcher tries to apply his/her special general education interest area to Technical work.

One-sided and narrow aspect is the natural starting point in research, when the subject area to be researched is already mapped out and when the preliminary research is made. That supposes naturally, that the approach is sound and relevant.

When the object area of research is not yet clearly defined or is going through preliminary discussions, the research approach should be broad, mapping the general boundaries. On the other hand there is the need to be pragmatic.

The ideal team for research should consist of general educator, Technology Education specialist and the possible representants of special areas, Statistics, Philosophy of Technology, Sociology, Psychology and so on.

In Finland there is a need for the preliminary mapping out. In the piece of research this report is referring to an effort was made.

**About the Past and Present of Education to Work in Finland**

**Technical Work (Technology) Education** in Finland is developed through several stages.

**The Finnish Craft Education** was begun during the time when the industrial development was beginning in the country.
According to Uno Cygnaeus (1810-1888) the People was to be educated "through work for work".

Cygnaeus made his program on the tradition of work education from the Middle of Europe, the most famous representatives of which were Francke, Pestalozzi, Georgens and Rousseau.

Finland was the first country in Europe (1866) where Craft Education was made a compulsory subject in general education (Kaiser 1974; Wilkening a. 1970).

The main idea of Mr. Cygnaeus had been to support general education but it led as well to the effective industrial development of the country.

At the time of the Finnish Comprehensive School Reform (1970) there was an effort to replace the old boys' and girls' craft with a Nordic idea of a new subject called "Forming". It is art-based and integrates the areas of both boys' and girls' crafts (needlework) and art.

This new subject area was experimented in Finland (Kananoja 1975; 1980) and it was found out to be only a way to enrich the approaches of practical subjects' teaching. The idea of total integration of the three subjects was avoided.

The curriculum of the subject was then directed with the national teachers' guide booklets (1976-1979) more and more to the world of work (Kolehmainen 1979). So the development of the Finnish Technical Work education was separated from that of the Nordic type.

The new direction can be called the all-European idea of education to work.

Craft Education as a discipline in Finland has traditionally been connected with the History of Art and Ethnology.

In teacher training the academic discipline of Technical Work is (from 1970 on) Educational Science.

However:
- Technical Work is the only subject in the school to teach Technology.
- Technical work is as well Education to the World of Work based
on the Activity Approach.
- The new approach of Technical work is to be more and more Product Planning, Design, instead of the old imitative approach.
- **Work is changing** to be more and more Technology.
- Work is researched in Sociology and Technology in the Engineering Sciences.

As the Academic Disciplines relevant to Technical Work, Engineering, should be more and more used **added to** the Sciences of Education, Sociology and Design and instead of Ethnology and the History of Arts.

**Techniques and Technology**
Techniques and Technology have been defined in different ways. Essential is:
- Techniques and Technology are the basic characteristics of the culture of our production-centered time.
- The definitions of Techniques and Technology are not the products of the modern times only.
- Technology has according to the recent anthropological research supported the mental development of Man.
- Development of Technology has been the beginning of Science.
- Techniques and Technology of today are defined by the development of Science.
- Technology has become more scientific.
- Techniques and Technology affect more and more in the human environment of today.
- Technological choices are value-bound.
- Technological Change requests new skills from the workers and the citizens.

**Activity Approach**
In the history of education activity and triggering the pupils' own active doing have been highly valued contents and methods of teaching. Especially must be mentioned the Work Education-movement (e.g. Kerschensteiner), Activity Pedagogics (e.g. Decroly), the Project Method (Kilpatrick) and the Art Pedagogics-movement (e.g. Steiner).

Dewey was one of the most important representants of activity education.
The pragmatic philosophy and the far-reaching practical educational thinking were united in his program.

In Finland the most prominent representants of activity approach have been Cygnaeus and Hollo (1885-1976). According to Hollo the most important thing in activity education is not "the outer activity" but what happens in the child, "the inner-consciousness activity".

Hollo mediated the thoughts of Dewey and Kerschensteiner and the activity approach to Finland. He warned that the School generally values too much the intellect and detailed loose facts. Instead of those the School must center on pupils' own activities. However, in practical education, too, you must be careful in order not to go too far, to "manualism", to value the hand skill too much and emphasize the mechanical performance. The activity must always be conscious.

Many educationists and philosophers have used the three mental dimensions by Plato: "Desire, reason, spirit", when describing the need for balance in education. (Plato 1955; Stevenson 1974). The same three components are used by e.g. Fröbel, Kerschensteiner, Lehmann, Mehrgardt, Piaget and Steiner. In Finnish Educational Science the same is done by e.g. Niinistö (1984), Tuomikoski-Leskälä (1979), Turunen (1984) and Wilenius (1978).

The importance of the three components above in all education can be described in many ways:

**Thinking** is connected with
- cognitivity, informationality and the discipline.

**Will** is connected with
- work, activity and motivation.

**Emotion** is connected with
- providing the emotional climate for the motivation and
- involvement, experiencing.

**Application of knowledge and technology** in teaching means uniting
- thinking and activity.

**Creative, active play** means uniting
- emotion and will.

**Creative design, perceptions and inventive work** mean uniting
- thinking and emotion.

The balanced give-and-take of the three components of education
happens as
- perceptive solving of problems
and results as
- insightful solutions of problems and
- "inner-consciousness activity". (Hollo).

Aebli (1980) has developed a theory about the connection between thinking and activity. According to him activity as always the basis of thinking. He discusses the connections of activity and problem solving, too:

The start

The aim

Fig. 1. Activity and problem solving (according to Aebli 1980).

Activity makes the educational process versatile. It is an instrument of thinking. Added to that it will:
- Strengthen the associativity of the learned.
- Add the motivation of the learner.
- Enrich the whole process of education.
- Promote the survival.
- Promote education to work.
The figure made according to Aebli resembles about the ideas of Mr. Todd (1985).

The school should aim to add both the quantity and the quality of activity. Activity can be a new central theme in school.

In the original research a comparison between the propositions for technology education of totally 12 countries or international organisations was made.

The following table is the analysis of the propositions or usages, their realisations and the origins of the subject:

<table>
<thead>
<tr>
<th>Origin</th>
<th>Realisation</th>
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<tbody>
<tr>
<td></td>
<td>Science</td>
</tr>
<tr>
<td>UK</td>
<td>x</td>
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<tr>
<td>Hungary</td>
<td>x</td>
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<tr>
<td>Italy</td>
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<td>Holland</td>
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<td>USA</td>
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<td>FRG</td>
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<td>GDR</td>
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<td>SU</td>
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<tr>
<td>Poland</td>
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<tr>
<td>UNESCO</td>
<td>x</td>
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<td>CCC</td>
<td>x</td>
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<tr>
<td>Finland</td>
<td>x</td>
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<tr>
<td>Total</td>
<td>6</td>
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</tbody>
</table>

**Practical and activity approaches** are generally the demands on Technology Education.

The place and status of teaching varies. Teaching can be situated as a subject on its own, as an integrated principle, as a central theme or as a part of a subject depending e.g. on local conditions and traditions.

When discussing the results of the comparison they have to be put against the technological development background of each country.

In this piece of research the author came to the view below (Fig. 2) concerning the relations of technology education and social development.
main socio-technical stage

the aims of technical education

social reference of technical education

individual reference of technical education

About the Science of Technical Work

The balanced entity of Technical Work is born only through cooperation of different academic disciplines in research, in curriculum development and in teaching.

The following figure shows the scientific background discussed in this research for Technical Work:

Fig. 2. The aims of Technical Work Education.

Fig. 3. The Scientific structure of Technical Work Education.
Conclusions
- The contents of Technical Work (Technology) Education should be relevant to the need for technology in the country.
- Technical elementary education should technologically be many-sided and educationally balanced.
- Skill development should not be neglected in Technology Education.
- Teaching should mostly be given on problem-solving methods.
- Technology Education should be researched and developed in order to be sure that it would serve as well as possible in its educational tasks both individually and socially.
- The needs of the modern technology should, however, not order the development of the subject as the only goal.

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PUPIL-SURROUNDINGS CONNECTION AS AN EDUCATIONAL MOMENT IN SELF-KNOWING AND PROBLEM SOLVING

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Summary

The paper deals with the framework of Technology Education in Italy. New Technical Education Programmes tell: "... complete form of culture must contain the knowledge of productive capacity in order to make possible taking part in a job and the ability in reflecting critically on the productive problems to choose upon the most suitable solutions in the constructing, producing, economic and social field ..." From which it comes significative tendency called "tassonomia" (i.e. classification and description of objectives) that leads the didactic importance of Technical Education into larger and larger fields particularly using the method of "problem solving". The frequency of Secondary School of First degree is obligatory in Italy for boys and girls from 11 to 13 years old. The new programmes request didactic interactions among different subjects and so it will be collectively elaborated a basic methodologic didactic proceeding into the Class-Council. The thematic I try to explain to you synthetically, is the following: "Pupil-Surroundings connection as educational moment in self-knowing and in problem-solving".
PUPIL/SURROUNDINGS CONNECTION AS AN EDUCATIONAL MOMENT IN SELF KNOWING AND PROBLEM SOLVING

I shall give some short informations to present myself: I am teaching "Technical Education" to pupils of 11-13 years old in the Secondary School of First Degree. This instruction is obligatory in Italy and its programmes are the same for boys as well as for girls.

I have been participating for three years to the C.E.E. guide plan for teachers formation in Technical Education, its aim was to search for the same meanings for languages, contents and methods in teaching this subject. One hundred teachers participated to this guide plan with the purpose of increasing verification and making their didactic experiences known. Besides I am a member in the study group of Scholastic Orientation for the Tuscany Region.

In Italy, the general premise to Ministerial programmes of Secondary School, individuates the "formation" and the "Direction" as the finality that Secondary School must support with the contribution of all sciences; that is ability in developing different logical capacities, scientific concepts and in helping the pupils to increase progressively their knowledge of the social reality in which they live and of the human activities in three great producing sectors: primary, secondary and tertiary.

New Technical Education Programmes tell: "... complete form of culture must contain the knowledge of productive capacity in order to make possible taking part in a job and the ability in reflecting critically on the productive problems to choose upon the most suitable solutions in the constructions, production, economic and social field ..." From which "Tassonomia" it comes an important tendency called "tassonomia" (i.e. classification and description of objectives) that leads the didactic importance of Technical Education into larger and larger fields particularly using the method of "problem solving".

The attendance at Secondary School of First degree is obligatory in Italy for boys and girls from 11 to 14 years old with the following weekly time table.
<table>
<thead>
<tr>
<th>Subjects</th>
<th>First class</th>
<th>Second class</th>
<th>Third class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religion</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Italian Language</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>History, Civil Education, Geography</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sciences, Mathematics, Chemistry</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Technical Education</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Musical Education</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Artistic Education</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Physical Education</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>30</td>
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</tbody>
</table>

The new programmes request didactic interactions among different subjects and so it will be collectively elaborated through a basic methodological didactic proceeding into a Class-Council. What I am talking about now in this meeting, concerns one experience in a first year class with 11-year-old pupils. In the first place at the beginning of the school year: I try to urge the pupils in conversation, as they do not perceive the transition difference from Primary School to Secondary School too much. I try to obtain a serene environment to facilitate their interest in insertion into a new school where there will be not a single teacher, but actually, some more teachers for different disciplines. For this reason we try to program in groups, with cross-curricula interactions among different subjects.

I try to explain the theme to you synthetically, in the following: "Pupil-Surroundings connection as educational moment in self-knowing and in problem solving".

**Educative Objectives**
- Initial development in knowledge and in self-conscience.
- The increase in perception and in individual skill.
- The increase in ability of disposing, choosing, arranging.
- The coordination between brain and hands (psychomotricity).

**Didactic Objectives**
- The education to the correct use of measuring instruments.
- The education to the correct use of drawing instruments.
- The education to the correct graphic representation of plain geometrical forms, as well as of graphs.
- Acquisition of an observation method: knowledge and all its surrounding has its own proportions.

Contents
- The knowledge of plane geometrical figures.
- Data collection of objectives observed, classification, and settlement.
- Acquisition of technical and scientific terms-meaning.
- Acquisition of the concepts of Measurement, Hygiene, Ergonomics, Economics, Serial Production.
- Free-hand sketching of their own chair saving its proportions. Relation between shape, function, material.
- Taking up of measurements and their arranging by means of technical drawings.
- Ability in reporting orally or written on the activity.

It is useful, initially to rise the interest by proposing to the pupils graphic objective trials leading to the individuation of geometrical figures taken from the built or artificial world. (Those shapes, utilized by mankind in order to obtain the goods satisfying its own needs by transformation of the raw materials that nature offers.)

Successively we can enter in a most specific field to provide pupils with the instruments and the means to know themselves and enabling them to put themselves into the surroundings. Therefore it is necessary propose an activity involving directly each pupil and chiefly try to promote the development of perceiving abilities.

Let us teach our boys that all which is surrounding us has well delineated proportions that must be respected and so must be for the proportions referring to their person in relation to their life, surroundings and their work reality. In other terms I think it is of basic importance since the first class to hasten pupils to realize that the surroundings where man lives must have particular hygienical requisites to protect one's own health. So pupils will get to know the meaning of "ergonomics" through real operations, showing the relation existing between one's own body and the furniture generally used in the school. The methodological path must support learning in order to realize its own place, that is it must give an
organized idea of space. First we must take into consideration the chair used by each pupil, and then we will ask them to select between the linear measuring instruments (rule or square), what they suppose would measure more correctly the height, dimension of their chair starting from the floor and next to compare such measurement with the height of their leg, from their knee to their foot (Figure 1).

![Figure 1](image)

Position taken up by body with various highness seats. Search the better situation and verify your seat function measuring its highness with regard to your legs' dimension.

Now we go on carrying out a verification with the help of the text-book or other illustrated documentation useful to explain the problem, we consider the rules suggested by ergonomy, physicians, so to have the possibility to individuate the functional degree of such seats used by pupils on the average for about four or five hours a day except some intervals caused by the course of motory activities, not requiring use of seats.

![Figure 2](image)

In order to proceed with method and with the aim to reduce waste of time and to promote apprenticeship, it is therefore advisable to organize this work planning one teaching unit. Its structure may be synthesized with a diagram:

So as to acquire instruments to know the surroundings in which we are living much time is necessary and as we like pupils to take appropriate the ability to learn, it is suitable to subdivide the teaching programme into three phases, each phase is self-sufficient; but gradually accomplished in First, in Second, and in Third class.

1. In First Class we will begin with the immediate environment, considering
the surrounding classroom and fittings in their technical and ergonomic requisites, requesting the students to note the connection existing between man-kind and the work environment.

2. In Second Class we will fix on the knowledge of scholastic building requisites, on its strong structures, of materials used to build it; or we will look at the theme of man's shelter energetic requirements, looking at the school-boys.

3. In the Third Class we will increase the field of the knowledge surrounding also by means of leading visits in environments concerned with activities in the productive world of primary, secondary and tertiary sectors.

So we are wishing to have supplied our pupils with enough self-knowledge to develop real ability for logic, ability for reporting, for criticising and conscious selections, but in a First Class I deem useful to limit the field only to the knowledge of the School environment. It is important, besides, to advance at the planning stage coordination with other disciplines such as Mathematics, Physics, and Italian language.

Activities

1. Verifying the prerequisites: degree of methodological knowledge to be followed for a correct technical analysis on the most common objects.

2. Projecting, reading and discussing on the importance to know the environment reality.

3. Remarking, and considering on images regarding several seats form. Discussing on the position the body assumes in relation to the seat-height.

Instruments and Materials

1. Proposing initial objectives tests of type multiple selection, or on graphic field of forms, individualization as well as of their settlement into a determined surface.


3. Images from the text-book.


8. Measuring the seat height (from the seat to the floor) and recording on the sketch the relative quotation in conformity with international U.N.I. regulations. Interchangeable sheets chequered exercise-book or worksheet card-directory.


10. Verification of learning degree exposition of self, written comparison or and if necessary expression of sentences for an eventual improvement of situation. Interchanging sheets, exercise-book.
Methods (inductive-deductive)
Problem solving. Documentary research. Use audiovisual means. Guided discussions. Technical analysis, individual and group-work. Coordination of several different subjects.

Verification and Valuation
Initial, Middle and Conclusive verification tests.
The pupil:
- has he shown working ability in organization pending activity treatment?
- has he shown sufficient sense of proportions in communicating graphic messages with free-hand sketches?
- has he shown having realized meaning of ergonomy?
- has he shown to be conscious of himself, of the relation between his own dimensions and those of scholastic fittings he is using daily?
- has he shown ability in synthetizing the worked out activity in own and written form, does he use proper technical terms, is he able to correlate the knowledge acquired also by other subjects?

To carry out this activity it is possible to foresee 3-4 lessons for about 10-12 hours in total. We will propose next some under didactic unities for further verifications on ergonomic requisites of work surroundings: to propose further connection between the pupil and his environment; in relation to surface available and the number of pupils in the classroom (crowding sign, according to scholastic building rules).

Bibliography
Summary

The difficulties of education and the development objectives are matters that bear upon technology education. So technology education would be faced with difficulties even if there were no problems there. However, technology education has numerous problems of its own. It is these problems I propose to deal with in my presentation. Since the chief topic of the conference concerns the principia of technology education, I intend to highlight the theoretical problems, giving just a brief enumeration of the problems encountered in everyday school practice.
THE DILEMMAS OF TECHNOLOGY EDUCATION IN HUNGARY

Ladies and Gentlemen,

The first dilemma facing me is how to give within the brief time allotted me adequate information about technology education in Hungary so as to contribute to the success of the conference. Allow me to refer to Johann Wolfgang von Goethe who wrote the words: "They say, truth is between the two extremes. By no means so! It is the problem that is between them." I fully agree with Goethe, but let me add a thought of my own: the identification and solution of the problems help us to recognize the truth. That is why I have decided to read a paper on the problems connected with technology education in Hungary. I trust that by the disclosure of these problems I can give you just as good an insight into the situation of technology as by the presentation of the bare facts. For indeed, the internal tensions and problems are just as characteristic of technology education as are the results.

The problems I am about to deal with concern technology education within the framework of general education. In order to understand them, however, it is necessary to become familiar with the problems of general education.

The dilemmas of general education

Socio-economic development in Hungary has slowed down in recent times, a circumstance which has drawn attention to education, particularly in the public elementary school. Slashing attacks have been made on the elementary school regarding its functional disorders, its curricula and textbooks, as well as its failure to provide the pupils with adequate knowledge and abilities, development of character and mental power. The lack of the development of basic skills, the insufficiency of the pupils' educational level and the lack of school discipline have generated discontent among the population. There is a lot of truth in these criticisms, which have come from the most diverse layers of the community. We must realize, however, that the school is not an island to itself. Therefore, we cannot consider the facts in isolation from others. Most problems connected with the school are due to the difficulties now prevailing in our society. These are, among other things, the mutually disruptive interests and endeavours, the deterioration of the country's economic situation and
erudition. It is to be regretted that the school aptly reflects these social problems.

Moreover, there are numerous contradictions which prevent the elementary school from functioning efficiently. These are:

a. The contradiction between the general character of the elementary school and the increasingly heterogeneous composition of the student population believed to be homogeneous. The centrally planned curricula, which are compulsory for all concerned, have been criticized by some because they put too heavy a strain on the pupils, and by others because they fail to adequately prepare them for the higher grades.

b. The sole criterion of selection is the ability to cope with the increasingly difficult subject-matter of instruction and the ever heavier work-load, with capable students becoming still better and those of small abilities lagging behind. As a result, the elementary school strengthens an antidemocratic system of selection - which runs counter to its aims.

c. Participating in the working-out of current curricula were the representatives of different disciplines. It is often heard these days that these disciplines enjoy a higher priority than pedagogy or psychology. Because of the curricula which over-emphasize academic subjects, personality and ability development has been relegated to the background. The pupils are burdened with a disproportionately great intellectual work-load and have little opportunity for acquiring practical experience, the ratio being about 70 to 30 per cent.

d. Hungary’s economic difficulties have increased in recent years, accounting for a deterioration of the schools’ financial situation. This has affected staff and equipment alike. An added problem is the steady increase in the student population. Due partly to the demographic situation, now the average class has 40 pupils. In 1984 the school system switched to a 5-day week, whereas curricula and the text-books - to have been designed for a 6-day system - remained unchanged. It is obvious that the school not only reflects the changes in the life of the community, but that these changes give rise to further tensions and problems in education.

In order to ease the worsening socio-economic situation, a new reform programme has been worked out, which affects the school too. Once again at issue is a development programme for different school types; new
methods have been worked out to resolve the above-mentioned problems, to modernize pedagogy.

Hungarian education has set itself five key objectives. These are to:

1. Increase the autonomy of the schools and teachers in accordance with the declared aims of the 1985 Act of Education; to support educational experiments and encourage local initiatives for curriculum and innovation.

2. Work out adaptive and alternative curricula in order to help realize an equitable selection by taking into consideration the unequal abilities of the pupils and the educational level of the different social layers.

3. Adapt scientific attainments to teaching purposes; to work out complex curricula and activities in order to encourage the development of adaptable skills and practical abilities suited to a modern technological society.

4. Work out a permanent strategy for education, one which keeps track of social development, scientific and technological achievements, and is designed to replace the strategy based on central decisions.

5. Combine central initiatives with local (school-level) innovation processes for the modernization of content.

The difficulties of education and the above-mentioned development objectives are matters that also bear upon technology education. So technology education would be faced with difficulties even if there were no problems there. However, technology education has numerous problems of its own. It is these problems I propose to deal with next. Since the chief topic of the conference concerns the principia of technology education, I intend to highlight the theoretical problems, giving just a brief enumeration of the problems encountered in everyday school practice.

1. Theoretical problems in technology education

1.1.

By the 1970s it had become obvious that there was a serious contradiction between the high standard of technical development and the technical culture of the population. It was realized that the lack of technical culture not only held up the qualitative improvement of the standard of living and the way of life, but that it was a serious obstacle to the socio-economic development of the country. Because for centuries on end people have had no conscious reaction to the technical aspects of life, we have to regard
the lack of technical culture as something to be expected. But there are poor prospects for the rising generation if they were to live in a world crammed with technical instruments of all kinds without a proper understanding of their functions, of their relationships to the environment. It would be an equally poor prospect for the specialist in his limited field to disregard the more general, wider relationships, utilizing technical feasibilities for their own end. The technical culture of the adult population can only develop spontaneously, and therefore, it will remain scanty. But it is of utmost importance to enable the rising generation to acquire an appropriate level of technical culture. It was to this end that in 1978 the subject Technics was introduced into the curricula of both the elementary school and the secondary school. In Hungary it was a turning-point in technology education. But the path leading to that turning-point had been attended with grave difficulties, involving numerous problems of theory and practice alike. Let us consider some of the theoretical problems.

1.2
The introduction of the subject Technics into the curriculum was a gradual process, so the subject Practical Studies had been maintained in the curriculum for elementary schools till 1985. Rather than providing the pupils with polytechnic education, the subject Practical Studies emphasized mechanical performance and so it fell short of the new requirements for technical culture. However, no sooner had they set about the job of working out the curriculum for Technics than some serious problems cropped up, the most important of them being that there was no precise definition as to the nature of the subject. What was needed was not a definition crammed into a brief sentence. What should have been clarified (and it still needs to be) was the relationship of technics to nature, to society, to man. We should know its origin, its recondite motives, in other words what it is ontologically. And moreover, it should also be made clear how one can familiarize oneself with technics, what roles it has in the recognition of truth, in the life of man and society - in other words, what it is gnostically. I fully realize that these questions belong within the domain of philosophy, but they are important to us if we are to decide whether we teach indeed technics when we teach it.
Another problem, which affects the logic of curriculum writing more directly, is this: should we teach the whole of technics or technics as a whole; merely a partial field of technics, or general technics if - indeed - there is such a thing at all. This is a dilemma of major importance not only from the point of view of its validity as a school subject, but also as regards its legitimacy and acceptance. Hungarian experts in technology education have reached an understanding that technics should be presented as a whole and that principles, conceptual structures and methods of procedures which pertain to its very essence should be taught. There were many, however, who refused (and they still refuse) to accept this argument and, concerned with practical results and values, enumerated the pragmatic elements of usefulness against scientific reasons. In their opinion, it is what is scientific and general, but what is of use to the individual, that should be taught.

This is a serious problem in Hungary, and it has been dealt with by the mass media time and again. Nevertheless, these two points of view can be reconciled.

It is obvious that the solution of this problem depends on the ideological traditions of the given country, on the dominant interest relations, on the given level of economic and technical development.

It was in keeping with the interests of society as a whole that we have worked out the curriculum for Technics, only slightly stressing the pragmatic elements. As we understand, technics is a system of artificial systems, which man created from nature to serve his ends. And just as in the case of all organized systems, so technics is characterized by its origin, totality, hierarchy (i.e. its relationship to other systems), its structure, function and development, also its effect on man and nature. Technics is a product of the metabolism between nature and society, and as such, it is a historical category. In this sense, the principles pertaining to technics are expediency, methodicalness, economic efficiency, synthesisization, alternativeness and systems approach. These principles cover such basic categories as matter, energy, information, model and system. Under these categories we find the basic functions. These are: change of state, transformation, storage, transport etc. These functions are realized through work, which is the most natural and most comprehensive activity of mankind.
We must admit, however, that in the 1970s we were unable to bring about such a system.

1.4
To my mind, it pertains to the essence of technics that it has numerous dichotomous characteristics. Simultaneously it is theory and practice, natural and social, static and dynamic, stable and unstable, object and process, individual and general, abstract and concrete, small and big, simple and complicated, stationary and mobile, useful and harmful, up-to-date and out-of-date, dangerous and harmless, perfect and imperfect, old and new, and so forth.

These characteristics hamper considerably the development of the curriculum. We must find the answers to a number of important questions:
- Which of technics' characteristics are constant and which are variable?
- What is the ratio between theory and practice, abstract and concrete?
- What relationships are there between the earlier classical products of technics and its new achievements?
- How can all these aspects be made integrated whole in the new curriculum?

1.5
In its outward forms technics is extremely varied and many-coloured. If we adopt the view that it is the principles and basic structures that should be taught, there arises immediately the question of how to show in the curriculum sameness in variety, essence in irrelevance, constancy in change, necessity in randomness, practicality in eventuality, method in unmethodicalness.

1.6
The next dilemma is this: if we accept the fact that technics is linked to nature and society, what relationships does it have with the natural sciences and the social sciences? The question is still a moot point in scientific circles. Some maintain that technics is the application of natural sciences for practical ends. It is strange, though, that the possibility that it might be the application of the social sciences has not been entertained. Indeed, we can find examples that support either one or the other point. Essentially, however, neither is true if we consider the question from the
point of view of either phylogenesis or current practice. Nevertheless, it is an important issue, for it can help to determine the future of the subject Technics: should it be an independent subject or should technical knowledge rather be taught within the framework of Physics, Chemistry, History or even Art?

The education authorities of Hungary have decided that Technics should be an independent subject, though there are views still - motivated by the increase in the number of weekly classes of certain subjects - that suggest it should be incorporated into other subjects. The arguments and the efforts at stability stress the importance of throwing light on the relationships that technics has with other disciplines. No subject can be independent by itself, disassociated from the others. Each and every subject must be linked to all the others. Such an interrelationship will only strengthen its independence. This is also true of the subject Technics.

1.7

The introduction of a new subject into the curriculum calls for a careful study of the existing traditions. It is a matter of common knowledge that industrialization started rather late in Hungary. It follows that in the mind of the public the branch of study that deals with mechanical or industrial arts does not belong to the traditional concept of a classical education. That is why we have considerable difficulties in having the subject Technics accepted in the schools, especially in secondary schools (called gymnasium) where academic branches of knowledge are taught.

Polytechnic education and the training of pupils for work have firm traditions in the Hungarian system of education. It should be made clear what the relationship of new technology education is to the traditional areas of education.

2. Practical problems in technology education

Most teachers were caught unprepared by the concept of new technology education. Due to their traditionally specialized training, they felt somewhat uncertain in the areas that were outside their scope. What should the teacher who teaches Technics be: a specialist or an all-round teacher? Is it morally right for the education administration to expect them to teach a subject that their qualification is not suited for?

For the most part, education aims at providing knowledge rather than
classroom activities. Can the subject Technics compensate for the cognitive load which preponderates over other considerations in the system of subjects?

The variety of the methodological possibilities in the new subject took the teachers by surprise. Their methodological freedom in treating the subject is nearly without limit. Since there is no set methodology for the teaching of Technics, in practice matters are often carried to extremes. For instance, the methods are stuck in the manipulation designed to have an end in itself. This is no doubt due to the traditions of the subject Practical Studies. Or in the other extreme, the effort at memorization, where the methods of academic subjects are applied when they are not needed. This I call a negative transfer of the academic subjects.

The curriculum for this subject is classified within a framework of given limits. In the regular material it provides the principles and the activities, in the supplementary material and the text-books it offers optional selections. The teacher has the option to reduce or select from the suggested curriculum. However, most teachers feel that the responsibility weighing on them is too great and that they do not possess the necessary creative ability to reduce or select from the curriculum. They are characterized by an overly adherence to the curriculum and their overestimating of the role of the text-book. It is likewise of frequent occurrence to over-emphasize the importance of the work pieces treated in class. They become independent and have an end in themselves. As a result, less emphasis is given to the process such as planning, construction, problem-solving, execution etc. in which the intrinsic value of education lies.

Inadequate conditions at the schools hamper the high-standard teaching of the subject Technics. There are not enough specialized classrooms and there are difficulties in obtaining the necessary materials and equipment. These deficiencies also affect the content of the course. The question we are faced with is this: should we lower our standards or should we try to establish the proper conditions gradually?

Teacher training and extension training play an important part in the quality of teachers. Predominant in their training was academic education, with little emphasis given to the practical and methodological aspects. This is clearly a source of failure in practice-teaching.

There is no evaluation system for the subject Technics. The aims and
requirements laid down in the curriculum do not always give precise criteria for the evaluation of the results.

Most pupils have a positive attitude to the subject. But compared with the possibilities, there is a shortfall in their achievements. One of the reasons perhaps is that the subject-matter of Technics failed to take the psychological aspects into account, such as age characteristics and the difference between the sexes.

These are but a few selected problems which clearly show that there is a wide gap between the pupils' preparedness, the teachers' qualification and the objective conditions of the schools. We are more and more convinced that the subject Technics needs a curriculum that can flexibly adapt to the new, widely diverse conditions and technical development. Research is under way at present to develop a modular type of curriculum for Technics. We trust that it will help us to reduce the problems, avoid the errors and increase our results.

Thank you very much for your attention.
BASIC PRINCIPLES OF SCHOOL TECHNOLOGY IN OUR COUNTRY

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Summary

The restructuring of the Czechoslovak school system, being anchored in the Document of 1976 on further development of education, stresses a continuous enhancement of education at all stages and types of schools. At the same time, the implementation of the scientific and technological achievements into practice must find its reflection also in the content of education both in school and outside. Therefore, the students are likely to be acquainted with the recent scientific and technological results as well as with the principles of progressive courses of manufacture. They are in need of attaining appropriate working skills and solid knowledge in this field.

At primary level, the teaching subject of work education has been introduced. Besides mathematics and sciences, it contributes to the implementation of the objective as reported above. It is taught through the whole course of study, being obligatory for both boys and girls. The students thus get acquainted with selected technological procedures, they work with various materials, raw materials, kits, plants, using thus the needed tools and instruments, as well as the technology and mechanics available. The set of obligatory polytechnical subjects is complemented by optional and non-obligatory subjects as well as by numerous free actions in technology and sciences.

As far as gymnasia are concerned, the system of vocational training is included in the syllabuses through the whole 4-year course of study, both for boys and girls. After passing through a general fundamental technology and propedeutic vocational training at the 1st and 2nd grades, the students make a choice of any vocational training subjects, i.e. engineering, chemical engineering, agriculture, programming, etc. On the basis of a successful A-level in vocational training subjects the students acquire professional qualification in the respective field. Moreover, they are better prepared for the study at colleges of technology, economy and agriculture.

The development of students' interests in technology is also supported by their work in various forms of free actions both in school and out of school, including the participation of the students in different competitions in technology, etc.
BASIC PRINCIPLES OF SCHOOL TECHNOLOGY IN OUR COUNTRY

The problem of our further improvement of the quality of the education of youth is one of the major tasks in building up a developed socialist society in our republic. The implementation of these objectives is regularly being reflected also in a subjective component of forces of production which are the key elements in implementing the scientific and technological achievements into the whole national economy as well as all spheres of life in Czechoslovakia. A continuous development of man's creative abilities in the period of the scientific and technological advancement exacerbates the development of all the other forces of production. Thus, the quality of education of youth as well as the preparation of young people for life is becoming a decisive factor in the socio-economic development of our country.

This thesis, promoting a decisive role of human being in the development of society, has become one of the principal conceptual starting points for the content and organizational restructuring of the Czechoslovak education system, being anchored in the Document adopted by the Czechoslovak supreme authorities in 1976. In our republic there is a ten-year compulsory school attendance as it is laid down legislatively in the Education Act No. 29 of 1984. The Czechoslovak youth is thus enabled - after completing 8 years of study in primary school and 2 years in secondary school of various types - to attain secondary education level. The implementation of measures ensuing from this Act is an important prerequisite to increasing the common educational and cultural standard of the nation.

These are some introductory notes in which I try to characterize an atmosphere of the content and organizational restructuring of the education system which is now in force in Czechoslovakia in accordance with the above-mentioned Document.

The main task of restructuring is to increase the quality of educational content, to update and renew the content and methods of work in schools as well as to maintain a proper link between school and life and social practice. Accordingly, from this a necessity in the development of new curricula, syllabuses, textbooks and educational programmes has arisen; we have already launched the work according to these programmes in the school year 1976/1977, beginning with the 1st grade of primary school, after a period of its experimental testing.
Now allow me to concentrate more on a problem of getting primary and secondary students - the latter being students at gymnasia in particular - acquainted with technology and technics.

At the lower primary level (1st to 4th grades) the curriculum comprises work education in a capacity of 1 hour a week. Its main purpose is to provide pupils with the most important knowledge of technology and production and the appropriate skills and thus to contribute to polytechnical and work education of pupils according to the objectives and tasks of school as a whole, as well as in accordance with other relating disciplines. This subject supports the development of the pupils' abilities and interests, their career choice, as well as their further education.

Within the work education, mental and physical activities of pupils are very closely connected. This subject, its content being common for both girls and boys, supports the link between school and life a great deal.

The pupils of the 1st to 4th grades in primary school (i.e. 6 to 19 years old) systematically attain knowledge of and skills in work with different material, stuff, products of nature, modelling clay, paper, cardboard, textiles, timber, various plastic and metal construction kits etc. just through being taught this subject of work education. Moreover, the teaching subject of work education comprises also a plant-breeding both inside the school and outside in the school fields. The pupils thus learn how to work, using different appropriate tools and aids.

Through this subject the pupils acquire fundamental knowledge of the production of material they work with (paper, timber, etc.). They also get acquainted with technology and technological procedures during their excursions to industrial and agricultural enterprises.

Teaching this subject, great emphasis is put on educating pupils for creative and independent work. Being familiarized with working activities, the pupils also learn about the qualities of the processed material as well as about the construction and function of tools they work with, and they also perform a problem-solving and experimental work.

At the upper level of primary school (5th to 8th grades), involving 10 to 14-year-olds, 2 hours a week are devoted to work education. The content of this subject is oriented mainly to testing theoretical knowledge, to the acquisition of basic working skills in different fields of work and particularly in handcraft, electrotechnical work, cultivating land and breeding agricultural plants, in the preparation of food as well as in hand- and
machine-sewing. Through this subject the pupils get acquainted with the scientific and technological achievements, and they are informed about the process and organization of production. Essentially, a practical activity of the pupils remains a cornerstone of the subject.

Bearing a polytechnical character, the subject thus enables the pupils to get a better idea about selected technological procedures, about how to work with various materials, including raw material, plants, as well as how to apply suitable tools, instruments and aids and available technology and mechanics.

The subject of work education at the upper primary level is divided into the following components: at the 5th and 6th grades there is a technology-oriented work and a plant-breeding; at the 7th and 8th grades work education comprises also girls enrolment.

Timing of the respective components of work education at the 5th to 8th grades:

<table>
<thead>
<tr>
<th>The components of work education</th>
<th>Timing of work education (hours per week at 5 to 8 grades)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>technology</td>
<td>5 6 7 8</td>
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<tr>
<td>technology</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>plant-breeding</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td>girls enrolment</td>
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</tbody>
</table>

The content of technology is oriented mainly to the work in timber, metal and plastics, including simple operations in electrotechnics and electronics. The pupils thus get acquainted with the construction, function and purposes of the used tools, as well as with the technological procedures. In the course of excursions they are more involved in the process of production at industrial enterprises.

Through the plant-breeding the pupils attain basic knowledge and skills connected with the cultivation of land, breeding fruit and vegetables and various flowers. They get more experience in breeding and, moreover, also the knowledge of the current agricultural large-scale production during their excursions into agricultural enterprises.
The content of girls enrolment is oriented to the tasks of nutrition and food production, clothing, the technics of hand- and machine-sewing, homekeeping etc.

The pupils who have shown greater interest in technology may choose an optional (but still obligatory) subject of fundamentals of technology at the 7th and 8th grades (2 hours a week). This subject enables them to develop their technical abilities and inclinations, to deepen their knowledge of technology, and to prepare them for further professional training in accordance with the scientific and technological advancement and the needs of the society. As to the content, the subject matter of fundamentals of technology follows the practical activities in technology. The pupils thus get acquainted with new technology, materials, drawings, with the construction and operation of machines, they complete some assembly work (e.g. a small motorbike), they also get a briefing in road safety education as well as in the utilization of electric power in current technology.

A non-obligatory subject of practice technology also contributes to the deepening of technology education. It may be chosen by the pupils at the 5th and 8th grades (2 hours a week). The main emphasis again lays on pupils' practical activities, and namely on the work with timber, metal, plastics, on electrotechnical work as well as on the production of goods within the pupils' independent and creative abilities.

Another non-obligatory subject, homekeeping, is catered for girls and also for boys, being taught 2 hours a week at the 5th to 8th grades. This subject is oriented to the problem of family, household, nutrition; the pupils acquire skills in handicraft, e.g. embroidery, knitting, crochet, food production, cutting out and making a garment, etc.

The set of obligatory, optional and non-obligatory subjects of polytechnical education in primary school is followed by various free actions of pupils in technology and sciences, being performed out of school. Besides the different hobby groups of young modellers, radio-operators, etc., the groups of computer technology in the pioneer and youth clubs or in computing centres, at enterprises, research centres etc. have been recently attracting more and more pupils.

Within a new conception of a four-year education in gymnasia which came in force in 1984 after having been tested experimentally, beginning with the 1st grades, an important place is given to the system of vocational training. The vocational training has become an integral part of education...
provided at gymnasium of a new, higher quality. However, it remains to say that the gymnasium still bears the character of general education and polytechnical school and it does not replace vocational school in our system of education. The introduction of vocational training into the curriculum of gymnasium makes the preparation of students for their further study at universities, and particularly at the colleges of technology, economy and agriculture more effective and of higher quality. Apart from this, it enables those who are not willing to go on with their studies to enter a job as skilled workers in various fields of national economy on the basis of the attained professional qualification in the respective field.

Timing of the subjects of vocational training for both girls and boys as included into the curriculum of gymnasium (14 to 18 year-olds):

<table>
<thead>
<tr>
<th>Teaching subject</th>
<th>Timing of the subjects (hours per week at 1st to 4th grades)</th>
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<tbody>
<tr>
<td>Fundamental vocational training</td>
<td>1 2 3 4</td>
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<tr>
<td>Technical designing or Fundamental business</td>
<td>- 2 -</td>
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<tr>
<td>Optional subjects in vocational training 1)</td>
<td>- - 4 6</td>
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<tr>
<td>Optional subject of practical seminars in</td>
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<tr>
<td>vocational training</td>
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</table>

1) The pupils may choose from the disciplines according to their inclinations, the conditions in schools, production orientation in the respective region as well as with particular regard to the needs of the whole society as concerns the respective disciplines in vocational training: engineering, electrotechnics, civil engineering, chemical engineering, agriculture, programming, economy and administration, geology, communications, cultural activity, mining industry and metallurgy. It is a matter of fact that every gymnasium provides teaching of 4 branches as minimum, some large gymnasium even 7 of them.

A subject matter of the subject **fundamental vocational training**, bearing a general technology character, is oriented to maintaining a close link
between technology, production and the society, as well as to problem-solving in the field of technology and economy, to the utilization of raw materials and electric power, machinery and equipment, and to energetics. At the 2nd grade this subject has a more propedeutic character. The subject matter of technical designing comprises predominantly the technical drawing; in the alternative syllabuses of fundamental business there are particularly typewriting and theory of fundamental business included. At the end of the 2nd grade the students undergo a two-week vocational practice at enterprises.

The last two years of study at gymnasium are specialized within the vocational training according to the branches as mentioned above. At the 3rd grade there are two two-hour subjects — and at the 4th grade even three of them — devoted to professional orientation in which a very important place is occupied by practical seminars (so as it is within the whole system of vocational training). They are given ca. 40-50 per cent of teaching time. The students make a choice of the branches of vocational training in which they sit for the Final A-level, then. Also at the 3rd grade there is a two-week practice period included into the curriculum. The practice period is maintained mainly at enterprises, research institutes, computing centres, commercial services, etc.

A newly introduced subject informatics and computer technology at the 1st and 2nd grades at gymnasium supports the implementation of recent achievements in this discipline through the system of vocational training.

In the system of vocational training the students at gymnasia get acquainted with current technology, new technological procedures, organization and administration of the process of production, as well as with the implementation of the scientific achievements both in agriculture (2) and industry (1), be it not only in school but also in the course of excursions into and practice periods at enterprises. The schools cooperate with such enterprises under contracts. From this point of view it is the educational impact of specialized subjects upon the work education and career choice that should be stressed, as well as their contribution to the establishment of non-formal link between school and life under the conditions of the scientific and technological advancement.

By analogy with primary schools, also gymnasia face a successful development of the students' free actions in technology and sciences. The students, according to their inclinations, get involved into the work of
different hobby groups either in school or outside in the associations of young technicians and scientists which are attached to enterprises, computing centres, research institutes, etc. Very popular among secondary education students is a competition in vocational activities in which the students solve interesting problems related to technology to be utilized in broader scale in the society.

In conclusion it leaves me to stress the fact that the new conception of schools and gymnasia in Czechoslovakia creates favourable prerequisites for students to get acquainted with recent technological and scientific achievements through obligatory and facultative parts of a teaching/learning process, or through the students' free actions out of school. A new quality of education in these general education schools proves that the road we have chosen according the above-mentioned Document is right; the Document sets out the major tasks and objectives in the education of an all-round developed personality. Essentially, a close link between school and life and social practice contributes to the fulfillment of such objectives a great deal.
THE SYSTEM OF POLYTECHNICAL EDUCATION IN THE G.D.R.

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Summary

A survey is given about the system of polytechnical education and training at schools in the G.D.R., from grade 1 to 10, including the range of school clubs and working groups. Reference is made to the objectives and guidelines set by curriculum organizers as well as to the ever-growing importance of polytechnical education in the future, the new opportunities due to modern technology are also shown.

An explanation is given of some trends in the integrative approach at school to certain phenomena in production, such as material, energy and information, and of how the methods of technical thinking and working are taught on the basis of design and construction, of how the whole reproduction process of a firm is included, of how contradictions in certain situations (such as needs and demands) are used as the starting point for creative thinking, and of how knowledge about hard- and software is acquired at interacting levels.
THE SYSTEM OF POLYTECHNICAL EDUCATION IN THE GDR

1. Subjects
In the GDR, all healthy children of compulsory school age have the right and the chance to attend the "General Polytechnical Secondary School". This type of school comprises the grades 1-10 and forms the basis for any kind of further special or higher education within the integrated education system.

"Polytechnical Education" as kind of general education persues in our sense the principles of connecting "learning, working and sports". The "Polytechnical Principle" of our school is realized by the interrelation of all subjects. Each single subject provides practical aspects, opportunities of their application to many spheres of social life, in which technology plays an essential role. Particular potential to realize the life-oriented principle of education have been opened up by introducing the special subject of "Polytechnical Instruction". The respective school political decision was made at the end of the fifties and right from that time onwards, the subjects of polytechnical instruction were introduced and have developed to a pillar of the education system. Polytechnical instruction with its subjects does not only bring technology and real life into the classroom, but it also introduces the students to the fields of production.

Between 1982 and 1985, new curricula in polytechnical lessons were introduced gradually; they take the growing demands of scientific-technological progress and its consequences for general education into account.

A new curriculum in crafts lessons for the classes 4 to 6 was introduced in September, 1985. The former basic structure with the sub-fields "Processing of materials" and "technical model construction" was maintained. The pupils produce useful things, thus learning basic skills. This is the basis of the subjects "productive work" and "technical drawing" beginning in the 7th grade. Later, mechanics and electrotechnology will be connected more closely in the subject "technical model construction".

The best opportunities to demonstrate scientific-technological progress are given in the subject "Introduction into Socialist Production" ESP. Fundamentals of the production processes in the main fields 'processing technology', 'mechanical technology', 'electrotechnology/electronics' and 'automation technology' are taught. Teachers make great efforts to relate
these lessons to production. Therefore, these lessons contain a lot of practical activities. To develop the technological-economic and technical-constructive thinking of the pupils more efficiently, the proportion of active work to be done by the pupils (experiments, exercises etc.) was increased, and a closer connection between subjects of mathematics and natural sciences on the one hand and subjects of social sciences on the other was obtained.

In the following, the general survey of the subjects of polytechnical instruction shall offer you an impression of the system of technological education in the GDR.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Subject</th>
<th>Weekly period allotment</th>
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<tbody>
<tr>
<td>1-2</td>
<td>Handicrafts</td>
<td>1</td>
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<tr>
<td>4-6</td>
<td>Handicrafts</td>
<td>2</td>
</tr>
<tr>
<td>7-8</td>
<td>Introduction into socialist Production</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Technical Drawing</td>
<td>1</td>
</tr>
<tr>
<td>7-8</td>
<td>Productive Work</td>
<td>2</td>
</tr>
<tr>
<td>9-10</td>
<td>Introduction to socialist Production</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Productive Work</td>
<td>2</td>
</tr>
</tbody>
</table>

After the tenth class, the knowledge acquired in the ESP lessons is used in the basic subjects of vocational training. The curricula of vocational training valid since 1 September, 1986, are directly based on the new ESP curricula of the ten-class secondary schools. These curricula had been introduced as follows: for the 7th and 8th grades in 1983, for the 9th grade in 1984 and for the 10th grade in 1985.

Productive work done by the pupils of the 7th and 8th grades in Socialist industrial or agricultural enterprises is of a differentiated character but generally, it is concentrated on the same fields of work and demands on working and learning. Generally, it is done in "pupils' production units" in enterprises and in an "atmosphere of production", that is, under conditions of production adapted to the age of the pupils.

Productive work done by the pupils of the 9th and 10th grades is concentrated on specific activities that are to develop working abilities and
a Socialist mode on attitude. In accordance with the possibilities and demands as well as with regionally different structures of the national economy, the plan for productive work done by the pupils of the 9th and 10th grades contains differentiated forms of training: for example, in the fields of metal-processing industry, electrical industry, textile industry, wood-processing industry, leather-processing industry, clothing industry, the maintenance of agricultural machinery, chemical industry, agriculture or building trade.

Generally, productive work is done under real production conditions so that the pupils, together with the working people, are involved in fulfilling production aims, implementing innovations and rationalizing production processes directly.

Pupils have to solve fixed production tasks more and more independently in the enterprises; the respective technological aspects also help to fulfill the plan "productive work" in accordance with the required knowledge, skills and abilities. Through their greater flexibility, the revised curricula introduced in 1983 make it possible to use local conditions and facilities for doing productive work in an improved manner.

Polytechnic lessons are of a trade-preparing character but they are an integral part of general education and are not vocational training in advance.

2. Objectives and aims

All subjects of "Polytechnical Instruction" are an integrated part of general education, which is continued after leaving grade 10 by vocational training or by the "Extended Secondary School". This fact determines the general objectives of "Polytechnical Instruction" which consist in the following broad aims:

- Providing conditions of education, which secure the all-round mental and physical development of children and the promotion of their talents.
- Making students familiar with the scientific basis, the structures, social and scientific-technological interrelations and dependencies of the production process.
- Imparting, exercising and applying technological knowledge and skills, facilitating practical and creative work as well as possibilities to solve scientific problems and tasks.
- Developing to human characteristics and habits such as convictions,
attitudes, behaviour and responsibilities as normative base of the conscious utilization of technology for the benefit of the society and the individuals.

The objectives are shown in Fig. 3.

Linking work experience with the idea of general education means that it has ramifications with other subject matters and similarly other subject matters have ramifications with the area of work experience and acknowledge the working process as a source of social wealth. During the actual teaching-learning process every subject teacher relates knowledge belonging to his area to productive work so that this knowledge will be better evaluated. The teacher of technology either himself or with the help of other subject teachers will make available such knowledge which is necessary to pursue the work intelligently.

The idea of teaching technology is based on the fact situation that the production process is a source of social wealth and a purposeful means of pedagogics to develop the individual to the full personality. The purposeful human activity by which man produces the necessary conditions for life, is a pre-condition for human life as a whole. To be able to work for himself or for the society every citizen must have:

- Elementary skills in mental and intellectual work for the various subjects according to the local conditions; Elementary capacities to compare the quality obtained with the quality desired and independent choice of the successive working steps; general ability to organize any job correctly;
- Elementary knowledge of the structure of the workplace and raw materials (wood, plastic, metal, leather, plasticine, glue etc. ...) their specification, their method of identification, processes of their manufacture, their physical, chemical and mechanical properties ...;
- Elementary knowledge of the structure of the means of production (tools, borer, loom, spinning wheel, file, scissors ...), their parts and their construction ...;
- Knowledge about the basic principles of the working people's interaction with others and cultivation of correct attitudes towards work, about cooperating with others and accepting blue-collar jobs;
- An inculcated sense of dignity of labour, of self-reliance, of spirit, of initiative and of discipline.

From this it will be clear that both education and the curricula of our
schools have a special significance in balancing the socio-economic development of the country through educational planning. On the one hand these are tasks for all subjects like science, mathematics, geology and biology, on the other hand they are tasks for a special subject. From the pedagogical point of view, linking of the students' training with productive work is necessary for the unity of the mental, moral, and physical development of the child. Productive work, acquisition of knowledge and the development of character and behaviour are inseparable from each other. The natural relations of the children during work will be used for developing creative thinking among the students, for forming qualities of character like diligence, perseverance, accuracy, punctuality and to realise the importance of dignity of labour.

According to the main aims of technology in teaching stage, the subjects for work experience are particular part every working process with technical means. In any productive work with technical means (tools, machines, mechanical and electrical engineering) all components interact in a complex. Therefore work experience must be introduced as a special subject for teaching with a theoretical and a practical part according to the interaction of these parts during the working process.

Every man's environment will not be the same over a long time. Every day new findings, intellectual processes and more and more efficient methods are being put into practice. These in turn demand more productive knowledge and scientific experience which can be acquired during the manual work with tools, instruments and other means of production.

This assessment basically suggests that man no longer influences nature only with his bare hands that he has created for himself more and more technical means for this process (tools, water pump, bellow, lathe, chemical plant building, plough, pulley block, sewing machine, weaver's loom, spinning wheel). Different levels of the relations between manual skills, mental process and technical means are selected for training the students according to their age and educational level. These relations have been shown in figure 5.

Explanation to Fig. 5.

In the horizontal line typical steps of the historical evolution of the technical means are shown. Starting with a simple bill hook of stone man has prepared more and more technical means for his activities up to a
numeric and adoptive control, for example, for automatic machines and software. At last, these lines show the development:
- from draw-well up to an electric pump-set;
- from wheel of wood structure up to an aircraft;
- from bill hook up to a motor-saw;
- from drum up to a television;
- from an ox up to a tractor; and
- from a counter up to a computer.

In the first column typical activities of man are shown for most working processes. The other columns show how man has prepared more and more technical means for his activities. Through the interaction of the human activities and the technical means more and more complicated processes have been created.

With this figure we understand better the demands that modern working processes need also highly cultivated and skilful hands, trained eyes and developed hearing together with a knowledge about the workpiece and the technical means.

3. Curriculum organizers
Curriculum organizers are mainly constitutional elements like content and the way of considering the selected matters of technology, which leads to a certain teaching approach and structure of instruction. In the following we would like to give a rough survey, which is more or less limited to the aspect of content organization.

Handicrafts grade 4-6
Priority is given to the practical aspect while producing items with use-value, which interrelates practical activities of students with cognitive activities like the acquisition of knowledge on materials, tools, simple technological systems etc.

Main contents are:
- Processing and treatment of materials like paper, wood, plastics, metal etc.
- Planning, constructing and investigating models in the field of mechanics and electrotechnical engineering.

Subelements of content are:
- Planning of working steps - joining
- measuring and checking - finishing
- technical drawing - structure and elements of technical drawing
- marking out - machines
- cutting procedures like - stability of machine elements
  sawing, filing, etc. - elements of a simple electrical circuit

Introduction into Socialist Production
Experimental and theoretical activities of students dominate in instruction. In terms of content, important curriculum organizers are:

Grade 7
- Structure of a socialist enterprise and the way of manufacturing a selected product
- Technological basic procedures like casting, rolling, turning, etc.
- Machine elements
- Protecting and maintaining of products by coating
- Efficient application of technological procedures.

Grade 8
- Basic structure of tool machines
- Function and interaction of machine elements
  - Mode of operation of the tool machine
  - Transmission of energy
  - Controlling processes
- Efficient application of tool machines.

Grade 9/10
- Economical aspects of production processes
- Electrical engineering and electronics
  - Designing, mounting and testing of electrical basic circuits of certain practical applications
  - Electrical checking and measuring
  - Applications of electrotechnical engineering and electronics in control systems
  - Automation of production
    - Analogue and digital controlling systems and examples of application
    - Numerical controlling systems in machine tools (principle of NCM).
Technical Drawing
Grade 7
- Introduction into basic principles of technical drawing
- Reading and presenting of selected items (simple shapes)
- Dimensioning
- Reading and presenting of items with more complex shapes.

Grade 8
- Selection views
- Presentation of threads
- Complex draitying task
- Reading and presenting of building construction drawings.

Productive work
In this subject, students for this purpose enter specially provided departments of enterprises of different branches according to the respective infrastructure of the territory. For grades 7 and 8 special workshops for instruction purpose are equipped, while students of grade 9 and 10 are more or less involved in the real production process. There are differentiated syllabi (framework plans) for more than 10 different branches.

Grade 7/8
The content of work correlates more or less with the content of theoretical instruction of the subject "Introduction to socialist Production". Students are instructed in basic technologies of metalwork etc.

Grade 9/10
The plan of "Productive Work" in the branch of metal-processing industry may give some insights into the structure of instruction.

Complex I
- Adjusting, operating, controlling and maintenance of different machine tools
- Assisting a skilled worker in operating an automatically controlled machine system

Complex II
- Integration of students into assembling work
- Implementing of service and maintenance work

Complex III
- Participation in quality-control and test-departments
- Work in storage- and transport-departments.

The orientation of education toward productive work, to acquire the basic working knowledge, skills and habits which, in turn, form a broad basis for subsequent vocational training and a sound preparation for life and work, has been implemented in a systematic manner.
How the functions of technical devices are being developed when processes are realized—illustrated by levels of mechanization and automation

<table>
<thead>
<tr>
<th>Levels of mechanization and automation</th>
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<th>( M_1 )</th>
<th>( M_2 )</th>
<th>( M_3 )</th>
<th>( A_1 )</th>
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\( M = \text{man} \)

\( TD = \text{technical device} \)

The increasing complexity of man's activities with higher levels of mechanization and automation
The present syllabus of Introduction to Socialist Production (grades 9 and 10)

<table>
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<th>Grade 10</th>
<th>Electrical engineering (28 Lessons)</th>
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<td>6.3</td>
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Pilot project: Syllabus of Introduction to Socialist Production for grades 9 and 10 taking a basic course in computer technology

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### Subjects in a degree course for secondary school teachers

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<th>Term</th>
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<th>Marxism</th>
<th>Leninism</th>
<th>Pedagogics</th>
<th>Psychology</th>
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<tr>
<td>V</td>
<td>9</td>
<td></td>
<td>Teaching practice, preparation and defence of the thesis, preparing and taking of final examinations, special lectures and seminars on education, psychology and methodics</td>
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</table>
The cooperation of various social institutions in realizing subject Productive Work

General process of polytechnical training and education

institutions of education          productive areas of National Economy

Ministry of Education

County Council
directional pedagogical officer

District Council
directional pedagogical officer

Polytechnical secondary school
Headmaster

Enterprise

Polytechnical training
Head of the polytechnical centre

Ministry of...

Director

Director

VEB, VEG, LPG

- Polytechnical Advisory
  Council - responsible
  for productive work
- working men
- engineers, educators
- partners in
  after-school work
- orientation to future
  occupation
- etc.

Pupil

- allround development of the personality
- creativity / flexibility
- needs / awareness of productive-intellectual and productive activities
- originality and productivity in thinking
- commitment in scientific-technological progress
- intellectual and social activities
  etc.

1)

VEB = People's owned
  Factory
VEG = People's owned Farm
LPG = Co-operative farm
Table of lessons of the ten-year general polytechnical school

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| lessons per week                      | 21 | 21 | 24 | 27 | 30 | 32 | 33 | 35 | 36 | 34 | 35 |
Structural pattern of polytechnical education
Polytechnical instruction in forms 1 to 12

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## A selection of groups of interest

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<td>Microelectronics</td>
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<td>Automobile engineering</td>
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<td>Construction of rationalization means</td>
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<td>Repair / maintenance</td>
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<td>Construction of teaching aids</td>
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<td>Telecommunication engineering</td>
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<td>Construction of and sport competition with</td>
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<td>model planes, cars and slips</td>
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<td>Photography</td>
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<tr>
<td>Technical construction / model building</td>
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<td>Technical games</td>
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<td>Elementary work</td>
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Grade 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
The integration of informatics into the subject-matter of grade 7

natural-principles

energy flux

screw-gear
rack-and-pinion
steering gear

electro-motor

information processes
(demand: $R_z < 20$ should be realised by $s!$)

START

INPUT actual value($x$)

$x - w > 0$?

yes

U diminished

no
OBJECTIVES FOR INTRODUCING THE PRODUCTIVE WORK AS AN INTEGRAL PART OF EDUCATION DURING THE SCHOOL STAGE

Schools are institutes for the child's preparation of the daily real life situation, in which human labour uses tools, technical creations for social or individual purposes.

Using of more and more advanced techniques and tools in all professions to help the citizens in the proper handling of technical means.

Real education is related to productivity, to economic activity as a source of social wealth, to social and national integration and to monetary return to the student.

Transferring of the workers' and farmers' experience to the children for their own work and for right attitudes towards work inculcate the spirit of enterprise and self-reliance.

To give an orientation for all teachers for the right valuation of all learning results in all subject-matters.

Orientation and vocational guidance for choice of a vocation during the school stage.

Including of productive situation as an integral part of general education.

The increasing frequency of technical means involves an increase of applied knowledges and skills for each child regarding basic principles of all productive processes, to enable the learners to become intellectual and judicious consumers.

Practical work is a field for putting into practice new scientific findings and it is a source of new learning results.
ITEMS OF SELECTION IN THE DIDACTIC PROCESS CONCERNING TECHNOLOGICAL EDUCATION

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Summary

1. A reasonable selection of objects is - due to the huge number of different technological processes, methods and problems - inevitable. Every syllabus is a result of more or less proved selection.

2. The necessity of selection will become more and more important, as the store of human knowledge is always increasing: more than half of the scientists, which ever lived, live in our days.

3. If we want to avoid too accidental and personal influence and if we want to achieve comparable level among pupils of different schools, we have to use the same methods and items of selection, or at least, we have to lay open the applied instruments.

There are several methods of designing a school syllabus as a result of a selection process:

a. reducing the scientific disciplines of technology (at university or polytechnic) in order to make them suited for pupils of the concerned group;

b. using situations of real, present and foreseeable life to show the role and influence of technology, thus enabling the pupils to get through these problems;

c. optimizing the methods of teaching and learning in order to learn more in shorter time: rationalizing the process of learning;

d. using exemplaric principles, that means common items of (close) related objects, in order to reduce the variety of real objects to objects with key-function.

4. All these methods have advantages and disadvantages. It will be tried to show that the method 3.b. in combination with some other ones is well suited for technological education in the general school system of West Germany.
The importance of technology for a country like Germany is evident, we live from and with technology. As we have neither ores nor big energy resources in our country, we had to develop production technologies which save energy and material.

Especially energy has to be imported, and as we can't change our climate, we depend from expensive import: nearly 80% of the private consumption of energy (including traffic) we need for heating in the winter and this can only be reduced by thermic isolation and automatic controls of the heating systems.

Beyond this, we are a country, where rather high wages have to be paid, so we had to apply information technology for automatisation, a technology where we had to learn a lot from other countries, and we are still learning from them now.

You will see later on, which importance these three terms Material, Energy and Information have for our understanding of technology and technological development. Last but not least, technology is question of political decision, a social process, which has to be controlled by society. So we have to teach it in general education as well as in vocational.

In other words: the sort of technology, which we need for school, is no question of technology itself. The knowledge of technology, however it may be defined, gives us by itself no reference to the items of educational importance. So the engineers can tell us, what is correct in technology, not - what is important for schools.
Before entering the process of selecting, respective the
denomination of items for selection, it is necessary to
determine the components of Technology in the here men­tioned sense, or - as we call it - the dimensions of tech­nology. I think, that this subject will be discussed in
other lessons too, so that I can do it very shortly here.
Perhaps we can pick it up again in the discussion.

1) Technology is always bound to science esp. physics laws
so far, as the science laws mark the frame, in which tech­nology can be realised. That does not mean, that all science
laws must be available, before making technology. Sometimes
technology works - at least has worked in history - without
our knowing precisely, why it works. We have, very often
- only a theoretical model imagination of function.

2) Technology has always a close relation to practice. Theory
in technology gets its value not from itself, but from appliance,
from the possibility to solve new problems in shorter time, in
better ways. Practice confirms vice versa theory respecting the
identity with reality of products, objects or methods.

3) Technology is orientated to economical purposes, at least
normally. Technology serves human demands, normally these demands
are realised in economic ways and items, e. g. prives. Real
technology does not exist because of science laws, but more
because of human demands. So technology is not neutral in value;
before generating technologies, there have been lots of decisions
most of them economical ones.

4) Technology has to be related to the social demands of man too.
The consequences of technology in respect to environment, the
ecological system, the employment, the changing qualifications,
the advantages in respect to supply food and energy, the tackling of diseases and so on - in short words: the fact, that technology is part of a system and not a subject of its own has to be taken care of, if you intend general technological education. We call these the "dimensions" of technology, and I will come back to them later on, when I shall have to give reasons for items of selection.

When listing up a programm (syllabus) for technological education, we have to decide between several main methods from which I select two: firstly we could derive it from that, what is actually done at universities or technical colleges. Looking at that, you would realise very quickly, that the amount of specialised objects makes this impossible: we have about 130 different technical disciplines on technical universities in West Germany, highly specialised and each of them deeply convinced to be the most important one. To avoid this problems, we often use an idea, which has come originally from Boltzmann und Wiener, later on further developped by Horst Wolffgramm in the GDR and Günther Ropohl. This proceeds from the theory, that you can describe real world by the categories Material, Energy and Information. The functions, that means the methods of handling technology, can be described as changing (transformation), transport and storage. By crossing these lines and columns you get the most important technological subjects in a synoptical scheme. (figure 1). Horst Arp will - as I believe - report later on the appliance of this system for teachers training. This way is also followed in some syllabusses in general education in my country.

On the other hand, you could follow the idea, that schools shall not reproduce knowledge, which has been developped at high schools. School - especially in general education - means qualification for situations in real life (so called situations of life) which
are at presence or foreseeable tasks for human beings to get through. By this we follow the theory of S. B. Robinsohn, which starts from the precondition, that education means "fitting for problemsolving" in real life; real life: that means private life, profession and community or society.

We can illustrate this situations by listing them up like following in a "line. 

To master, to go through, these situations or problems, we need qualifications, abilities which can be described as follows: (figure 2)

1) qualification of knowing (cognition), that means disposal of science and knowledge, e.g. attributes of material, science laws, mathematical or graphic describing of technology, systems and methods of organisation of work and production

2) qualification of acting, that means being able and willing to handle technology, also in practical respect.

This has several aspects: Firstly: I hope you agree with me, that technology is never theory alone but always also practical work. This spreads out over all levels, from the unskilled beginners till to the skilled craftsman and to the highly qualified experts. Secondly: Practical work is highly motivating because it is an alternative method to normal learning by sitting and listening, it meets the pupils, where they are. Practical work narrows the gap between school and real life. Thirdly: Some of my students in Germany believe already a task to be done, when it is ready in theory, for instance as a technical drawing: I think they have to learn the
difference between thinking and doing or - in other words - between to suppose and really to be able. There is sometimes a long distance between a plan and its realisation. Experiences in practice help to be careful with theory and a little more modest in estimating own abilities. For the pupil, practical doing can be the correction for a non-perfect design, a correction which comes from the concrete object and not from the teacher. Some of the pupils learn a lot just and only by that, at least they learn to estimate the difficulties of real, technical binding problems solving in comparison to only verbal ideas or projects. Last but not least practical work is a possibility of alternative performance, especially for pupils with less abilities in verbal respects. So it can become the way to build up compensatoric self-consciousnes, to give evidence for abilities beyond the normal mostly verbal scales.

3) Qualification of judging about the value and desirability of a special type of technology.
(Urteilskompetenz)
That means to enable the student to find a defendable standpoint in relation to technical problems, processes and objects. Background of this ability is the above mentioned sophisticated structure of real technology, on the one hand well-defined application of science, on the other economically bound, finally made for the service of man to overcome the restrictions and risks of nature. Technology is never gratis, it costs money, time, work, ressources, it has influence on the environment and needs space - in a small country like Germany a certainly very important idea. But - everytime you have to weigh, to judge the advantages and disadvantages to get a reasonable decision.
There is, nevertheless, a big problem yet to be considered: you always ask for situations, which are important for the future, but you get answers for the present time. To extrapolate to future qualifications, if these are special ones, is rather difficult and normally uncertain. So you must not formulate them too narrow, too special. In consequence of the quick change in technology - regard the time from school to using in real life - we in Germany are on the way "back to the basis", special education should be done in the job itself.

By using this methods, we have found some main fields, which have to meet the following items:

1. their importance is obvious, for the pupil too

2. they can stand as key-objects for technical fields, as seen in figure 1.

3. they offer facilities for own practical doing for the pupil by using materials, tools, instruments, equipment, and so on

4. the dimensions of technology, that means science laws, economical conditions, ecological and political effects can be shown

5. they can be done in normal schools, by normal teachers, normal equipment and pupils of the meant age and school type.
After long discussions we denominated this fields of problems:

- **work and production**
  (methods of production in mechanical engineering, civil and chemical engineering, single and large scale production, job and qualification, ergonomics, (e. g. production of a useful device in single/large scale production)

- **supply and waste managing**
  energy supply (technology of power stations)
  energy saving.
  water and food supply
  refuse and waste water/recycling
  (e. g. plumbing of sanitary or electrical equipment)

- **transport and traffic**
  (means and methods of transportation,
  planning of roads, bridges and traffic systems, controlling of traffic
  (e. g. construction of a suspension bridge, controlling of traffic lights)

- **building and dwelling**
  (stability and durability of buildings, planning, designing and using, methods of adapting the conditions of dwelling to individual demands) (e. g. groundplan of a flat or a house, variation of rooms)

- **information and communication**
  (transforming, transportation and storing of informations, control-technology, automation
  (e. g. logic structures (Boole))
  automatisation of a production process
  computer-aided drawing (CAD)
Literature:


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<th>System of Technology</th>
<th>transformation</th>
<th>transport</th>
<th>storage</th>
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<tr>
<td>material</td>
<td>production engineering</td>
<td>civil engineering (roads, bridges, harbours)</td>
<td>methods of conservation material protecting corrosion prevention</td>
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<td>chemical/physical technology</td>
<td>traffic technology</td>
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<td>energy</td>
<td>technology of power stations</td>
<td>energy transfer (long distance lines, pipelines)</td>
<td>storing of energy - electric - pneumatic - thermic - mechanic</td>
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<td>information</td>
<td>control technology</td>
<td>transfer of informations: - tele-processing - tele-communication</td>
<td>technology of storing informations: - memory units - data recording</td>
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<td>measuring data processing automatisation robotics</td>
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<td>acting (=being able and willing to do it)</td>
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<td>judging (=ability of critical view of real technology)</td>
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Summary

This paper aims to set out a conceptual framework for Technology in schools. In doing so I do not wish to limit its potential within the curriculum of any school, but provide a working model that could aid teachers evolve their interpretations within an accepted model, whilst enabling them to readily evolve methods and strategies necessary to facilitate the development of technological capability amongst pupils.

It is set out in the following form:
1. Preamble.
2. Elements of School Technology - exploring common features that identify Technology in schools.
3. Aims for School Technology - an assessment of its aims and how they may be interpreted by planners of the school curriculum.
4. Implications for Pupil Capability - thoughts related to the development of knowledge, skills, attitudes and personal qualities amongst pupils through School Technology.
5. Planning - some implications for the teacher to consider.

There are many issues that force the development of Technology in schools, this script concentrates on some of those critical to planning for more effective learning.
DEVELOPING KNOWLEDGE AND SKILLS THROUGH TECHNOLOGICAL PROJECT WORK

1.1 Educationalists make many assumptions in their planning and operation of educational processes that involve young people. With the advent of change in curriculum methods in recent years our assumptions may have grown. This, I would advance, is particularly true when reviewing Technology in schools. Through experience we are aware of the varied interpretations that exist in this ever emerging field of the curriculum. These differing perceptions and demonstrations of School Technology only serve to cloud many of the fundamental issues facing the learning situation.

1.2 Before considering in greater detail the essence of these assumptions (and potential dilemmas) let us first consider the nature of Technology in our schools. I am aware that if I follow tradition and attempt to define what Technology is or might be, I will only add to the never ending list of such definitions. I do not intend such further propagation. However, if we take a little time in reviewing Technology in its many guises we can see common elements or features of its modelling in schools. I feel it would be helpful to attempt to identify these elements and use these as a basis for investigations and comments regarding learning practices in schools.
Elements of School Technology

2.1 Evidence for these elements lies in what we expect pupils to do, rather than just to know, in whatever we identify as being Technology in our curricula. Fundamentally most teachers would agree that project work, which demands pupils personal design statements, is a key feature of Technology. We are therefore calling upon the pupils to operate technological processes in order that conclusive statements might be made. Many teachers refer to this element as the PROCESS of Technology.

2.2 As part of the formative experiences that teachers lay before pupils within courses, direction may be given to particular projects. This direction in the early stages of pupil technological development is normally translated into a teacher-authored 'brief' which may well be followed by operational constraints. However, it is hoped that even through this technique, that relevance is given to the pupils ensuing experiences. If this is so then we could identify this element as being the purposeful setting for learning experiences. If the pupils are more in control of the direction of their activities then (provided adequate preparation and counselling has featured in the pupils progressive experiences) surely their ensuing action will be driven by that self-generated purpose. This PURPOSE I identify as the second key element of Technology.

2.3 Whenever pupils engage in active demonstration of their personal attributes toward the satisfaction of a purpose (where the purpose might well be taken from real-world situations as exemplified by the only aim of The Technical and Vocational Education Initiative-TVEI which refers specifically to what pupils should experience) then they must call upon knowledge and skills as a resource for their involvement.
These resources (knowledge and skills) remain tangible and, to a large extent, identifiable to most teachers. It is also true to say that resources of personal qualities (determination, enterprise, resourcefulness, innovation and perception to name a few) which whilst appearing less tangible, and may be even elusive to more traditional teaching techniques, remain equally important in the development of the whole person through their educational experiences. These resources provided for thorough involvement in problem solving and decision making within project work. The third element of Technology is therefore that of RESOURCE.

2.4 To summarise in graphic and text form

Fig 1

**PROCESS OF TECHNOLOGY**

- **HUMAN PURPOSE**
  - Examples: Building sandcastles, Making artificial limbs, Making scientific discoveries, Artistic expression, Feeding, Stirling an airport.

- **THE RESTRAINTS ON TECHNOLOGY**
  - Laws of Science, Technical, Financial, Limits of knowledge, The specified purpose, Personal and Social

- **THE PROCESS OF TECHNOLOGY**
  - Identify problem, Propose solutions, choose the best, Implement the practical design, Test and compare with original purpose

- **THE RESOURCES OF TECHNOLOGY**
  - Concepts and methods of science, Concepts and methods of technology, Material, Sources of information, Manpower quantity and quality, Personal creativity

- **HUMAN ACHIEVEMENT**
  - Adverse side effects
  - Achieve purpose
  - Examples: Culture, Exploration, Comfort, Artefacts, Knowledge, Leisure

- Incidental gain in resources
2.5 Where technology is

i human purpose at an appropriate level drawn from divergent fields

ii the active involvement in the processes that take pupils from a purpose to realising an achievement

iii the acquisition and developed use of resources on which achievement is dependent. These resources being material, physical, intellectual, intuitive and personal.

The Interpretation of Aims in Curriculum Design

3.1 The importance of Technology in our schools is by no means divorced from its importance in society as a whole. Our history and culture is inextricably linked to advances of a technological order (fire, weapons, extraction and conversion of ores, harnessing naturally held energy, etc). It is therefore appropriate that our aims should reflect the development of an individual's competence in, and appreciation of, technology. After all, the world of the late twentieth century encompasses rates of change which could lead to large scale alienation of its citizenry, unless education acts responsibly in raising their awareness and capabilities. Moreover, it would lead to vast human potential being unexplored.

3.2 To these ends three major educational aims provide insight into the manner in which Technology in schools intends to tap human potential in this ever changing world, namely the development of

i an AWARENESS of the nature and purpose of technology, and its significance for the individual, the community, and mankind, including the responsibility of the individual to contribute to its control at all levels and to develop a sense of values in decision making.
the CAPABILITY, both individually, and with others, to engage in the processes of technology, from the recognition of some need, or purpose, to its fully evaluated satisfaction.

the personal RESOURCES needed with which to engage in technological processes including knowledge, intellectual and physical skills, personal qualities and value judgements.

3.3 The nature of real-world situations in which pupils undertake to satisfy a need is inherently cross-curricular. Rarely, if ever, does a problem occur from a discrete area of the curriculum (history, mathematics, etc). We should also be alert to the influence technology has on the developing nature of each of these discrete subjects. It is, therefore, true to say that there is a two-way dynamic relationship between traditional school subjects and technology. Within this little explored relationship will be potential for the development of the scope of the curriculum, as well as providing acknowledged relevance (purpose) to the learning of the pupils. This interaction is discussed more fully in 'Technological Across the Curriculum - Working Paper No 6 School Technology Forum NCST 1986.

3.4 As mentioned previously schools have many interpretations of technology within their curriculum provision. These fall into five main categories

1. Structured Courses - such as Modular Technology or Control Technology which centre on specified aspects of Technology and are normally aimed toward a nationally accepted qualification (General Certificate of Secondary Education - GCSE)

2. Courses - created out of the merging and rationalisation of whole or parts of a number of school subjects. This is where the interaction between
Technology and School Subjects becomes most well developed.

3. General Studies - which quite often develops pupils awareness of technology and its impact in societies.

4. Subject enrichment - where each school subject is required to react to the model of technology given by purpose-process-resource.

5. Projects - where time is given to pupils working as individuals or in groups on projects that may be taken from an industrial/commercial, home or community context. Each of these identified real-world problems may be supported by the pupils' more formal curriculum studies.

Implications for Pupil Capability

4.1 Any of the above interpretations will have their own particular parameters within any one school. Indeed the organisational patterns that permeate both emerging technologically influenced curricula and TVEI curricula are considerable in type and number, each having its own unique reasons for being developed.

For the sake of awareness I include several of the more common approaches to organising technological type curricula.
4.2 Without commenting on the merits or otherwise of each or any of these, I would welcome research to illuminate the worth of at least some of these in providing a worthy prolonged, progressive experience aimed at developing an acknowledgement by pupils of their technological worth.

4.3 As teachers we must not forget that the reasons for our work are for the benefit of pupils, and as such we should always be mindful of the effects of our methods and strategies on the development of the pupils. The learning environment should be such that it enables pupils to optimise their capacities of knowledge, skills, qualities and values. The curriculum requires considerable scrutiny in order to ascertain whether the critical progress of individual pupils is capitalising particular pupil attributes. It is not only for teachers, parents, etc to recognise that pupil capability is being nurtured in this manner, but the education received by the pupil should consolidate this in pupils minds also. For in this atmosphere of confidence and achievement the pupils potential stands a greater chance of being realised.

4.4 As implied earlier the fullest demonstration of a pupil's capacities can be seen when autonomous, extended project work (purpose, process, resource) is entered into.
If we believe that teaching, and its associated strategies, can enhance the manner in which a pupil might operate in these conditions, then we must analyse, plan, synthesise and evaluate our support for the elements of learning (knowledge, skills, qualities, values, etc) during the period of compulsory education. The question is, how can this be achieved?

4.5 Let us first look at a more traditional curriculum organisation.

Our experience in any one of these separate subject disciplines is that pupils do not readily transport information and experiences from one subject situation to another. They see their schooling as a series of unrelated boxes. This is certainly borne out by Her Majesty's Inspectorate (HMI) and other researchers who have shadowed individuals or groups throughout their curriculum experiences for a period of time (normally either one day or one week). Also we find that experiences based on unconfirmed learning methods (where the teacher accepts that learning has taken place because he/she has taught) lead to confusion amongst pupils. This is so whether the need for recall is immediate or after the passage of time. Of course
this is basic educational theory and should not surprise any teacher. However, many in the profession still insist on using techniques that are centred on teacher convenience and not learner orientated.

4.6 Even when planning technology courses, which by their very nature overcome some of the learner difficulty (purpose driven action experiences provide concrete learning opportunities), we should remember that problems in the learning environment can still be created.

4.7 Recent work in the area of 'knowledge as a resource' (interpreted through intellectual skills of knowing how to analyse a situation and explore previous experiences in order to find appropriate, reasoned solutions), particularly that undertaken by Amos Dreyfus (Hebrew University of Jerusalem), has shown that pupils easily transport a variety of ill-appropriate principles to given situations. He likens the situation to a 'lock' and the pupils response to the situation as the 'key'. Dreyfus asserts that pupils misfit key to lock in a variety of ways.

4.8 1. Pupils use totally invalid principles in the answering of the situation. This means that a pupil when asked to find ways of increasing the efficiency of a mechanical machine constructed from a variety of polymer materials might well say that "if the machine is made to go faster it will become more efficient". This is an ill-considered response, but one that could naturally follow a superficial introduction to efficiency. Using the analogy the pupils have tried to fit the wrong key into the lock, but without knowing it.

4.9 2. When faced with the same situation the pupils may
well use a partially correct principle, but one that does not fully (or even satisfactorily) give rise to effective understanding and application. The pupils may resolve that "Oil could be used to increase the machine's efficiency". This (lubrication) in itself is one of many principles that will offer some solution. However, the principle of lubrication in this instance is over-simplified. One might say that the pupils have found a 'key' that has missing 'teeth'. Unfortunately again pupils will think they have found a correct answer.

4.10 3. Children could also say, in answering the same situation that "cooling and lubricating the machine will lead to increased efficiency". This again shows some degree of accuracy in finding principles that are relevant. However, the depth to which pupil understanding is demonstrated remains minimal. It may be true that the friction in the machine produces heat and therefore if we reduce heat the machine will become more efficient. However, in this case the pupil may have found a useful 'key', but one that the teeth are insufficiently developed to fit the 'lock'.

4.11 There are many other conditions where pupils are assumed to be using correct 'knowledge' as a resource, but are in fact not. In the design conditions in which pupils often operate, systematic use of appropriate knowledge therefore has to be balanced with the heuristic approach to their learning. We cannot assume because a pupil 'needs to know' that the pupil will find out. In many instances the pupil is not sufficiently prepared even to 'ask the correct questions', let alone 'find appropriate solutions'.
Complex pattern of constraints could mirror the resource trace. These constraints develop in complexity with the advancement of intellectual engagement in technological activity.
4.12 In the cycle of technological knowledge, knowledge acquired prior to or during a purposeful process may act as a catalyst for experience bringing about more knowledge that can be used as a resource in future situations: care must be given to the strategies used with the learner to create a supportive formation (in the pupil's bank of tangible experiences) of concepts (generalised fields of knowledge) and particular knowledge that can readily be transported by the pupil into project situations.

4.13 It may be that research in this area of concern will point the way to teachers using 'concepts' (stability, efficiency, amplification, conservation, etc) through areas of knowledge and experience (aesthetic, scientific, mathematical, linguistic, etc) as a means of providing support for learning particular facts. Thorough grasp of concepts may also allow pupils to ask the appropriate questions necessary for decisions to be made through reason and justification.

4.14 As with the resource of knowledge, 'skills' cannot be treated as a unique element of pupil learning. Skills exist in order that pupils may operate and perform. These too, as with knowledge may be of a generalised 'transferable' nature (cutting materials, analysing data, communicating, etc) whilst also encompassing particular operational skills (specific methods of joining materials, assimilating drawing conventions, etc). Their development and support is also just as crucial to the enhancement of pupil capability (see Fig 4) as that of knowledge.

4.15 Teachers often assume that the skills required to investigate, invent, decide, test, etc are natural to pupils and are not in need of supporting. These same teachers then are critical of the pupils when aspects of these skills are not demonstrated or are used only
superficially. It is to be considered of importance to the teaching rather than a condemnation of the learner. Providing pupils with the opportunity to progress through a planned framework of support for skill development is necessary not solely to enhance pupil capability, but to satisfy ourselves that education is performing its duty to the whole pupil.

4.16 Mentioned before are the other resources for technological project work. Those of personal qualities (determination, resourcefulness, patience, etc) and value judgements (when to do things, when not and why through economic, social, aesthetic, etc considerations) also require considerable positive thought by the teacher. Planning for the development of such aspects of personal resource are difficult, but not impossible. We the teachers should certainly actively provide environments for the demonstration and development of these resources wherever possible.

Planning

5.1 Certainly, whatever teachers decide to offer in the way of Technology in schools, they should analyse very carefully what they do, the manner in which it is done and what sequence or organisational system they are to employ and why? This does not imply that planning does not occur at present. In many schools considerable thought and care for what is best for the children is devoted to this planning. However it is true to say that many schools function with minimal thought to the effects of the diet of education on the pupils. With something as uniquely integrating as Technology (with its demonstrated interaction with many of the traditional curriculum areas) then the development of its potential in releasing untapped pupil capability must not be left to accident.
5.2 The complex nature of the way pupils will perform in the Technology model - PURPOSE - PROCESS - RESOURCE - is worthy of considerable analysis. I suggest that schools could do far worse than commence their appropriate overall planning, by first analysing what the pupils actually do when demonstrating their technological capability. For this to be done with any degree of conclusion then the means for analysis must be found. Without pre-determining what schools might do, a valid suggestion may come from tracing the elements of learning (knowledge-generalised and particular; skills-physical and intellectual; personal qualities - determination, resourcefulness, enterprise, etc; value judgements - economic, social, aesthetic, etc) during the process (investigating, inventing, deciding, making, testing and reflecting). Of course we must not forget that the reason for this demonstration is given by the purpose of the technological activity.

5.3 Once we are more sure of what the pupils are actually doing in their curriculum then we will be in a better position to plan the way in which future courses might support the development of pupil capability. If this is undertaken within separate subjects then, whilst this may optimise the effects of pupil education in that unit, there will undoubtedly still exist considerable overlap, duplication and repetition that does little to make the curriculum a stimulus for learning. If planning Technology means a complete analysis of what happens to the pupils during their time at school, out of which may appear a more rational curriculum, then so be it. The alternative of top-down subject statements paying little or no regard to the overall, cannot provide educationalists with any degree of satisfaction.
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Pupils' lack of sophistication leading to applications
of unapplicable principles in agrotechnical contexts
Amos Dreyfus - IPN 1987
TECHNOLOGY EDUCATION IN THE U.K.

Dr. Ray Page
South Bank Polytechnic
London, United Kingdom

Summary

In the paper a survey is given of Technology Education in the United Kingdom. Beforehand the author indicated what he means by technology and how he sees the relationship between Science and Technology and between Technology and Society. There are various ways to introduce Technology at schools. No single mode of teaching can hope to give a comprehensive view of Technology and Industry. Usually one mode, or a combination of five modes, have been used in the UK. These five modes are:

a. as a single subject;
b. as enrichment of existing subjects;
c. as part of a general studies programme;
d. as a unifying factor or as a topic;
e. as project work.

Each of these modes is discussed in the paper. The author is convinced of the fact that good curriculum material can develop an attitude to technology and industry, which is likely to lead to more positive consideration of technological careers.
TECHNOLOGY EDUCATION IN THE U.K.

1. A working definition of technology

There are probably as many definitions of Technology as there are branches of technological activity. This undoubtedly arises from the complex nature and purpose of Technology. Nevertheless, it is necessary at the outset of this paper to establish a view of the purpose, process and product of Technology that has some common agreement which can form the basis for establishing the aims and objectives of school Technology and which can offer criteria to judge whether courses and materials can be considered to foster these aims and objectives. The following definition is a summary of such a consensus as far as educational institutions in the UK are concerned that are involved with school Technology.

"Technology is a problem-solving process which has as its goals the improvement of the quality of human life, as its starting point human need, and as its continual companions the resources and constraints of human knowledge and natural resources."

Figure 1 gives a useful diagrammatic representation of this definition and has been adopted by the International Organisation for Science and Technology Education as its working definition of technological activity.

Figure 1 Technology - a disciplined process using scientific, material and human resources to achieve human purpose.
This diagrammatic representation of technological activity illustrates the way in which many of the restraints and resources of Technology are scientifically based, as well as the similarity of the process of Technology with design activity.

There is, of course, a strongly held view that Science teaching enriched by emphasizing the applications of Science, and Craft teaching which emphasizes the design process, gives students a sufficiently round view of Technology. While this may well be true if both these subject areas undertake such enrichment in the same school, it must be remembered that the former can ignore the problem-solving nature of Technology, while the latter can disregard many of the constraints and resources within and with which the Technologist has to work.

The terms "Science" and "Technology" are frequently used together and many people assume that they are synonymous. Although this may only be a case of emphasis, the goals of the scientist are not the goals of the technologist. For example, the scientist tends to emphasize that Science is a field of knowledge and that this knowledge is pursued for its own sake.

Scientists do not have to apply this knowledge to solve everyday problems and when they do, that they are operating as technologists rather than scientists. Also, to cope with the expansion of scientific knowledge, the scientist tends to compartmentalise his or her knowledge and much of a scientist's thinking is of a convergent nature. The technologist, on the other hand, is committed to solving everyday problems and acquires knowledge, from whatever source the knowledge is available, only to help to do this. This involves divergent as well as convergent thinking, constrained and supported by more than just the boundaries of scientific knowledge.

The technologist working as a problem-solver operates within particular constraints and with particular resources and, in this respect, closely resembles a designer. However, while a designer tends to concentrate on the aesthetic aspects of a problem, the technologist must have regard for its functional, technical and scientific aspects as well. Anyone who plans a particular activity is to some extent a designer, and it would be wrong to imply that the technologist just does not have to plan according to a
framework which is very close to that of the designer. Again, the frequent use of the title "Design and Technology" to describe school examination syllabuses has led many people to assume that these two activities are one and the same thing.

While accepting that some educationalists see the scientific, the design and the technological processes in much more synomymous terms than presented in this paper, and others argue that the design function subsumes the technological process, there is equally a body of opinion that sees these two viewpoints as an oversimplification which can detract from the nature and purpose to Technology as earlier defined in this paper. That is, that Technology is not a defined area of knowledge, but rather a process drawing on our knowledge and resources, while its purpose is to improve the quality of some aspect of human life. Frequently, the counter-view is held that Technology pollutes and destroys, rather than creates and improves. This point needs to be explored a little further to understand the relationship between the process and the people who operate it.

2. Technology and society
Many commentators believe that pupils leaving schools in the United Kingdom have little awareness of the role of Technology (and Industry) in our society. For example, the criticism has been made that schools have formed and reinforced negative attitudes in the minds of pupils towards such things as technological development and industrial careers, with the result that many young people do not see technology as a poverty reducing agent, but as a necessary evil. They just reject a career in industry or technology because of the low esteem with which these are held. Certainly, the point must be clearly established that the technological process in itself is neither good nor bad, it is the use to which it is put in any society by the people who use it that determines its outcome. In a democratic society, that outcome must be determined by its citizens if that society is to remain truly democratic.

Although technological activity is not identical with industrial activity, the manufacture of goods to satisfy the needs of any society and the improvements of its living standards must constitute the major technological activity of that society. This activity forms the basis of the 'high technology' approach of the developed countries, the UK included. But as
the developing countries move from less organised approaches, or less sophisticated and complex ones - the 'alternative' or 'third world' technologies - to those of the developed countries, they challenge the latter to adopt even more sophisticated and advanced commodities. 'High' technology is not so labour intensive as 'intermediate' technology and so employment problems may be created as a result of change to the former. This is a dilemma that faces the developed world today. Furthermore, 'high' technology and industry are very demanding on energy and other material resources which are no longer present in large supply. The arguments that many serious minded people put forwards for an 'alternative' technology which emphasises conservation and the use of non-exhaustible energy resources cannot therefore be dismissed lightly.

Any technological advance which is mishandled can bring unwanted social problems, and the advent of the micro-chip is no exception. To opt out of the micro-chip revolution in the developed countries would only increase unemployment as both the home and overseas market are lost to competitors. Certainly the micro-chip will create jobs as well as destroy them and improved medical care and increased leisure will also provide more jobs. But this will mean more retraining programmes, the upgrading of skill level, and sufficient financial support for the caring and leisure services to expand, however that finance is created. People will also have to acclimatize to a shorter working week and more than one job in a lifetime. If any conclusion can be drawn from these brief comments, it is that at the present moment there is no guarantee of full employment in the UK and other advanced manufacturing countries even if their economy and industrial output remains relatively strong. However, it would be wrong to indicate that doom is automatic. If it is possible to encourage young people to realise that the manufacturing industries can produce wealth that reduces poverty, not only in the developed countries, but throughout the world, and that to take part in the microprocessor revolution can help mankind as much as becoming a doctor, a nurse, a teacher or a social worker, then at least there will be a shift up careers in technology and industry. However, Governments of the manufacturing countries will also have to ensure that the wealth created goes to the many and not the few if the general quality of life is to be improved.
We must also be very careful that the present shortage of young people to fill technical and craft apprenticeships and jobs is not overplayed in the developed countries. There is a danger that the present Technology courses being introduced into schools in the UK and other developed countries may be geared too much in this direction, rather than trying to raise the general esteem of young people for technological and industrial activity, as well as their "self-sufficiency" in applying the knowledge they have gained from other parts of the curriculum. Care must also be taken in the current climate of concern about standards in the basic areas of the curriculum on the one hand, and financial cutbacks on the other, that the traditional craft skills, physical education and creative arts pursuits which give so many young people the means by which they can use their leisure constructively, are not reduced to a meaningless level.

Finally, if anyone doubts that the above issues are real, let it be remembered that the agricultural industry in the UK which once employed as much as 80% of the nation, now only has a 4% workforce producing our total food output and that many cars now come off totally robotic-controlled mass production lines.

3. Technology and the school curriculum

It has been argued by many that the nature of Technology and the present problems facing industrial activity in the industrialized countries constitute a too complex subject to be studied in the school curriculum. With so much pressure on the curriculum in schools as well this is an attractive argument. If technological activity is to be introduced into the school curriculum, there must be strong reasons for so doing. Four principal arguments can be advanced for the inclusion of Technology in the school curriculum.

First, technological activity involves the application as well as the acquisition of knowledge, and it is certainly no respecter of subject boundaries. For this reason alone, it is of great value in strengthening two highly desirable factors in the school curriculum, namely a problem-solving approach on the one hand, and an inter-disciplinary one on the other. In the changing world that young people must face it is important that they are given self-sufficiency skills which allow them to adapt to the society of
which they are to become a part.

Secondly, the manufacturing industries are likely to remain the principal wealth producers of the UK and many other countries for the foreseeable future. Without them there will be no food, shelter, clothing or warmth, let alone any form of welfare state or cultural activity. But resources are becoming scarce, particularly energy resources, and this poses problems about the balance of the biosphere and technosphere. Can we leave the younger generation ignorant of such problems?

Thirdly, to attract the necessary manpower of quality to sustain industrial growth at whatever level in any country, that activity must be held in high esteem, especially by more able pupils. Thus an awareness by pupils of the dependence of their society on technological activity is vital to their country's survival.

Fourthly, pupils must be educated to a level where they can make an informed judgement of the existing political and economic structures of industry, because the technological process in itself is neither good nor bad. It is the use to which technological and industrial activity is put that needs close examination and monitoring. In a democratic society we can hope to ensure good use by producing a technologically literate society and by attracting some of the best of our able young people into technological career and industry. A technologically literate society cannot be achieved until the third culture - the Technik - is restored to the school curriculum.

This is an argument that has been accepted by the UK Minister of State for Education, Kenneth Baker. Technology now forms part of the National Curriculum for England and Wales.

Thus the overall aims of school technology must be to let pupils experience the technological process for themselves, learn something about technology and how it impacts on society.

4. Ways of introducing technology into schools
No single mode of teaching can hope to give a comprehensive view of Technology and Industry. Usually one or a combination of five modes have
been used by schools in the UK. These five modes are:
a. as a single subject;
b. as enrichment of existing subjects;
c. as part of a general studies programme;
d. as a unifying factor or as a topic;
e. as project work.

4.1 Technology as a single subject
In this mode Technology is offered as a structured course in its own right, based on either the Science, the Technical or the Craft, Design and Technology departments or involving a combination of these departments. It is frequently offered as a choice subject rather than as a core one and taught on a team basis. This mode has much to recommend it, because it fits into the existing school framework and can be examined at 16+ and 18+, but suffers the disadvantage that the emphasis may still appear to be on the acquisition rather than the application of knowledge, and pupils do not experience the technological process for themselves, unless a project is specifically included. The main pragmatic gains of a structured course are:
a. it offers an examinable subject which gives it status in the sight of headteachers, parents, local industrialists as well as pupils themselves;
b. it makes less demands on a school's resources and space than does more open-ended and extended project work;
c. teachers do not need to be highly expert in anticipating and dealing with unpredictable problems at short notice;
d. it works within a framework in which disorderly behaviour is easier to control;
e. it is easier to time-table and one person can be seen to be in charge.

The educational advantages of a structured course are:
a. it is important for pupils to learn about Technology and Industry as well as behaving as technologists or experiencing how industry operates;
b. for many pupils the demands of extensive project work or rather more diffuse general studies are beyond them;
c. for pupils taking either Science or Craft courses, a structured technology course can complement the Science taken by more able pupils as well as keep a Craft element in their curriculum for a while, for not so academically motivated pupils who tend to opt out of pure Science
courses, it can offer an element of Science and, at the same time, complement their Technical Studies or Craft.

If a project is included, the advantages of project work are also gained and these can largely offset the criticisms that the structured course:

a. tends to foster the acquisition rather than the application of knowledge;
b. gives a limited view of Technology, emphasizing the resources and restraints rather than the process;
c. is subject-based rather than skill-based and develops convergent rather than divergent skills.

While many Science departments do run a Technology course along similar lines to those mentioned above by themselves, they are generally hampered where a project is involved unless there is close co-operation with the Craft or Design department. Experience has therefore shown that really successful Technology courses need to be a joint venture by both the Science department and the Craft and Design departments.

Frequently, a structured course is used to replace existing courses such as Physics, or as an acceptable alternative (e.g. Engineering Science in place of Physics at A level - the UK examination at 18+ which precedes University entrance). Alternatively, it can act in a complementary capacity (e.g. a Technology course based on Modular Resources in Technology). Some structured courses try to give an overall view of Technology and Industry, while others look at one facet. Finally, some structured courses are not long enough to stand fully in their own right and form part of a larger course.

4.2 Technological enrichment of existing curriculum subjects

In this mode Technology is introduced as the enrichment of existing curriculum subjects, in particular, Science, Craft and sometimes the Humanities (e.g. Geography, History). Although this may be the only way a school can introduce technological activity and industrial awareness, the disadvantages of this type of approach have already been alluded to. However, the gains of such an approach can be listed as follows:

a. in the early years (e.g. nine to thirteen) it can provide the necessary base for later courses on Technology or extensive project work;
b. it can show the dependence of Society on Technology and raise the esteem for Technology and industry, especially if enrichment takes place both in the Science and Craft and Humanities programmes;
c. it makes the least demand on existing time-tables and organization and meets the least resistance from teachers;
d. it has value for later development in industry if the course contains elements of problem-solving, planning and decision-making (1).

Against these gains the dangers of the subject enrichment approach must not be overlooked, namely:

a. in Science and Craft Studies, Technology can become confused with applied Science and Design and the pupils receive less than a rounded view of technological activity;
b. it puts Technology in second place and as such can foster the attitude that practical studies are not as important as purely academic ones;
c. it does not easily change attitudes and develop the skills and understanding about Technology, implicit in the aims listed earlier unless the enrichment spreads across the curriculum;
d. it may be difficult to decide who should co-ordinate the enrichment approach when more than one department is involved.

However, this approach has been found useful in the early years in UK secondary schools, particularly as a forerunner to applied Science, Technology and Design courses at GCSE. It must be admitted that it has proved to be as acceptable a way of introducing Technology into secondary schools in the UK as the single-subject approach. The UK Government's Science Inspectorate have indicated that they believe Science teaching in secondary schools should include an element of 'Science for action' and the UK Association for Science Education in the review that they undertook some five years ago of school Science have indicated that the role of Technology in Science teaching must be considered. The re-naming indicates the thinking of the UK Government's Craft Inspectorate on this matter as well.

4.3 Technology in general studies
This mode is really a variation of the last mode but it differs slightly in that it introduces Technology as part of a General Studies programme,
which makes it easier to achieve good balance between the various components of technological activity. Certainly it is possible to acquaint pupils with aspects of 'living with Technology', but they may not experience much decision-making for themselves and the teaching approach may easily become a 'talk-and-chalk' one. Pupils may also form the impression that Technology has nothing to do with the other subjects of the curriculum, while nearly all such subjects do in practice have a contribution to make.

At a practical level, however, this mode can keep a technological component in the programme of 16+ students in schools or Further Education Colleges who would otherwise drop work in this area. The British Petroleum 'Decisions' kits that were developed by the School of Education at Bath University proved to be very successful in giving students a real taste of management decision-making from an industrial viewpoint, and the Science and Technology in schools project known as SATIS have produced a lot of material on particular topics that gives a general overview of technology or a technological problem for a particular topic, e.g. Acid Rain.

4.4 The 'topic' approach
In this mode Technology is introduced as a unifying factor throughout the curriculum where several departments link forces to develop a particular technological theme or topic. Until more secondary schools become less subject-bound in their organization, this approach, while having much to commend it, will suffer from lack of sustained and continuous activity.

This approach, however, is certainly used by primary schools and with the right support and encouragement much valuable work can be done in the primary school context. Certainly an early introduction to technological activity can produce positive attitudes which will augur well for future development. Educational Support Grants from central government in the UK has helped this work develop in UK primary schools.

4.5 Technology through project work
The fifth and final mode of introducing Technology into the curriculum is through extensive and/or open-ended project work, frequently based on a
technical activity centre, and therefore often run as an extra-mural activity. As a consequence, project work is frequently beyond the capacity of many UK maintained schools, especially those in rural areas where children are transported by bus to school from the outlying regions. It is therefore the independent private schools which have tended to adopt this mode where, as an afternoon/evening/weekend activity it does not interrupt classroom-based teaching. This mode does pose a few problems, since:

a. it is not easy to time-table;
b. it demands a large resource bank of information, ties up equipment needed for other courses, and needs its own accommodation and storage;
c. it requires pre-project skills and knowledge and a fairly extensive independent-learning back-up facility;
d. it is difficult, but not impossible, to assess in objective terms for examination purposes;
e. it requires experienced staff and takes several years to build up effectively.

On the other hand, when run successfully, project work allows:

a. pupils and teachers to work alongside one another as co-workers and co-problem-solvers;
b. pupils to experience the technological process for themselves, providing they have developed the necessary skills in the work that precedes the project;
c. decision-making skills to be developed and knowledge to be applied rather than acquired;
d. cognitive, affective and psychomotor development to be integrated into the problem-solving aspect of the work;
e. pupils to work at their own pace, realising their own limitations and abilities, so that they are more intrinsically motivated (1).

Thus, although project work by itself may leave pupils knowing about how technologists work but ignorant of the range and scope of Technology and its relationship to manufacturing industries, in terms of motivation this mode has much to recommend it as it is central to technological activity modelling itself on the core process of Technology.

Quite a lot of impetus has now been given to this mode in maintained
schools (as well as the independent sector) with the setting up of prestige project competitions such as those organized by the Department of Industry's 'Young Engineer of Great Britain' and by the Design Centre. Some county Education Authorities are now organizing similar competitions at a more local level. Many teachers still have reservations about the competitive element of such work but others would argue that it gives pupils a chance to experience life as it really is.

In order that single-subject courses in Technology can fulfill the aims for school Technology, it is necessary that they include a project.

4.6 Which mode is best?
There can be no answer to this question as the need for these different strategies in introducing technological activity into schools, is inherent in the nature of Technology which, it must be stressed, is not a defined area of knowledge but rather the process by which men and women learn to cope with their environment. It is therefore important that teachers choose the right strategy for their particular situation. At present, the single-subject and the subject enrichment approach seems to be very popular in the UK, especially when combined with structured project work.

Because not one way has been identified as the best method for introducing technological activity, projects that have been charged with producing materials to help teachers with the task of introducing technological activity into schools, have frequently developed a modular approach to the production of material so that it can be used in the most flexible way.

5. The benefits of a modular approach
Although some of the advantages of a modular approach are apparent without discussion, they are listed here for completeness, together with illustrative examples from the School Curriculum Development Committee's "Modular Resources in Technology" (2) with which the author of this paper has been particularly associated, referred to MRIT from now on. A modular approach:

a. allows a flexible approach to developing single subject courses, provided the age-range of the material is born in mind; the MRIT project's material, developed for able 14-16 year old pupils, has trialled a three
and five-module course and four-module course has been developed by a separate group of schools;

b. means single modules can be used to enrich existing courses, and in this context may be used more to the extreme of the age-range for which the material has been designed; e.g. the MRIT project's material has been used in third form Physics and Craft programmes for very able pupils, and at sixth form level in General Studies programmes;

c. allows link schemes to be developed between schools and other institutions; e.g. some schools using the MRIT project's material for a five-module course have completed three modules in the fourth year in school while the other two modules and a project have been completed at a local Technical College;

d. helps school-based or locally-based curriculum development by offering a base from which home-grown modules can be developed or by supplying, say, three out of four modules needed to establish a course, leaving the fourth to be developed by the staff of a school or local workshop group; e.g. Schools in one Local Authority developed a five-module course based on the MRIT project's material but developed one of its own modules on "Microprocessors"; similarly some other schools came together to develop their own "Control Electronics" module, which is being used in their Technology courses;

e. allows schools to orientate a single subject course, or an enrichment approach, to the needs of the pupils, the expertise of the teachers and the resources of the school; e.g. the MRIT project's modules range in equipment costs from £40 to £2400 so a school on a limited budget does not have to fund the £2400 module because alternative modules are available;

f. makes the up-dating of material easier since individual modules can be re-written when they become outdated, rather than writing a whole new course, or by adding new ones; e.g. the demand for topics first discerned by the MRIT Project team has changed since 1976. As a consequence, "Technology and Society" and "Optical Instrumentation" modules have been entirely re-written and each module has also undergone up to three revisions as a result of trials. Work has begun on a "Robotics" and "Ergonomics" module to take account of technological advances and the need to accommodate girl's interests.
6. The disadvantages of the modular approach

It would be wrong to overlook the shortcomings of a modular approach. These can be identified as:

a. A lack of balance in content and non-achievement of aims caused by choosing modules looking at very similar topics, concepts and examples: e.g. "Electronics", "Pneumatics", "Microprocessors" are all concerned with control and have a similar conceptual base;

b. A possible overloading on information which can be overcome by placing a maximum limit on the number of modules used;

c. A difficulty in establishing any significant difference in curricular need from one group of pupils to another as 'curricular need' is often interpreted as 'teacher interest'.

The "MRIT" team tried to overcome the first criticism by adopting two approaches. The first approach was to make three modules out of five compulsory, namely "Energy Resources", "Materials Technology" and "Problem Solving". This core was then designed to cover the aims listed earlier. The second approach was to see sufficient modules developed for a three-module scheme, that schools would be able to avoid this pitfall themselves and to ensure that topics were chosen that avoided duplication. Only in "Pneumatics" and "Electronics" is there any significant overlap of ideas, but the emphasis is still different enough that it has not been thought necessary to include an 'exclusion' clause.

The second criticism has been avoided by designing the modules to provide teaching material for ten to fourteen weeks. This sets a limit of five on the number of modules that can be used to produce a two-year (5 term) GCSE course with a project. Again it would also be difficult to run a course with less than three modules.

7. Teacher training

In the context of the varied demands laid upon a teacher training technology, overlaid with an on-going shortage of physical science and craft (or industrial arts) teachers, teacher training has not been an easy task in this field and has been one of the factors slowing down the introduction of technology into UK schools.
In the early days of curriculum development of school technology two levels of teacher training were thought to be needed, namely:

a. Initial training through a 1 year Postgraduate Certificate of Education (PGCE);
b. In-service training of existing Physics, Chemistry, Craft and Technical Studies teachers (INSET).

The author was involved in developing a PGCE course in Applied Science and Technology at Bath University School of Education in 1969 but with others in the field found it was difficult to recruit this type of course, as posts were not available in schools because schools did not have existing teachers to set such courses up and create the demand for new entrants. So the few young teachers who did train went out to teach physical science or craft studies and then tried to set up their own technology courses. However, they were often defeated by their inexperience and lack of status.

So attention switched to training experienced teachers (INSET). Here the difficulty was that many of them were already teaching in shortage subject areas and so release was difficult and progress was slow, but was more successful than the PGCE approach in the early years of school technology.

However, the INSET courses provided were often not long enough to give sufficient experience and skills and led to no recognised qualification. Proper training demands getting in-depth experience of the resources and processes of teaching technology, particularly in handling project work and topics outside a participants experience (e.g. electronics and instrumentation for craft teachers; mechanisms and pneumatics for physics teachers; etc.).

A break through came when the National Centre for School Technology at Trent Polytechnic in the UK set up a part-time (and then a full-time) BEd for secondary teachers in school technology. This course was able to provide the depth and qualifications needed to attract experienced teachers to retrain or reorientate (particularly craft teachers).

The Open University of the UK around the same time also provided a degree route for experienced teachers without a degree that could include a
unit on school technology. This has now led to the Open University offering an Advanced Diploma in School Technology which will give impetus to senior teachers gaining a qualification in this field. Part of the Diploma is devoted to Attitude Testing (which the author of this paper has written) as well as major issues such as teaching controversial topics, equal opportunities, and developing an appropriate framework for technology education.

From this experience of teacher education in the UK it is generally felt that teachers need more than 1 year PGCE after their degree to be effective technology teachers until the subject is well established. Thus the emphasis needs to be on training or re-training of experienced teachers in the first instance.

When technology is more established in the school curriculum initial teacher training courses become both necessary and viable. In the UK the establishment of technology has been helped by a national initiative called the Technical and Vocational Education Initiative that makes a technology component compulsory for all schools taking part in the project, and by the Minister of State for Education recognising technology as part of the national curriculum. Without this additional supply of technology teachers acute shortages soon develop. With more senior teachers of technology in schools, young graduate teachers can gain sufficient help to develop into experienced teachers.

Under encouragement from Central Government, a number of initial teacher training courses in the UK have recently been started for technology teachers. As well as one year PGCE courses and BEd degree courses, concurrent sandwich degree courses in Engineering linked to a parallel teachers' certificate course have been set up (e.g. at Bath University and South Bank Polytechnic). Under such schemes, the sandwich year of an industrial placement is split between a shorter industrial placement and part of the teachers' certificate course. Prior to the sandwich year, a "taster" course is run in year 1, followed by pedagogic studies for one morning or afternoon during year 2 in addition to a student's degree programme. Some degree studies of this and the final year contribute to the degree as well as the teachers' certificate, in such areas as design study and technological
problem-solving.

Concurrent degree and teachers' certificate courses are not new, but have only recently been acknowledged as providing certain advantages over either the BEd route or degree plus PGCE route.

PGCE courses have been criticised for their shortness (only 36 weeks) because they do not allow student teachers to develop sufficient understanding of pedagogic theory to underwrite their classroom experience and a prior commitment.

The BEd degree has on the other hand been criticised for the tension between the personal education of students and their professional preparation particularly method work. The degree also has little currency outside teaching.

The concurrent degree and teachers' certificate route overcomes most of these problems in that students:
- commit themselves only after a "taster" programme;
- get a full academic degree with an industrial placement, so their degree has currency outside teaching and with their academic professional Institution;
- are qualified to return to teaching in later life without having to undergo a major retraining course (and several do this);
- have more time to assimilate ideas and test them out in practice, finding out more about their strengths and weaknesses in the process;
- tend to be less opposed to new ideas and methods than their PGCE counterparts;
- improve their own personal learning skills to the improvement of their degree studies in many cases;
- influence teaching methods used on their degree modules, giving additional benefits to all students.

8 Conclusion
The teaching of school technology is not easy but is vital for any country's development. Effective strategies can be developed, particularly using a modular approach. Attitudes towards technology will not change without a
curriculum input. Teacher training needs an emphasis first on the in-service of existing teachers and then student teachers as the demand grows. Attitude studies have shown that attitudes towards technological activity and industry are not as strong if there is no technological component in the curriculum (3) and that materials such as the "Modular Resources in Technology" can develop an attitude to technology and industry which is likely to lead to a more positive consideration of a technological career as such careers currently exist (2).

Therefore it is both important to develop appropriate material and to assess what changes it brings about in pupils' perceptions and attitudes. PATT has in the author's view rightly done this at this third International Conference.

References
TECHNOLOGY IN PHYSICS EDUCATION

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Summary

Since 1984 the Project Physics and Technology is carried out in the Department of Physics Education of the Eindhoven University of Technology. The PATT-research resulted from this project. The main question of this project is: which characteristics of technology can be taught to pupils of 12 to 15 years old, so that they get a better concept of and attitude towards technology? The research consists of 3 parts:
1. research into the content of the concept 'technology' in education,
2. research into the concept of and the attitude towards technology of pupils who did not have technology education,
3. development and evaluation of courseware on technology for physics education.

The first sub-research resulted in a description of technology in five characteristics (see the report 'What is Technology?').

The second sub-research has already been described in report books of previous PATT-Conferences.

In cooperation with teachers of physics 6 courses on technology have been developed. These are meant to be used in physics education. The evaluation of these courses is focused on the research into the concept of and attitude towards technology of pupils who have worked with these courses. It appears that these pupils have a concept of technology that is not so much focused on product as the concept of pupils from the second sub-research. They grew to more alive to designing and problem-solving in technology. They have also acquired some knowledge of technical subjects. Not all characteristics of technology could be made clear in the physics lessons. It appears that a separate subject technology is not superfluous. Boys liked the technology lessons better than girls, in spite of the fact that during the development of the courses we paid special attention to the attractiveness for girls. In the development of technology education there has to be special attention for this problem.
WHAT SHOULD AND CAN PUPILS LEARN IN TECHNOLOGY EDUCATION

Introduction
In our society technology has an important position. Therefore elements of technology should be taken up in education.
Many professions are of a technical kind. The orientation towards a choice of a later profession is a second reason to acquaint all pupils with technology in education.
Three ways to do this are:
1. integrate technology in physics education,
2. integrate technology in various existing school subjects,
3. introduce technology as a separate subject.
This research is about the question how technology can be integrated in physics education. The results of the research are also used to give recommendations for the introduction of technology as a separate subject.
In this respect we first of all think of pupils in the lower part of secondary general and pre-university education. In the second instance we pay attention to the upper part of these types of education.
The research was carried out in the framework of the project Physics and Technology. Research and development work are combined in this project.
It is the aim of this project to teach pupils the characteristics of technology in physics education.

1. The research questions and the design of the research are discussed
The main question of the research is:
"What elements of technology can be integrated in physics education, so that pupils get a balanced concept of technology and a balanced attitude towards technology?".
With a balanced concept of technology we mean being able to distinguish the characteristics of technology. With a balanced attitude we mean being aware of both the positive and the negative aspects of technology.

Three sub-questions arise from the main question:
1. what are the most important characteristics of technology that people want to integrate in education,
2. what is the concept of and the attitude towards technology of pupils who did not have technology education yet,
3. how do pupils experience the use of courseware on the characteristics of technology and what is afterwards their knowledge and concept of and attitude towards technology?

Each of these three questions was answered in a sub-research:

ad 1. the first sub-question by means of a literature study into the characteristics of technology, combined with an oral consultation of experts,

ad 2. the second sub-question by means of attitude research among pupils in the second grade of junior and senior secondary education and pre-university education. This research was carried out by means of the following instruments: a questionnaire with items of the Likert-type, a list of open-ended questions, essays, and a list of subjects and professions.

ad 3. the third sub-question by means of the development and evaluation of six courses of physics, in which the characteristics of technology are dealt with. The following instruments were used in the evaluation: a pupils' questionnaire with Likert-items, a teachers' questionnaire, course-evaluation forms, tests and observations.

The research was carried out in the period between September 1984 and February 1988.

2. The first sub-research: the characteristics of the concept 'technology' in secondary education.

In literature five characteristics of technology were found. Experts we consulted agree with these characteristics.

The characteristics are:

1. technology is an essential feature of mankind.

Three consequences of this are:

a. there is a relation between one's view of mankind and one's view of the world, and one's view of technology,

b. technology goes with both men/boys and women/girls,

c. technology, as mankind, undergoes a historical development;

2. matter, energy and information are the 'pillars' or base material of technology;

3. there is a mutual influence between technology and natural sciences. This influence concerns both the methodology of technology and natural sciences and also the technical and scientific knowledge;
4. the three most important skills in technology are:
   a. designing,
   b. producing,
   c. using technical products;
5. there is a mutual influence between technology and society.

3. The second sub-research: the attitude of pupils towards technology.
This subresearch has already been described in the reports of PATT-1 and PATT-2.
These are the most important conclusions:
1. pupils have an incomplete and distorted concept of technology. This applies to girls to a greater extent than to boys;
2. the pupils' overall interest in technology is moderately positive. Boys are more interested than girls;
3. the attitude of girls is different from that of boys. For most dimensions the attitude of girls is less positive than that of boys. Only with reference to the possibilities for girls in technology girls have a more positive judgement;
4. pupils from junior secondary school have an attitude towards technology that is different from that of pupils from senior secondary or pre-university education. Pupils from junior secondary school are more interested in technology, are more acquainted with technology and they see more clearly the importance of technology than pupils from senior secondary and pre-university education, but they do not have such a broad concept of what technology actually is;
5. the influence of the parents' profession on the attitude towards technology is small.
The PATT research came forth from this second sub-research of the project Physics and Technology.

4. The third sub-research: the experience with and the results of physics lessons on technology.
In cooperation with teachers of physics six courses of physics were developed:
1. Making musical instruments,
2. Electrical equipment at home,
3. Communication,
4. Water at home,
5. Do-it-yourself,
The courses 1 up to and including 4 are meant for the lower part of secondary general and pre-university education, the courses 5 and 6 are for the upper part of these types of education. The five characteristics of technology have been taken up in the courses. The courses for the lower part have the same structure. The basic material consists of five chapters:
1. the recapitulation of the subject-matter of physics that pupils have to be acquainted with to be able to study the remainder of the course,
2. a chapter about the stages that a designing process consists of,
3. two chapters about the way two existing technical products have been designed,
4. a chapter about the social aspects of technology,
5. a chapter that was added in the second version of the courses, in which the characteristics of technology are recapitulated.
Teachers who wish to do so may use revision material and additional material as a supplement to the basic material.
The developing strategy that was used in the development of the courseware has been evaluated by means of a questionnaire among the author-teachers. The teachers had a positive judgement on their contribution to the development, but they indicated that the work was a heavy burden on top of their regular teaching task.
Preceding the use of the courses an exploratory research was carried out into the attitude towards technology of physics teachers in secondary general and pre-university education, and they were compared with teachers of mathematics, craft and English at secondary general, pre-university and senior technical schools. The physics teachers had a better concept of technology than the pupils and their attitude was rather positive.

For the users of the courseware regional information meetings were held. Both the first and the second meeting was visited by ten teachers.
The first version of the courses was used at fifteen schools. A formative evaluation took place on the basis of the results of teachers' and pupils' questionnaires and tests. The second version was used at eighteen schools. Data from 880 pupils were gathered. Apart from the slightly adjusted instruments of the formative evaluation, observations were used as well as
instruments for the summative evaluation.

The analysis of the results of the pupils' questionnaire consisted of frequency analysis, factor-analysis, t-tests and regression-analysis. The group of pupils from 5th form pre-university education was not involved in the regression-analysis. This group appeared to be different from the other pupils, both as regards the initial situation and as regards the eventual situation. For the teachers' questionnaire and the tests only a frequency-analysis was carried out. The reliability of the results was determined by means of the homogeneity coefficient alpha, the validity was determined by comparing the results of the teachers' questionnaire and the observations with the results of the pupils' questionnaire and the tests. For the pupils' questionnaire factor-analysis was used as well in order to determine the concept validity.

These are the most important conclusions from this sub-research:
1. the interest in technology of pupils who have studied the course material is less than that of pupils who did not have technology education (investigated in the second sub-research). Liking the course material has a positive influence on the interest in technology;
2. after studying the course material pupils think positively about the opportunities of girls in technology, as did pupils who did not have technology lessons;
3. after the lessons on technology pupils think that technology is important; pupils who worked with the courses have a broader concept of technology than pupils who did not work with the courses and they think that technology is less accessible;
4. after the physics lessons on technology pupils realize that there is a relationship between technology and mankind and society, that there is a relationship between physics and technology and that designing is an important skill in technology. There was not enough attention for practical-technical skills in the lessons;
5. after the technology-lessons pupils have a fair knowledge of technical products and of the technical designing process. They did not acquire the skill to design something themselves;
6. the lessons on technology mostly appealed to boys, to pupils with an ambition for a technical profession and to pupils who are about to choose physics as an exam subject. The more practical work the technology-lessons contained, the higher the appreciation of the pupils.
was;

7. both before and after the technology-lessons the pupils from the 5th form of pre-university education showed a rather positive attitude towards technology and they had a rather broad concept of technology.

5. **Integration of the results of the three sub-researches**

On the basis of the three sub-researches the answer to the main question is as follows:

"It is possible to teach pupils in the framework of the physics lessons by means of the courses developed for this purpose, to distinguish the following characteristics of technology:

- the relation between technology and physics,
- designing as a skill in technology,
- the relation between technology and mankind and society.

The attitude of pupils that used the courses is for some points more positive, for others more negative than the attitude of pupils that did not use the courses.

After the technology lessons the pupils generally have a rather positive attitude towards technology".

Additional products of the research are:

1. a description of the concept 'technology' for secondary education, consisting of five characteristics,
2. an instrument to measure the attitude of pupils towards technology,
3. six example courses on technology for physics education.

The results of the research lead to the following recommendations:

1. it is recommendable to discuss technology in the physics lessons in such a way that the most important characteristics of technology are given specific attention;
2. in the teaching of technology specific attention should be paid to the attractiveness and the relevance of it for girls;
3. for the teaching of technology teachers should be given guidance and inservice training;
4. in the school subject technology the five characteristics of technology we postulated should be discussed to convey to pupils a balanced concept of technology.
TECHNOLOGY AS A SCHOOL SUBJECT: THE KENYAN EXPERIENCE

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Summary

The paper starts by tracing and highlighting the origin of education in Kenya up to the present state. Various shortcomings in the old system are identified especially the lack of planned and integrated technological curriculum essential for successful economic development in the educational system.

The difficulties of introducing technology as a school subject in the Kenyan school system are looked at and possible solutions advanced based on experiences gained in Kenya and elsewhere. The various efforts being put in by the authorities to overcome these difficulties are cited, especially the recently introduced system of education which places more emphasis on a technological oriented type of education.

Results of recent PATT-pilot scale studies in Kenya are presented to give an idea of what the concept of and attitude towards technology is among Kenyan pupils. These results show a wide variation in what is conceived as technology, thus adding to illustrate the difficulties of introducing technology as a school subject.

The paper is concluded by presenting a summary of the proposed joint large scale research project into pupils' concept of and attitudes towards technology and its impact for the Kenyan school curriculum to be done by the Appropriate Technology Centre, Kenyatta University, Kenya and the PATT Research Team of the Eindhoven University of Technology, The Netherlands.
TECHNOLOGY AS A SCHOOL SUBJECT: THE KENYAN EXPERIENCE

Background
Formal education was introduced in Kenya by Christian missionaries sometimes during the middle of the 19th century basically as a means of promoting evangelism. This however later became an instrument for production of skilled labour for European farms and clerical staff for the colonial administration.

The education that was available to the Africans at the start of formal education and which continued for many years was one of three types stratified along racial lines in matters of system, structure, curricula and resources. The European system had an entirely academic curriculum based on British traditions and had an upper hand at resources with its main objectives being to prepare their youth for leadership positions. The Asian and Arab systems came second while the African system tended to develop as a hybrid of some academic, technical and vocational components designed principally to prepare the African youths for servitude, especially on European farms. There were therefore great disparities in educational opportunities not only between the races but also between the regions of the country (Ministry of Education, 1987).

The dominant role played by the missionaries in determining the type of education suitable for the Africans persisted throughout the colonial period. They built schools, managed and supervised them, determined the curriculum and influenced the direction of education policy. All along, the stress had been placed on technical and vocational education, with the Fraser report of 1909 being the first official report to recognise an Industrial curriculum as the basis of African education. The sentiments expressed in this report remained government policy until independence in 1963. That educational activities were not integrated into national economic activities prior to independence is evidenced by the fact that education policy was dictated and championed by the missionaries. Further, education at this point in time was administered as a department, being however elevated to one of the senior ministries at independence. The school system was then brought under localised standard curriculum and public examinations.

At independence in 1963, it was not possible to instantly overhaul the then unfair system of education. Further some of the Africans who took over
leadership positions were happy to inherit the privileges then enjoyed by colonial administrators. Therefore, the various imbalances that existed in the educational system continued to exist for many years after independence. Because those who undertook a technical oriented education always ended up in less privileged positions and this continued for many years, the majority of the populace were thus made to believe that this was an unacceptable type of education. It is against such a background that it has and continues to be extremely difficult to successfully introduce technology into the school system (Otieno, 1987). This may partially explain the rather slow and almost unsuccessful attempt of introducing technology as a subject into the school system by the authorities.

**Present Kenyan School System**

There have been several working party's and government acts to streamline education in Kenya since independence. For example, to meet the main objectives contained in Sessional paper No. 10 on "African Socialism and its application to planning in Kenya, 1965", the government passed the Education Act 1968 which was later revised in 1980. This Act attempted to streamline the country's education system. Much later on, the Presidential Working Party of 1981 which was appointed to make general recommendations on the implementation of establishing a second university in Kenya recommended that it be technologically oriented. Also in their review of the existing structure of education in Kenya, they recommended that the education system be restructured from the old 7-4-2-3 to an 8-4-4 system of education which meant that:

- 7 years of primary education cycle to be extended by one year to become 8 year cycle.
- Secondary education to take 4 years instead of the 4 years of Ordinary level plus 2 years of Advanced level.
- University education to take a minimum of 4 years as opposed to the current 3 years.

**Primary Education**

This is the first phase of the 8-4-4 system of education. It ensures the provision of a more functional and practical education that largely meets the needs of the majority of the children who terminate their formal education at the end of the eight years.
Secondary Education
The new four years of secondary education in Kenya have seen the introduction of more relevant curriculum based on the requirements and aspirations of the nation and the individual. More job oriented courses such as Business Education, Industrial Education and in a few schools, Computer Studies have been introduced into the secondary school curriculum.

Technology in the Kenyan School System
Technology as a subject does not exist in the Kenyan school system. However, in the new 8-4-4 system of education, Industrial Education is the name given to what in some countries may be referred to as technology. The technological bias in this system of education is spelt out in official publication (Ministry of Education, Science and Technology, 1984) and amplified by (Otieno, 1987). At the primary school level, technology is encompassed in the subjects "Arts and Crafts", while at secondary level, the only obvious and major difference between the new and old systems of education is in the additional subjects taught and their structure. These are broadly classified as "Applied Education" which include subjects such as Agriculture, Industrial Education, Business Education, Home Science and Music.

Some of the objectives for Industrial Education (Technology) as listed in (Ministry of Education, Science and Technology, 1985) are that the learner should be able to:
1. Identify, develop and apply their individual talents in practical subjects.
2. Interpret and express practical ideas effectively.
3. Develop an insight and appreciation of practical skills and their place in society.
4. Solve problems related to design and construction of selected projects.

Technical Training Institutes
It is a recognised fact that a nation's ability to economic advancement depends to a large extent on the ability not only to innovate but also to make use of technological inventions. Because of this, a vast educational effort is needed to create the technological skills which are necessary for an advanced industrial economy. It is in recognition of these basic requirements for economic advancement that previous technical secondary schools were changed to technical training institutions with the introduction
of the 8-4-4 system of education. Presently there are 19 such institutions. Training offered at these institutions is for form four leavers at craft level. It is proposed that these courses have a broad based content that will cater for training skills which are necessary for the country's manpower requirements at the middle level (Otieno, 1986).

Concept and Attitude of Technology among Kenyan Pupils

To assist in understanding what school children think technology is, results of two independent pilot scale studies undertaken in Kenya in 1985 and 1986 are presented. The first survey involved administering a modified version of the original PATT questionnaire to 245 pupils from two schools, one a high cost primary school and the other a typical low cost school.

In the second survey, essays from 246 pupils from three different primary schools were used. The pupils were asked to write a short essay about what they thought technology was. In both surveys, prior to their answering the questionnaire and writing the essays respectively, the pupils were assured that they were not sitting for an examination and that there were no correct and wrong answers. In both cases, they were asked not to write their names on the scripts.

In the first survey, the review of some of the factors in the measurement of pupils' attitude towards technology have indicated that the pupils whose attitudes we were keen to measure come from different home backgrounds. This therefore implied that any factors isolated as accounting for the pupils' attitudes (for example, interest in technology, girls and technology and importance of technology accounting for 30% of the pupils' attitude towards technology in Kenya) can only be explained in terms of those specific contextual factors, which unfortunately cannot be picked by the items of the questionnaire (Kapiyo and Otieno, 1986). From the results of this survey therefore, it comes out clearly that any survey of pupils' attitudes towards technology in a country like Kenya would require awareness of the context factors, followed by careful sampling according to the key factors such as rural vs. urban and the type of school in question. Failure to recognise and isolate these factors could lead to unreliable results and even invalid data being collected.

In the second survey, (Kapiyo, 1987) has categorised the concept "technology" into seven meanings. The results of this survey as categorised by him are modified and reproduced here as Table 1.
The results of Table 1 clearly show that there is a general trend in what pupils think of the concept "technology", concentrating mainly on 1 and 2 (70.3%). When split into rural vs. urban, there is some considerable difference in terms of diversity of the concept technology, with the urban pupils having more diverse views about technology compared to pupils from the rural areas. Kapiyo (1987a) points out that this should not however be interpreted to imply that urban pupils have a better notion of the concept technology.

**Proposed Large Scale Research on Concept of Technology**

It is evident from available information on technology in Kenya that there is great uncertainty and even confusion among both pupils and teachers as to what constitutes technology. The two small scale studies so far done and reported show that it is difficult to measure contextual factors such as pupils' background, the level of expectation and aspiration, the school system and other socio-geographical differences by using a standardised questionnaire. To attempt to eliminate and solve some of these problems and as major contribution to the development of technology curriculum in the school system in Kenya. The Appropriate Technology Centre of Kenyatta University, Kenya has proposed to carry out in cooperation with the PATT-Research Team of the Eindhoven University of Technology, the Netherlands, a large scale research project into pupils' concept of and
attitudes towards technology and its impact for the Kenyan school curriculum.

Kind of Proposed Research on Concept of Technology
Basically the proposed research will be a survey type, utilizing questionnaires, essays and personal interviews all aimed at determining the concept of and the attitude towards technology of certain school age groups.
Structured interviews will also be administered to teachers mainly to assess their attitude and concept towards technology. (Further details of this proposed research can be found in Kapiyo, 1987b.) It is proposed to use instruments developed by the Eindhoven PATT-Research group already in use. The instruments will however be vigorously tested and scrutinized before being adopted for the Kenyan situation.

Conclusion
It is hoped that upon completion of this proposed large scale research, we will have made a major contribution to the development of a technology curriculum for use in the Kenyan school system. It is anticipated that very soon, technology as a subject will be a common and accepted thing in the school system.

Selected References


FRAMEWORK OF TECHNOLOGICAL EDUCATION AT POLISH HIGH-SCHOOL

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Summary

The main features of technology education at secondary level in Poland are presented in the paper. The goals of teaching technology at high-school are described. An example of basic technological knowledge at this level is quoted and also examples of technological tasks are given. Some information about the teaching of culture and the organization of labour and orienting towards a profession is also presented. The timetable of the subject "Work - Technology" at high-school is shortly described.
1. Introduction

General characteristics of the educational system in Poland and information about technology education at elementary school were given in the report of PATT-1 Workshop "What Do Girls and Boys Think of Technology?" (pages 137-146). The results of PATT research in Poland can be found in "Report PATT-conference 1987" Vol. 2 (pages 121-126 and 170-184).

In this paper, the framework of technology education at high-school (secondary school preparing for universities and other higher schools), will be given. The students at this school are 15-18 years old.

2. The timetable

The exact name of the subject is the same like at the elementary education: "Work-Technology".

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<tr>
<th>Grade</th>
<th>Students' age</th>
<th>Number of hours per week</th>
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The characters A, B, C, D design different ranges of education:
A - basic range of education,
B - math.-physical range of education,
C - biol.-chemical range of education,
D - classical range of education.

Notes:
*) The curriculum is common for all ranges.
**) There are small curriculum differences between A+B and C+D ranges of education.
***) The subject exists only in basic and math.-phys. ranges of education.
****) At 4th grade a student can make his option of one of facultative training groups (among others technological group). This is 4 hours per week. The facultative technological training group is meant for students which are specially interested in science or selected domains of technology and management.
The subject "Work-Technology" is not integrated with other school subjects but there are some correlations to physics. The graduates of specialization "Technology Education" are qualified to teach the subject "Work-Technology". This specialization exists mainly at Higher Pedagogical Schools (Pedagogical Universities). The graduates get the title "master of technology education".

3. **Main goals of technology education**

The main aim of the subject "Work-Technology" is to prepare the alumni to the appropriate exercise and use of technology. The other goal is further developing the culture of work and technological culture among students.

The alumnus ought to know:
- principles of operation of mechanized tools and technical devices being used in everyday life,
- principles of operation of selected technical devices typical in specified working environment,
- principles of effective organization of labour,
- social and ecological results of industrialization,
- principles of work safety (labour legislation) and basis of ergonomics (human-factor engineering).

The alumnus also ought to know how:
- to use the laws of science when explaining structure and properties of technical materials and construction or operation of machines, tools, devices,
- to assemble and disassemble some typical technical devices,
- to design and make simple technical devices,
- to make use of basis measuring instruments, tools and machines from students' environment,
- to organize individual and team workplace,
- to make economical evaluation of the work results (quality and quantity criteria).

The alumnus ought to have also the following social attitudes:
- creative enterprise,
- labour discipline,
- respect for people of different professions.
4. Culture and organization of labour
In technology education at high-schools special attention is paid to the following topics:
- organization of different forms of work,
- the use of safety methods, the accordant use of technical equipment,
- the concept of work environment and organization of workplace,
- scientific basis of working environment-ergonomics,
- general standards of occupational hygiene,
- work protection, health protection (e.g. shock isolation),
- selected problems of standards and principles of efficient work,
- common rules of manual and mental work: planning, improvement.

5. Basic knowledge of technology
In the "Work-Technology" curriculum for high-school this item is divided into three sub-items:
- materials science and process engineering,
- technical equipment,
- technological information.
As an example of basic knowledge let us quote a part of curriculum for grade 2 of high-school.

MATERIALS SCIENCE AND PROCESS ENGINEERING:
- physical and technical properties of conducting electrotechnical material (Cu, Al wires and others),
- properties of insulating material (synthetic plastics, electrical porcelain),
- materials used in home power net-work,
- assembling low voltage electric circuits,
- treatment of conducting and insulating material,
- electrical measurements.

TECHNICAL EQUIPMENT:
- function and construction of selected electric machines,
- induction motor, commutator motor, mains transformer, rectifier,
- direct-current generator, alternator (also in cars),
- electric drive at gramophone, tape-recorder, film-projector,
- different kinds of wiring systems,
- electric heaters in cookers, flat-irons, heating fans,
- electric shock isolation in electrical equipment and rescue.
TECHNOLOGICAL INFORMATION:
- designations and symbols in engineering electrical drawings,
- drawing and reading electrical schemes,
- servicing electrical devices,
- assembling home electrical devices.
The basic technological knowledge in grade 1 of high-school is connected mainly with mechanics and in grade 3 with electronics.

6. Technological tasks
Typical technological tasks at high-school are quoted below:
- construction (including mounting) models of mechanisms transmitting motion (most typical solutions),
- using following materials: wood, synthetic plastics, metal,
- activities: cutting, boring holes, smoothing, polishing, mechanical assembling,
- making an electro-mechanical lock,
- making educational aids connected with electricity for physics and chemistry laboratories,
- designing and making the rectifier for charging a battery,
- construction of a selected electronical device (amplifier, generator or wireless set) on the basis of documentation,
- construction of a device with photo-diode or other electronic sensor (on the basis of documentation),
- fault clearing in electronic devices.

7. Orienting towards a profession
Orienting towards a profession is realised in high-schools through information about postgraduate courses and university studies connected with precision mechanics, construction of machines, electrical power engineering, servicing every-day electronics and computers.
INTERNATIONAL COMPARISONS OF TECHNOLOGY EDUCATION AND TECHNOLOGICAL LITERACY

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Summary

An initial model of Technological Literacy was presented during PAT-2 (Eindhoven, 1987).
The threedimensional model (technology components, educational outcomes and levels of Technology Literacy) may be applied to educational programmes.
At PAT-3 the results of international comparisons of technology education and technological literacy will be presented. The study is based, among other things, on interviews I had at the time with the participants of PAT-2.

Besides the comparisons I will include a suggestion for one analytical model that would guide such international comparisons.
INTERNATIONAL PERSPECTIVES ON TECHNOLOGICAL LITERACY

Overview
Considerable attention has been afforded the concept of technological literacy - in North America at least and perhaps even overseas. Despite this, it must be recognized that there is a tremendous range in the definitions of such key concepts as technology and technological literacy. Why is this? Don't the members of our profession do their homework? Are the terms so new that we are just now defining them? Are others as confused as we sometimes seem to be? Or do the differing uses of the terms actually mean different things?
The purpose of this presentation is to address these and related concerns. The intent is to place the terms and their meanings in an international context. I wanted to see these ideas in context - i.e. against the backdrop of others' thinking. Because I find the North American branch of our profession to be somewhat parochial, in that it seldom looks outside the borders of the U.S.A., I thought it would be valuable to see what our international colleagues are doing with the concepts central to technology. How are they defined in other countries? How are other educators using them if at all? What could be learned from them?
However, in addition to the quest for some perspective, I also wanted to test an idea. The idea was that a country's concept of technological literacy (if any existed at all) was positively linked to its stage of development. In essence, this idea is analogous to Maslow's hierarchy of needs. It suggests that when a country's human resource needs are for economic or other survival, then the country's educational policies will not emphasize technology for all. Only after the basic technical skill needs have been satisfied would the country be likely to shift to technological literacy as an important outcome of education.
Finally, prior to launching this investigation it must be noted that technological literacy is being viewed as an outcome of technology education, i.e. education about technology. Furthermore, technological literacy is considered to be an essential characteristic of those with a quality general education. Consequently, the importance of having deeper insight into this concept is what provided impetus for the research being reported.
Procedure

Essentially the methodology employed was primarily that of personal interviews. My sense was that there was just too much opportunity for misinterpretation with paper surveys and other approaches with little or no direct contact between the researcher and the respondent. However, quality research demands that one systematically sample the population if one wishes to reach some defensible conclusions. Given the huge range of possible respondents, e.g. countries, types of schools, levels of education, role of respondents, and the like, sampling of such a large and diverse population is clearly out of the realm of possibility for a small, informally supported project such as mine.

Instead, the procedure employed was based on self-selection. In essence, it depended on the action of those interested in the issues of technology and education. My logic was that many of the most interested colleagues would be participating in several key international meetings that focussed on the topic. Consequently, I set out to participate in these meetings and to conduct my interviews there. The meetings attended included: The World Congress on Education and Technology, Vancouver, Canada, May 1986; The PATT-2 Conference (Pupils Attitude Towards Technology), Eindhoven, The Netherlands, April 1987; The European Common Market Conference on People and Technology, London, United Kingdom, November 1986; The International Vocational Education and Training Association program at the AVA Conference, Dallas, December 1986 and Las Vegas 1987; The International Technology Education Association Conference, Tulsa, Oklahoma, March 1987 and Norfolk Virginia 1988; and International Symposium on Technological Literacy, Columbus, Ohio, May 13-16, 1987. In addition, my personal insights into the European (and some international) situations were enhanced considerably by a one month academic exchange in West Germany.

Ongoing literature searches in the computerized data bases further enlarged the input base for this study.

The actual instrumentation was most simple. It consisted merely of a single sheet used to guide the interview questions and to provide a convenient place to quickly record the information that was obtained. This guide provided a structure that engendered a consistency of response that would not have been possible with a mail survey. Soon after beginning the process, it became obvious that the approach was appropriate. Given the difficulties inherent in communicating across cultures, let alone languages,
the opportunity to clarify the meaning of questions and responses was invaluable. Furthermore, it often was necessary to explore the respondent's context that housed the perceptions of technological literacy. Consequently, the interviews probed the respondents':

- Country's status with respect to the implementation of technology education
- Description of the nature of any implementation that occurred
- Definition of the term/concept "technology"
- Thoughts about technology's key components
- Usage of the term/concept "technological literacy"

In general, the reader must review these results with a keen awareness of the possibility for their being affected by Type I and Type II errors. The opportunity for committing either of these seems very high when working on comparisons in the international arena. For example one gets totally different answers when one meets with ministries of labor instead of education. Because of this it is extremely difficult to support generalizations based on what must be recognized as a cursory contact.

Observations and Findings/Conclusions
The results of my experiences and procedures are detailed in two tables. They were recently supplemented by some personal correspondence from M. de Vries (The Netherlands) who has been working along similar directions. It should also be noted that the approach was clearly impressionistic. Given the nature of this study, it was felt that any numerical treatment of the data would yield a false picture. Similar approaches were employed by De Vries (1987) and Todd (1986).

Concepts & Terminology
1. Technological literacy, as a concept, is clearly in a state of flux. It shows some signs of emerging from this early evolutionary stage but for now it remains more a notion than a precise construct although an increasing number of countries are becoming sensitive to the term/concept - technological literacy. Overall however, the term "technological literacy" is not generally used overseas and consequently it typically is not considered to be the primary outcome of technology
education - although there was little resistance to such a concept once the idea was broached.

2. It seems that there is considerable agreement that technological literacy necessarily involves an ability to do.

3. The Europeans have also worked out an important rationale supporting the need for technology education. It states that a large part of being educated for the professions is of a technical nature (De Vries, 1987) therefore such education is a valuable service to students.

4. On the technology v.s industrial technology issue, generally my observations suggest that the technology education view has more proponents - it is clearly the preferred term overseas. However, there is also evidence pointing to the use of a general label, i.e. technology, being applied to what is clearly the industrial subset of technology.

5. There is considerable congruence in support of the generic technology clusters of materials, energy & power, and communication. Transportation, manufacturing and construction are not widely addressed.

6. In Europe, much more is made of the technology - technique distinction than is the case in the U.S.A.

Implementation

1. More countries are concerned with technology education for all students than are concerned with technological literacy.

2. If one were to be "hard-nosed" and use the criterion of numbers of students affected, I come to the conclusion that technology education, i.e. education to develop technological literacy, is much more hype than reality. In most places, technology education is not structurally integrated into the educational systems of the country - despite what evangelical proponents would have us believe. In addition there are many who "bastardize" the concept of technology education and technological literacy by "forcing" what they are currently doing in regular, vocational or other education and passing it off (mislabeling) as technology education or its products.

3. Overall there seems to be a "quick fix" mentality in thinking that one, two or three years of courses could meet the societal need. Very little evidence was found to demonstrate a concern for a spiral curriculum that would systematically build a depth of understanding and capability throughout the school year.
U.S.A. - International Comparisons

1. The U.S. approach to technology education seems to be considerably more developed than that of most other countries. Although, it is clear that rather sophisticated models and programs exist internationally and some even have considerable history, e.g., the English SCSSST model.

2. The leading characteristic that distinguishes overseas implementations of technology education from ours is their emphasis on design and problem-solving processes of technical knowledge and/or skill.

3. Our approaches seem to emphasize the delineation of objectives, competencies and essential elements to a much greater extent than did overseas ones. Many of the latter programs had difficulty in stating even their most general goals.

4. Eastern block countries approaches lean much more to the vocational side that do the British, Flemish or Dutch.

General Observations & Methodological Concerns

1. Often international science and other non-industrial/vocational educators value technology education more than ours do.

2. It seems appropriate to conclude that we cannot, and in fact we must avoid, the casting of technology education as the 'deus ex machina' of our time. We cannot expect a set of solutions carved out of the political feasibilities of our realities to be as powerful as our conceptual models suggest. In short, we must not oversell the potential outcomes of technology education.

3. Our European colleagues were much more tuned into the nature of the student than we seemed to be. For example, it is to the credit of Jan Raat and Marc de Vries' project' groups, and in fact several others of the PATT research group, that they noted the great difference between their intellectual and conceptualized model of technology and the model that young students have in their minds. The implications of this for instructional practice seem to loom large!

4. There is good evidence to suggest the computer is an overused example of technology overseas as well as in the U.S.A.

5. There is a serious terminological problem that must be overcome before mailed or other form of non-contact survey approaches become feasible.
Conclusion & Summary

There is much to be learned overseas. The opportunity to be outside looking in yields fresh perspectives that invariably help improve local practice. Overall, the profession can feel proud of the level of their conceptualization of technology education and technological literacy. Now what remains in the U.S.A. as well as in most other countries is to implement programs that deliver on the promise!
One of the glaring ironies of modern education is that educators try to prepare children to live in a world that is yet to exist that preparing them through a world that has ceased to exist. Traditionally, educators organize curricula within compartments, with the content being taught in such way to inhibit knowledge transfer and stifle the development of creativity and problem skills. Very little is being done in curriculum development to utilize technology as the curriculum integrator of curricula.

This paper will present a curriculum model for the study of technology that is research based and holistic in nature. It utilizes a process approach with problem solving being the driver of the curriculum. The model organizes the study of technology under three categories (a) systems of technology, (b) research and development, and (c) design and innovation. The content for each organizer is organized and taught through an understanding and application of the elements, limits, and impacts of technology. This curriculum model provides a mechanism to develop knowledge transfer, creativity, and problem solving skills.
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Preparing children to live in a future with an exponential factoring of unknown variables with which to cope is education’s biggest problem. With the knowledge base doubling every three years, how do schools prepare children to be technologically literate to solve tomorrow’s problems (Bensen, 1987)? This is, especially, difficult when one does not know what the technologies of the future will be. It is hard to say to what degree of importance today’s known technologies will be in the future or if they will still be in existence. Therefore, the educational question is, how schools prepare children to be technologically literate when tomorrow’s technologies may not be known or today’s technologies may not be recognized in their present form? One solution to this question is a holistic and methodological study of technology.

Key Descriptors of Technology

To add to this dilemma, there is much confusion on how technology is described or defined. One can find as many definitions as in the number of articles one reads or people one asks. Current research has identified key descriptions of a definition for technology that can help clear up this confusion. These are:

- Innovations
- Inventions
- Creative
- Extends human capabilities (physical, social, and intellectual)
- 212 -

- A process (change, individual, corporate, design, creative, and systematic)
- Extension of human potential
- Problem solving
- Purposeful human manipulation of the material needed
- Closely linked to science but not simply applied science
- Body of knowledge
- Used to solve problems and create opportunities
- Played an important role in the emergence of Homo sapiens
- A system of tools, knowledge, and behaviors associated with the exploitation of environment
- Has social, economic, political, and environmental impacts (Barnes, 1987, p.182).

Organization

Parallel to the problem of describing and defining technology has been the confusion of how the technology curriculum should be organized and taught. This confusion is due, in part, to technology advancing at an exponential rate and how can all of this technological advancement and knowledge be incorporated into the curriculum and be manageable. Others are confused by the abstractness that technology tends to portray to them. Still others debate as to whether technology should be organized and taught through a content or process approach.

To clear up this confusion, it is imperative that the study of technology be organized in a curriculum model of manageable components that are universal to a holistic study of technology and that are transferable from one technology to another. By
doing this, one can logically analyze and organize any technological study by utilizing these universal constants of technology as major headings of the content to be studied. Therefore, the following curriculum model is suggested as a process approach to the study of technology and is highlighted in Figure 1. Problem solving is the technological method and it is the component that drives the curriculum. The curriculum is organized under three major categories: (a) systems of technology, (b) research and development, and (c) design and innovation. The content to be taught is analyzed and organized under three headings: (a) elements of technology, (b) limits of technology, and (c) impacts of technology.

Under these universal components any technology can be studied. This organizational structure, also, provides a system for transferring knowledge from the study of one technology to another. Thus, this method of transferable knowledge provides the basis for children to understand tomorrow's technologies and solve those problems associated with them.

The operation of this curriculum model for the study of technology is based on the premise that the method, elements, limits, and impacts of technology are constants for the three curricular organizers. The differentiation, then, is the variables that influence and interact with the organizer. To further understand this concept, each level of the hierarchy will be explained.
THE FRAMEWORK OF TECHNOLOGY

![Diagram of the Framework of Technology]

**Figure 1.** The Framework of Technology.
(Adapted from Barnes' and Todd's Research)
Problem Solving

Problem solving is the technological process (Black and Harrison, 1985, p. 3). Therefore, problem solving is the method that drives the curriculum. It is the holistic method that allows knowledge to be transferred from one technology to another. Problem solving, however, must be systemic in nature, not linear, if knowledge is to be successfully transferred from one technology to another.

It should be noted that problem solving and the scientific method are not the same and should not be confused or substituted for one another. The problem solving method produces the best possible solution to a problem based upon the best judgment and decision making at a given moment in time. The problem solution is not exact, since may other solutions could be effective in solving the problem. Conversely, the scientific method produces an exact solution to the problem.

This distinction can be further supported through Gradwell’s comparison of science and technology (1986). He stated that the study of technology (a) is an open system; (b) utilizes deductive reasoning; (c) uses the design method; (d) is concerned with how things ought to be; and (e) results in discoveries which lead to theories. Conversely, science (a) is a closed system; (b) utilizes an analytical reasoning; (c) uses the scientific method; (d) is concerned with how things are; and (e) starts with a problem and is guided by a theory (p. 7).
In a similar fashion, Fisher (1986) identified the basic elements of technology education and science education when he compared the two subjects in the United Kingdom. Technology education (a) is project based; (b) involves controlling systems; (c) is broad based; (d) is a creative process related to human needs; (e) uses the design process; (f) utilizes problem solving; and (g) is concerned with the purposeful use of human's knowledge, utilizing materials, energy, and natural phenomena. Unlike technology education, science education (a) has a scientific body of knowledge of knowledge; (b) utilizes knowledge derived from empirical evidence; (c) uses inductive reasoning; (d) tests validity objectively; (e) has a distinct methodology; and (f) utilizes the processes of categorization, classification, close observation, measurement, and prediction (p. 12).

The technology or content being studied only provides the means to develop problem solving and creative/critical thinking abilities, thus, producing a technologically literate citizen. This concept is paramount, since the purpose of education is to prepare children for the future in which they will live. Therefore, to continue to organize the study of technology under the tradition organizers of manufacturing, communication, construction, transportation, or any other specific technology only delimits or stifles the study of technology.

Curricular Organizers

To properly foster a broad-based study of technology through
the problem solving process, the study must be organized by concepts or processes, instead of specific technologies. Therefore, based on Barnes' research, the study of technology should be organized as (a) systems of technology; (b) research and development; and (c) design and innovation (1987, p. 185). Subsumed within each curricular organizer are the values in technology and the awareness of implications and potential of technology. This curricular organization is student-centered, not teacher-centered. In this organization approach, students are given technological problems in which to solve, based on their abilities and needs.

The systems of technology focuses on the interrelationships between the various technological systems; not just the industrial technologies of manufacturing, communication, construction, and transportation. It is a holistic approach that does not isolate the study of technology into a specific technology. It, also, provides an application of the other school disciplines through the common thread of technology.

Research and development focuses on students solving technological problems, through advanced applications of the various systems of technology. Like the systems of technology, research and development is a holistic and integrative approach. The research effort is student generated, with the teacher serving as a student advisor.

Design and innovation is a capstone phase of the
organizational structure. It focuses on students brainstorming new concepts and ideas, then, problem solving an implemental solution for their innovation.

Curricular Constants

There, also, must be constants for these curricular organizers that ensure knowledge transfer. Therefore, three basic constants are applicable to the study of technology: (a) the elements of technology; (b) the limits of technology; and (c) the impacts of technology. These three constants are universal to all technologies. It should be noted that what varies are the environmental inputs that impact on a technological problem.

Todd, McCrory, and Todd identified six elements of technology that are universal to the study of technology. These are (a) tools; (b) materials; (c) processes; (d) energy; (e) information; and (f) humans. Tools are any kind of device, machine, or instrument. Materials are used to build machines, which in turn use materials to make products. These are the basic ingredients of technology. Processes are a sequences of operations that produce some result. Energy is concerned with the understanding of energy sources, forms, and conversion to change raw energy into a practical use. Information utilizes symbols and signals from which to construct communication and control. Humans use and interact with tools, machines, energy, materials, and information (1985).

The limits of technology is concerned with the degree to
which technology has been developed for the successful implementation of a solution to a technological problem. In some cases, the technology is available to solve a problem, but the science is not yet developed. The converse can be true, as well. Sometimes the scientific knowledge is there, but the technological knowledge is not.

The impacts of technology deals with the consequences of technology. This includes decisions regarding the environmental, economical, political, personal, social, and cultural effects on the control and wise use of technology.

Conclusion

The curriculum model of the study of technology presented offers an innovative approach to preparing children to become technologically literate to face the challenges of tomorrow’s world and to solve the problems associated with that world. This approach allows for knowledge transfer through a universal system, problem solving. Likewise, this approach to the study of technology takes into account the unknown and/or changing future technologies. This approach is not delimiting, but is holistic in nature, and allows for the integration and application of other school disciplines.
REFERENCES


TECHNOLOGY AT A DUTCH SCHOOL

Mr. J. van Engelen
'De Pijler' Comprehensive School
Dongan, the Netherlands

Summary

On Saturday, April 23 the director of 'De Pijler' Comprehensive School will receive the participants of PATT at his school.
'De Pijler' Comprehensive School is an experiment school. This means that new developments in education are tested at this school. Therefore by visiting this school the participants of PATT will get a good impression of what is going on in the Dutch system of education at the moment. At the centre of this there is the introduction of the BASISVORMING (Basic Education), an entirely new system of education in which all pupils up to and including grade 3 (lower part of secondary education, age 16) are presented with a common educational programme at only two levels. In this new system of education there will also be a place for the subject Technology.
"DE PIJLER"

SCHOOL FOR BASIC SECONDARY EDUCATION
AND VOCATIONAL EDUCATION

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PREFACE

From April 21-26 the conference on Pupils' Attitudes Towards Technology is held in the Netherlands for the third time. In these three years an important development has come about in the Netherlands. The plans for basic education have been announced. This school year a bill on basic education has been introduced to the Dutch Parliament. This is important for technical education.

The curriculum guideline Technology has also been finished by now. The curriculum guideline Technology Part 2 was published earlier this month. This proposal provides us with ideas about the content and form of technical education for secondary education as a whole.

In the third place, the government has made it possible not only for junior vocational schools, but for all schools in secondary education to introduce Technology as a subject. This school year more than 200 schools are making use of this arrangement.

In the Netherlands there is an increasing interest in Technology Education. After a long period of discussion on the contents and design of Technology Education all schools in Dutch secondary education can now start with the introduction of Technology at their schools. The government made it possible for all schools to put at least 160 hours of Technology on their time-tables. By the way, in view of the budgetary possibilities the introduction will take place in stages. The way the plans are now there is a possibility to introduce basic education in the educational system from August 1989 onwards. Schools that join in are obliged to put 180 hours for the subject Technology on the time-table.

This year the project group Technology of the National Institute for Curriculum Development has made important progress in the developing of examples of course material.

In the school year 1978-1988 we started with 4 experiment schools. At these experiment schools the experimental courses are tested in practice. The four experiment schools are:
- "De Draai" Comprehensive School in Smilde,
- "De Marke" Comprehensive School in Enschede,
- "Rijnbrughe" Comprehensive School in Arnhem,
- "De Pijler" Comprehensive School in Dongen.
The year 1987-1988 is a particularly convenient year for the participants of the PATT-conference to visit a school. "De Pijler" Comprehensive School was chosen because it is one of the experiment schools of the Project Technology of the National Institute for Curriculum Development. This comprehensive school was so hospitable to receive the participants of PATT-3.

In this paper you find the full texts of the introductions held during this excursion.
THE PROGRAMME

9.00-9.15 Arrival at school.
9.15-9.30 Word of welcome by the principal of the school, Mr. van Engelen.
9.30-9.50 Technology Education in the Netherlands.
   Introduction: "Off the main road".
   A description of the state of affairs as regards the developed courseware and the results of the experiments at the experiment schools.
9.50-10.15 Technology Education at "De Pijler" Comprehensive School.
   A description of the state of affairs of Technology Education at "De Pijler" Comprehensive School.
10.15-10.30 Break
10.30-12.30 Alternating programme to visit classrooms.
   The participants of the conference will be led through the school in three groups.

Group 1
10.30-11.10 Visit Technology classrooms.
   In the Technology classrooms 6-10 pupils will be working on various activities.
   In the classroom for Technical Information Theory the participants will have to carry out an assignment.
11.50-12.30 Visit to other classrooms.
   Visit to two classrooms for Mechanical Technology.

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<th>Alternating programme</th>
<th>Technology</th>
<th>Techn. Inf. Techn.</th>
<th>Other classrooms</th>
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<tr>
<td>Time</td>
<td>group 1</td>
<td>group 2</td>
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<td>10.30-11.10</td>
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<td>11.10-11.50</td>
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12.30-12.45 Questions, remarks and closing.
Welcome by the principal of the school, Mr. J.A. van Engelen.
Information on the region: history of the school in relation to the developments in the world of professions.

Good morning, Ladies and Gentlemen,
Welcome to "De Pijler", School for Basic Secondary Education and Vocational Education.
I shall introduce myself first: my name is Jan van Engelen, principal of this school. It is a great honour for me to be able to welcome you here today.
Apart from the honour to bid you all welcome it is my task to tell you something about the region, the place and the school of which you are guests.

Dongen is a village with about 25,000 inhabitants and it is situated in a rather densely populated area; about 5 km. from Oosterhout, 50,000 inhabitants; about 10 km. from Tilburg, about 160,000 inhabitants and about 15 km. from Breda with about 120,000 inhabitants.
Traditionally Dongen has a rich history in education.
This was mainly so because there were Catholic monasteries with boarding schools. Once there were two teacher training institutes in this municipality. With the decreasing of the interest in the monastic life these trainings also disappeared.
Yet, even though it is a small place, Dongen still has rather good educational facilities, with 3 schools for generally formative education and one school for vocational education: "De Pijler".
For a better understanding of the position of this school in the whole picture of the Dutch educational system I shall briefly tell you something about this region and the history of our school.

You, as participants of the PATT-conference, have gone out into the country today for an excursion. You are guests of Brabant and today you are wandering about the part we call West-Brabant. It is a beautiful region, specially now in spring. And besides, people from Brabant have the reputation of being warm-hearted and hospitable, and they like to make merry.

It is probably for this reason that tourism as a means of support is becoming more important to this part of the Netherlands. Close by there is a large recreation park, its style is comparable to that of Disneyland in America, and it has a very high frequency of visitors. Furthermore, the recreation on and round the water is also very important here.

I am convinced that after the afternoon programme, with a cruise on the Biesbosch, you will know all about that. Another important means of support in this region is agriculture and horticulture. There is no need to tell you much about that. After all, you will be touring our country by coach today, and that way, but also because our country is so flat, you will see quite a lot of what Brabant has to offer in this respect.

The last sphere of work in this area that I would like to draw your attention to is that of trade and industry. The reason for mentioning this subject as the last one is not because it is unimportant but because I want to say something more about this. Education at "De Pijler", the school of which you are a guest this morning, is directly related to this. The history of this school is closely related to that of the industry in this region. I would like to tell you a bit more about this. Therefore I shall go back in time a number of years. In the period just before and after the second world war the most
important means of support in this region was the shoes and leather industry and all things related to that.
Only for the manufacturing of shoes and leather there were 300 small companies in this region within a radius of 50 km.
Most of these factories were small, with 5 to 10 employees.
The production was half-mechanical, in larger factories there usually was an assembly line.
Often part of the production process consisted of home craft.
The stitching and glueing used to be carried out at home by women.
Apart from shoe factories there were also many tanneries in this region.
For the greater part it was unskilled work.
Just after the second world war this branche of industry was flourishing.
Little by little the work environment and also the wages became better.
However, particularly in the shoes industry there was increasing competition from countries in which the wages were lower.
High pressure was put on the leather industry as well, environmental demands played a major part.
After a short flourishing-time the industry started to decay and a large part of it disappeared from this region.
A small number of factories managed to survive the bad times and at the moment they are flourishing again.
However, the volume and the importance of the shoes and leather industry is substantially reduced.
The room that originated this way was taken by a different kind of companies: metallurgical industry, glass-industry, electronics, synthetic materials etc.
In this region there are few really big companies, the greater part of employment is created by small and medium-size companies.
The development of vocational education here in Dongen is closely related to what I have told you just now about the development of trade and industry in this region.
About 25 years ago the work in the shoes industry became so as to require training. This is why a vocational school for the shoemakers' trade was set up in Dongen.
Behind me a small exhibition has been set up with photographs, pieces of work and tools from this predecessor of our present-day vocational education.
During the guided tour that is part of this morning's programme you will be able to have a look at it.

With the disappearing of the industry this training also disappeared.
As a replacement a Junior Vocational School was set up.
Two directions could be chosen at this school: Construction Engineering and Mechanical Technology, and its population consisted almost of boys only.

At the moment the number of pupils in secondary education is strongly decreasing in the Netherlands.
This was one of the reasons to merge with a school for Junior Domestic Science Training here in Dongen.
This school was of about the same size as the Junior Technical School, and its population consisted of girls only.
In 1985 this combination resulted in a comprehensive school, "DE PIJLER".
A school that was then visited by 460 boys and girls, had 2 buildings at its disposal and employed 50 staff members.
Already at that time it was clear that at this school the last step in the development of education had not been taken with this merger. That is why "DE PIJLER" in the year after the merger started an educational project in which the development of Technology Education and reinforcement of vocational education play a major part.
We hereby give high priority to application of new technology.
"DE PIJLER" is a school which is still developing, people are working hard on the renewal and improvement of education.
In the further presentations of this morning you will be informed about the position of "DE PIJLER" in the entire Dutch school system and educational structure, but we particularly want to show this to you during the guided tour.
I hope you will have an interesting morning and also a pleasant continuation of your excursion.
Thank you for your attention.
Summary

The contribution by Jenne van der Velde consists of a description of the state of affairs of technology education in the Netherlands. The title is: 'Off the main road'. In other words no large reflections but the description of the state of affairs. This concerns the developed course material and the results of the experiments at the experiment schools. All this links up with the development at 'De Pijler' Comprehensive School that will be visited on Saturday morning, April 23.
Ladies and Gentlemen.

Participants of previous PATT-conferences have already been acquainted with various aspects of the Netherlands. Up to now the direct interest of the PATT-participants has not really been drawn to the Dutch school practice. This was quite understandable, so far there was a lot of discussion and little progress in the introduction of Technology in the first stage of secondary education. Therefore I will gladly join the principal of this school, Mr. van Engelen, and I bid you all welcome at "DE PIJLER" Comprehensive School in Dongen in Brabant.

Ladies and Gentlemen.

This school year is a special one for Technology Education in the Netherlands in more than one respect. First of all a Bill on basic education has been introduced to the Second Chamber (House of Commons). This is important for Technology Education. Secondly the curriculum guideline Technology Part 2 has been published last February by the National Institute for Curriculum Development. This makes a guideline on the content and implementation of Technology Education available to the entire secondary education. Thirdly the government made it possible not only for the schools for junior vocational education to introduce Technology, but for all schools in secondary education to do so. This year over 200 schools make use of this. I shall discuss the curriculum guideline Technology in greater detail.

I entitled my introduction "Off the main road". This title is borrowed from
a Dutch TV-programme. In this programme a route to a holiday destination is indicated. However, this route is not via motorways but it gives holiday-makers the opportunity to become acquainted with rural villages, wonderful prospects and it brings the holiday-maker closer to the people from the region. In my introduction it is not my intention to drive on large motorways by giving the starting-points of Technology in a few mainlines. On the contrary, I shall leave the motorway and try to show you what the Technology-scenery looks like. This will enable you to see better later on in the classrooms, what we think Technology Education ought to be.

It is obvious that one cannot regard a subject without looking at its context. Therefore I shall have to pay at least some attention to the Dutch educational system.

Before I go on to my actual subject I would like to focus on a second issue: how and where does the National Institute for Curriculum Development (NICD) fit into the Dutch educational system. As I have told you, the main part of my speech concerns the subject Technology in secondary education, intended for pupils between the age of 12 and 15.

1. A short review of the Dutch educational system

The existing school structure.

Primary education is the first stage of education in the Netherlands. All pupils from 4 to 12 years attend primary school.

After primary education there is secondary education. In secondary education we notice several different types of schools, namely:
- junior vocational education,
- junior and senior secondary general education,
- pre-university education.

Within junior vocational education other school-types can be distinguished, for instance: junior technical, junior agricultural and junior home economics studies.

Up to this point, Technical Education is usually given in junior vocational education or at some combined schools where junior vocational education is part of the school system.
Meanwhile it has become legally possible for all schools in secondary education to put Technology on the time-table. Gradually more schools pass on to the introduction of Technology. As I have told you before, over 200 schools made use of this opportunity this year.

Plans for basic education.
Along with the education given at this moment, plans have been made for innovations in secondary education. Briefly, the essence of the policy-intentions is as follows: in principle all pupils of the Dutch educational system will receive a so-called basic education. This basic education involves the primary school and the first three years of secondary education. This means that all pupils in secondary education will have to take fourteen compulsory subjects, regardless of the type of school they choose. In addition, every school itself is free to fill in 20% of the teaching time, the so-called free-space. One of those compulsory subjects is Technology, which has been allocated 180 hours. All subjects can be concluded at two levels and it will normally take pupils three years to reach that point.

It is the government's intention to introduce this basic education from the year 1989 onwards. Between 1989 and 1994 all schools will have to start with basic education. At the beginning of February working groups have been set up which had the assignment to have formulated goals at two levels by the end of this year.

Before I continue to talk about the content of the subject Technology I shall shortly go into the position of the NICD in the Dutch educational system.

2. Position and function of the National Institute for Curriculum Development
The support system.
The NICD is a part of the Dutch educational support system. A support system consists of institutes that can help schools in different situations.
The working field of the NICD.
The NICD is situated in Enschede and
- has as its tasks the development of curricula and the coordination of
  curriculum development in the Netherlands,
- works for all types of education, except for higher education,
- works mainly on request from: educational bodies and institutes,
  the Minister of Education and Sciences.
- develops experimental teaching kits and examples for course material,
- works closely together with people in educational practice and, if
  relevant, with trade and industry,
- employs 300 people and more.

I would like to point out here that in the Netherlands there is freedom of
education with regard to its contents and its organization. Obviously this is
a relative freedom, but plans drawn up by the NICD cannot be laid down
by the government. Therefore the innovative strength of the NICD will not
be found in the carrying out of law-enforced plans but in the power of
persuasion.

3. The subject Technology in secondary education
For Technology Education the government accepted the curriculum guideline
Technology as a directional document. This means that on the one hand
schools can point at their intention to use the curriculum guideline
Technology when applying for a Technology classroom and on the other hand
that teacher training institutes can use the curriculum guideline as a
contential framework for their inservice training.
The curriculum guideline consists of two parts.
The first part was published in 1986. In this part it has been indicated by
means of which method the goals were set and three examples have been
given of annual programmes, however, at a rather general level. The
curriculum guideline Part 2 is an elaboration of Part 1. In Part 2 the
annual programmes are described in detail. Apart from this there is
attention for process control, the didactic aspects of the subject
Technology, such as acting in a problem-solving way, differentiation and
testing. It also contains a chapter on Equipment and Furnishing of a
classroom.
In Part 1 the general objective of Technology is described as: pupils have to get acquainted with those aspects of technology that they cannot do without if they want to be a member of our technological society and with those aspects which are undoubtedly the growing force behind further technological development.

This general goal can be reached by three sub-goals:

a. teaching the pupils to produce technical products;
b. teaching pupils to handle several products of technology;
c. teaching pupils to form an opinion on the application of technology and the resulting effects on society.

These three aims have been further worked out into nine objectives.

To produce technical products:

1. The pupils acquire practical knowledge and skills necessary for preparation of work.
2. The pupils get experience in measuring and drawing, designing, sketching, reading drawings and handling symbolic languages.
3. The pupils acquire practical knowledge and skills on the processing of raw materials like wood, synthetic materials, metal and textile.

In the implementation in annual programmes these first three objectives together take up 40% of the total lesson time. It is particularly important that these objectives are discussed in relation to one another. Subjects are chosen so that pupils have to do preparatory work and that they pay attention to drawing. This does not always mean that they have to make an entire drawing themselves, but also that they finish off a drawing from which a corner is missing or that they draw one or more aspects.

To handle several products of Technology:

4. The pupils acquire practical knowledge and skills in assembling and construction techniques.
5. The pupils acquire technical knowledge and skills in carrying out maintenance activities permitted by law.
6. The pupils acquire practical knowledge of several types of energy and acquire skills in dealing with some forms of energy.
7. The pupils are taught the operating principles of everyday tools, devices, simple machines and appliances, through which they get some insight into the working of these objects in relation to their function.

8. The pupils acquire knowledge in cybernetical systems.

The objectives 4 up to and including 7 take up about 45% of the total time of the lessons. It is not the intention to attain these objectives by having the pupils carrying out assignments on paper. Models for practical work are used so that pupils are actively involved.

To form an opinion on the application of Technology and the resulting effects on society:

9. The pupils acquire knowledge of and insight into applications and consequences of Technology.

In the curriculum guideline Technology Part 1 it is indicated for each objective which contents may come up for discussion. This is further elaborated in the annual programmes.

Yet another objective has been incorporated, about the use of computers. The question whether computers should be part of Technology Education troubled the project group Technology and others too. At the moment we see also at schools an increasing interest in the use of the computer in Technology lessons. A computer has been taken up on the list of inventory for a Technology classroom. Because operating systems have become available lately that are also suited for pupils of 12-15 years old it is very well possible to fit the computer into Technology Education.

From objectives to annual programmes.
As we could see there is a relation between the different objectives. For instance, if we look at the first three objectives, they are all concerned with the processing of materials. In other words, the pupils will learn to make technical pieces of work by using materials like wood, textile, metal and synthetic materials. It is our intention to teach the pupils to work in a so-called technological process. This means that they will be taught not only to generate solutions to technical problems, but also to convert these solutions into drawings, to carry out the design and to evaluate their
solutions themselves. This is what we call the Thinking-Drawing-Making-Checking model.
The working-form of objectives 4 through to 7 is the practical laboratory work. We distinguish two sorts of practical work: those in which understanding technical principles and matters is essential and those practical works that are aimed at making the pupils more skilled in carrying out activities.
Objective eight involves focusing on new technologies.
At the moment there are five systems in the Netherlands that are more or less suitable for use in lessons. These are the well-known Fisher Technik and Lego Cyntech Systems, the material from Unilab and two Dutch systems, Cyntech and Brink-techniek. Several of these systems are computer-controlled.

The ninth objective concerns the social meaning of Technology. This objective can be realized by giving attention to this aspect in commissions for practical works or by presenting certain themes. In such a theme all the contents that are to be presented are brought together within one relevant context. Such a theme will be taken into a programme several times a year.

What do annual programmes look like?

In the aforementioned curriculum guideline Part 2 two annual programmes are described. To give you an idea of the contents of Technology Education the way it is described in the curriculum guideline we have a closer look at these annual programmes.

Both annual programmes have two important characteristics.
In an annual programme the school year is first of all divided into 4 to 6 periods. In those periods subjects are discussed that are mostly related as regards contents.
Secondly so-called shift-systems are often used in an annual programme. The idea is that a class is divided into 3 or 4 groups which carry out the assignments one after the other. The reason for this construction is that it is impossible from a practical point of view to have equipment or material for 24 or more pupils available for all activities.
Annual programme A looks as follows:

**YEAR 1:**

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WORKING ACCORDING TO PLAN</td>
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<td></td>
<td>After the introduction to the subject Technology it is explained to the pupils how the model of Thinking-Drawing-Making-Checking is used in practice. After this pupils carry out several assignments in a shift-system, these are an assignment for woodwork, metal-processing, information on materials and an assignment for drawing.</td>
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</tbody>
</table>

| 2      | TECHNOLOGY AT HOME |
|        | After the pupils' attention is drawn to the meaning of technology in our daily life, assignments are carried out in a shift-system. |
|        | - making a construction kit, |
|        | - hanging something on the wall or on the ceiling, |
|        | - practical work with locks, |
|        | - practical work with drawing. |

| 3      | TINKERING (AT THEIR BIKE) |
|        | After an introduction pupils carry out various assignments: lighting, adjusting of brake, fitting up of chain and assembling of pedals. |

| 4      | TEXTILE AND PROCESSING OF SYNTHETIC MATERIALS |
|        | Practical skills in the field of processing synthetic materials and textile. |

| 5      | THEME: ONE MONEY-BOX EVERY QUARTER OF AN HOUR (MASS PRODUCTION) |
|        | The pupils are acquainted with one form of organization of mass production, the conveyor belt. Pupils analyze the product that is to be made and they compile subassignments. |
REVISION AND OPTIONAL ASSIGNMENTS
This period may be used to finish off assignments or to have pupils working on other assignments.

YEAR 2:
PERIOD
1
SUBJECT
INTRODUCTION
Review of the first year focusing on rubbing up of the objectives of the subject Technology. Apart from this some small assignments are carried out as an orientation to the year to come and pupils carry out assignments by means of Fisher Technik.

THEME: ENERGY AND TECHNOLOGY
In the introduction there is attention for the shifts in the expenditure of energy that have taken place. After this pupils work in groups of 2 to 4 pupils on an assignment of their own choice.
The assignments are:
a wind generator, a collector of solar energy, a car on solar energy, a wind/waterpump and a sailing boat and a piece of practical work on electricity at home.

TECHNOLOGY IN THE SUPPLY OF OUR DRINKING-WATER
As an introduction the technical developments in the supply of water is discussed. Then various assignments are carried out in a shift-system:
- the designing of a system for water supply and sewerage,
- practical work on taps,
- the making of a double action pump.

PROCESS CONTROL
Various assignments are carried out:
- bimetal connection
- electromagnetical connection
- electric connection
- light connection
- water-level control
- Lego Robotics.

5

A WATER PURIFICATION PLANT
Together pupils make a water purification plant.

Annual programme B looks as follows:

YEAR 1:

PERIOD              SUBJECT

1                  TECHNOLOGY, HOW DO WE MAKE IT
Orientation to the subject Technology, then various
assignments are carried out in a shift system:
- practical skills in woodwork,
- practical work for measuring,
- practical work with materials,
- practical work with drawing.

2                  HOW IS IT CONSTRUCTED
In the introduction pupils are acquainted with the build-up
and construction of technical products. After this some
assignments are offered in a shift-system:
- practical skills in metal work,
- practical work with transmissions,
- practical work with construction and connections,
- working with construction kits.

3                  PUT ENERGY INTO ELECTRICITY
Introduction to the subject of the period which is, among
other things, about the generating, transporting and
applying of electricity.
In a shift-system pupils practise the processing of
synthetic materials and electric circuits are discussed
among other things.
PUT ENERGY INTO ELECTRICITY
This period is almost the same as the previous one, processing of synthethic materials has been replaced by processing of textile.

REVISION PERIOD
One part is the finishing-off of assignments, other pupils can carry out additional assignments in this period.

WIND, AN AIRY SOURCE OF ENERGY
Theme in which practical assignments on wind energy are carried out.

YEAR 2: SUBJECT
1 ENERGY AND LIVING
In the introduction the application, expenditure and saving of energy at home is discussed. Then pupils build a small model of a water-heater and they carry out assignments on electrical equipment, lighting and energy at home.

2 MAINTENANCE AND REPAIRS AND INTRODUCTION TO MICROELECTRONICS
Pupils are acquainted with various maintenance activities.

3 QUANTITY PRODUCTION AND AUTOMATION
In class pupils are working for 6 hours on a quantity product in a production line. Each pupil gives his/her own contribution.

4 STEERING AND CONTROLLING
After an introduction the pupils carry out a number of assignments:
- practical work with steering and controlling,
- practical work with pneumatics,
- practical work with microelectronics,
- practical work with Lego Robotics.
The developing of course material

In the curriculum guideline it was indicated in what way course material could be developed. However, no concrete lessons were taken up. Together with the developing of the curriculum guideline Technology the project group Technology started to develop examples of course material and material for practical work.

This school year the developed material was tested at the experiment schools. "De Pijler" Comprehensive School is one of the experiment schools of the project Technology of the National Institute for Curriculum Development. I shall now present you with a short survey of the state of affairs.

In the year 1987/1988 the following periods have been carried out in experiment schools so far:
- working according to plan,
- technology at home,
- tinkering away at their bike,
- processing textile and synthetic materials,
- process control (UNILAB),
- supply of drinking-water.

This year the following periods still have to be carried out:
- equipment and machines work this way,
- water purification plant,
- one money-box every quarter of an hour.

The implementation of the annual programmes

To be able to implement a programme Technology it is of course essential to have a classroom and inventory at one's disposal. The government makes available a maximum of Dfl. 70,000.-- for the building or altering of a classroom and a maximum of Dfl. 30,000.-- for the fitting-up.

Later on you can see this school's Technology classroom, and which equipment is available to implement the programme Technology.
Ladies and Gentlemen,
I shall start by introducing myself: I am Tineke Meijer, teacher of English at this school.

The previous two speakers informed you of the originating of this school and the state of affairs in Dutch education. Meanwhile it will have become clear to you that our educational world is in a state of flux; developments are coming about very quickly. In a short outline I shall try to give you an idea of the way "De Pijler" works on the development of education.

In view of the time reserved for this speech I shall confine myself to the part referring to Technology.

I shall talk about the view of the board of our school, the policy that has been developed on the basis of this and the way this is implemented during the educational changes.

In the choice of policy the board of our school was facing three factors:

1. Diminution of the number of pupils.
   After basic education pupils choose for secondary education. In the course of years a selection process has developed in which pupils prefer to go to a type of secondary general education. In general there will only be a direct choice for vocational education if there is no alternative, usually because of limited abilities. That is why the inflow of pupils showed a sharp decrease. The falling birth-rate is an important factor too, and because of the aforementioned selection process this is felt most strongly in vocational education.
2. Generalization of vocational education.
Stimulated by the political opinion that was current at the time an extreme generalization of vocational education appeared in the sixties and seventies. As a result of this the direct link with and acknowledgement of the profession in practice was partly lost.

3. Partly out-of-date equipment.
Under the influence of the worsened economic situation there have been severe cuts in expenditure for schools' inventories. The consequences of this could be felt particularly well at a time of slight recovery in trade and industry so that new technology was introduced there at a higher speed.

The outlined difficult situation did and does not only refer to Dongen, but it applies to Junior Vocational Education in the Netherlands as a whole. The board of the previous Junior Technical School and after the merger the new board of "De Pijler" tried to pursue an alert policy as regards the three aforementioned issues.

- By the merger and participation in an experiment for integrated secondary education (the so-called Double-project) possibilities have been created for a broader supply of education to both boys and girls. This way we try to improve the inflow.

- To improve the relation with the profession in practice an Interest Group for Vocational Education in Dongen has been called into existence. In it school and industrial circles together consider the contents of curricula and practical work.

- The Dutch government pursues a stimulating policy in the field of computer education. In agreement with this "De Pijler" also gave high priority to this, both in the lower grades and in professional applications in higher grades.

Ladies and Gentlemen, so far the short survey of this school's views on the development of education.
Better than with words we can show you during the tour of the school the
way we implement it during the lessons.
During this tour you will be divided in three groups.
You will visit in succession:

The exposition Shoemakers' Vocational School and the Technology Classroom
It was during this school year that the Technology Classroom was completely altered and furnished and partly provided with a new inventory.
The course material is still in an experimental stage.
The first experiences with the new framework are extremely positive.
However, a lot of things still have to be done and it will be clear to you that what we show you today is not finished completely.

Classroom for Technical Information Theory
In the classroom for Technical Information Theory you get a survey of a development that is unique in our type of education.
In this field our school had a pioneer’s task.
The course material and education models were largely developed by the teachers themselves.
During the visit to this classroom you will be given the opportunity to get some experience with computer simulation.

The Classrooms for Information Theory, Mechanical Technology and Construction Engineering
This school year the classroom for Information Theory was also fitted up with modern equipment and used for the first time.
The subject Information Theory is on the time-table of all classes.
Children's parents are also given the opportunity to take a short introductory course.
In the classrooms for Mechanical Technology and Construction Engineering only the pupils who chose these subjects are taught.

Ladies and Gentlemen, this is the end of my survey of the development of education at our school.
We deliberately confined ourselves to the technical aspects, which is understandable in view of the objective of the PATT-conference.
On the other hand, we could discuss the subject in such detail that you will probably be optimally motivated for the tour after the break.
I hope you will enjoy yourself!
SUMMARY OF THE PAPERS AND DISCUSSIONS ON THE FIRST THEME:
FRAMEWORKS FOR TECHNOLOGY EDUCATION

Dr. Ray Page
South Bank Polytechnic
London, United Kingdom

1. Introduction
Some 20 papers were presented under this particular theme and one
discussion period was devoted to it. A study of the papers and the notes
received from each discussion group revealed that there were features that
were common to all countries represented and in that sense appeared to be
culture free, and then there were those features that related specifically to
a country's circumstances which were culture dependent. In presenting this
summary I have emphasised the features which were common under three
headings:
- the Nature of Technology and School Technology
- the Function and Role of Technology in the School Curriculum
- the Place of School Technology in the Curriculum
I have done this because at the beginning of the Conference we tended to
dwell on our differences. As the Conference progressed and we learnt a
little more about the background to the papers presented and entered into
a discussion with each other, we began to realise that there was more to
unite us than divide us. I therefore think it is apposite in this summary to
dwell on that which we can agree upon rather than upon our differences
for these relate to our individual circumstances and by definition can never
become common ground.

2. Nature of Technology and School Technology
The common elements identified in the papers and by the discussion groups
concerning the nature of technological activity (and by implication the
nature of technology in the school curriculum) can be identified as follows:
- it is a problem solving process;
- it arises from human need and real situations;
- it utilises the knowledge from many disciplines and subjects;
- it draws on several skills (including those developed in the Industrial Arts
area of the curriculum);
- it works within constraints (e.g. economic, social, etc.);
- the key elements that arise in the knowledge and skill areas are ENERGY, MATERIALS, CONTROL, and COMMUNICATION (including INFORMATION TECHNOLOGY).

This leads to the model for technology given below which was included in one form or another, in a number of papers - not all of which were related to this particular theme.

While my definitions were given to the Conference on the nature of Technology, none of them disagree in any major detail with this particular model and, while it may be necessary to give a definition from time to time in a report, it was suggested that it is more useful to adopt a set of criteria by which to decide if an activity, programme, course or extra-curricular activity is technological in its nature and content. These criteria can be summarised as follows:

- some experience of the problem solving process and its stages;
- the development of knowledge about energy, materials, control and communication systems;
- the acquisition of skills related to making, communicating, information gathering, creative thinking, and so on;
- some awareness and understanding of the interaction between the technological developments and society;
- the development and/or modification of effective attitudes towards technology and industry.

This list is not intended to be definite nor is it easy to indicate how far a particular programme needs to incorporate these criteria to be called a
technological activity. On the one hand it is necessary to exclude project work that is just information gathering, but on the other hand no move towards technologically oriented courses should be discouraged. A tentative suggestion is that there should be a significant response to three out of five listed criteria.

The majority of Conference delegates agreed that problem solving should be more than information gathering (particularly at primary school level) and it should involve the following stages:

- defining a problem
- suggesting solutions to a particular problem
- choosing and making/modelling the chosen solution
- testing, modifying and evaluating the chosen solution

There was some discussion as to whether technology education should be distinct from technical and vocational education. The Eastern Bloc countries argued strongly that technology education should not be distinct from technical and vocational training. Other countries felt that while these two areas were mutually supportive, technology education should have a distinct role otherwise there was a danger that only pupils of average ability would be exposed to technology in the curriculum. The more able would as a consequence have a diet of science with a measure of applied science and this could lead to a continued lack of engineers of high quality and a section of the community technologically illiterate.

Function and Role of Technology in the School Curriculum

The papers and discussions revealed that there were two functions for school technology - laying the base for future national needs in engineering and allied fields and the development of important personal attributes such as the ability to make decisions, persevere and so on. This led to a general consensus that the aim for school technology should be to develop:

- knowledge about technology and its developments;
- experience of the technological process;
- the capacity to use knowledge and skills acquired from any technology course in a wider form.

Groups suggested that the balance between national need and personal development, and therefore the aims of school technology, should depend on a country's needs. It was noted that as a society develops, rule-of-thumb technology gives way to scientifically based technology. Alternative
technology (often associated with developing countries but now becoming of equal importance in developed countries) should be seen as being as valid as the high technology approach of the developed countries. It was also important that areas of technology such as those related to agriculture, medicine, the home, the textile industry, were seen as important as the more traditional engineering areas. It was also felt that the microelectronics industry should be presented in such a way that it was equally attractive to boys and girls as it did not need to present the "male dominated" image that has tended to be associated with mechanical, electrical, and civil engineering.

The Place of Technology in the School Curriculum

Various papers and discussion groups identified strategies for introducing technology into the school curriculum. These can be summarised as follows:
- extended; open-ended; extra-curricular; project work (drawing on the traditional subjects of the curriculum and other inputs from local industry, agriculture, and so on);
- the enrichment of existing courses (particularly Science and Industrial Arts, and more frequently the latter from the comments from several countries);

The strategy here could often be identified as diagrammatically shown below:

Traditional concepts and skills \[\rightarrow\] More open investigations and designing work \[\rightarrow\] Project Work \[\rightarrow\] Enterprise or Community schemes

Within syllabuses and the traditional timetable

Extra-curricular or through suspension of normal timetable for a short period

- as a single subject where there is a need for an examination syllabus, an appropriate supply of technology teachers, and where the approach is often on a modular basis; this mode can give focus to technology in a school but can be limiting in its scope;
- the topic approach which is more appropriate to primary than secondary
level where it can concentrate on developing effective attitudes and is less threatening to teachers;
- as a general studies activity, but this was not regarded as a successful mode because it tends to accentuate "knowledge about" technology rather than "doing" technology.

The enrichment, single subject and topic approach are frequently linked to guided project work and in this mode they all satisfy the criteria given earlier to be called "technology".

A Framework for School Technology
As papers and group discussions moved from debating the nature of technology, through its function and role in the school curriculum, to strategies for introducing technological activity each country's culture and needs began to increasingly show an impact and lead to differences of approach. This can be summarised in the pyramid model below:

Our Separate but Supportive Ways
Depending on the particular routes being taken in a country's technological education programme, different features emerge. I have attempted to summarise these under the three headings of the Industrial Arts route, the Science route, the Technology route and the problem-solving approach. The Industrial Arts route tends to accentuate skill development (in metalwork, woodwork, ceramics, textiles and so on), the relationship of technology to manufacturing industry, and the key areas of energy, materials, control and frequently a large element of electronics.
For those taking the Science route the base for technology seems to be
broader, including such areas as Biotechnology, Medicine, and the like but equally the emphasis does tend to be on knowledge about technological development in the form of how science principles are applied. Project activity is often done as an extra-curricular project linked to entry into local Science Fairs.
Where countries are taking the technology route, courses are frequently on a modular basis and are "owned" more by the Industrial Arts departments than Science departments. The problem solving activity may be of a somewhat limited form and concerned with the development to technical and vocational education, rather more strongly than is the case with the Industrial Arts and the Science route.
With respect to problem-solving in a technological context it can take two forms - an integrated approach and a final phase approach. In the former approach problem solving skills are developed on a gradual basis until they form part of a major project. In the latter case any problem solving exercise is saved until the end of a course.

**Conclusions**

It is traditional at this point to mention some of the warnings that have been heard in group discussions. In the case of Frameworks for Technological Education they have related to ensuring that consultation takes place beyond the teaching profession to involve industrialists and others working in the field of technology; the dangers of not doing anything until perfection in planning has been achieved; and the very real problem of technology being seen as producing "factory fodder" for industry.
Finally, there was a general plea for increased technological literacy to prevent the onslaught of technological determinism whereby, because we can achieve something technologically, we must do it. Several papers and discussion groups emphasised that technology was made for society, not society for technology, and the only way to ensure that the technological process enhanced the quality of life was to give pupils in school throughout the world a sound technological education.
Technology has a very large impact on our cultural, social, economic and political life, so in fact on our whole life.
Yet in most countries, little or no explicit attention is given to technology in general education. This is understandable, but it is a pity and not correct.

We consider it important that both at primary and at secondary schools more attention is given to technology.

At secondary school level (lower level, ages 12-15) we think of a separate subject technology, whereas at primary school level (ages 6-12) we think it is important to give some technological background at least to the teachers.

In many cases the subject technology starts from the zero level. One of the things we need to know is the pupils' ideas about technology: what is their concept of and their attitude towards technology?
This is investigated in the international PATT (Pupils' Attitude Towards Technology) project.

At the previous two PATT-Conferences in 1986 and 1987 results have been discussed together with the attention for technology curricula.

The main theme of PATT-3 (April 21-26, 1988) was: 'Basic Principles of School Technology'. In two volumes a mixture of research and curricula-examples is given from 23 countries.

Volume I contains papers with reference to Frameworks for technology education. Volume II contains papers with reference to PATT-research, related research, and its relevance; How to make technology education attractive for girls; The education of teachers for technology education.

Information on the PATT-project is published in TECH-ED-News.

There will be a fourth PATT-Conference from April 13-18, 1989, with the theme 'Teacher education for technology teachers'.
BASIC PRINCIPLES OF SCHOOL TECHNOLOGY

REPORT
PATT-3 conference
1988

vol. 2 • PATT-RESEARCH, RELATED RESEARCH AND ITS RELEVANCE
• HOW CAN WE MAKE TECHNOLOGY INTERESTING FOR GIRLS?
• THE EDUCATION OF TEACHERS FOR TECHNOLOGY EDUCATION

PUPILS' ATTITUDE TOWARDS TECHNOLOGY

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PATT-conference 1988

This is volume 2 of the report of the PATT-conference that has been held from April 21-26, 1988 in Eindhoven, the Netherlands, and was organized by the Department of Physics Education of the Eindhoven University of Technology in cooperation with the Dutch Ministry of Education and Sciences.
VOLUME 1

CONTENTS

OPENING

1. Technology in the context of school education. General Frameworks, Faqir C. Vohra 11
2. Introduction to the theme of the conference, Jan H. Raat 30
3. PATT-research in 1987/1988, Falco de Klerk Wolters 39

FRAMEWORKS FOR SCHOOL TECHNOLOGY

4. School technology in China's rural area, Cheng Donghong 49
5. Evolution and evaluation of technological education as a generally formative subject, Chris Claeyts 57
6. Technical work as an academic discipline in Finland, Tapani Kananoja 76
7. Pupil/surroundings connection as an educational moment in self knowing and problem solving, Ilia Natali 89
8. The dilemmas of technology education in Hungary, Janos Fekete 98
9. Basic principles of school technology in our country, Hana Novakova 108
10. The system of polytechnic education in the GDR, Dietrich Blandow 116
11. Items of selection in the didactical process, Wolfgang E. Traebert 136
12. Developing knowledge and skills through technological project work, Peter Edwards 147
13. Technology education in the UK, Ray Page 163
14. What should and can pupils learn in technology education, Marc J. de Vries 182
15. Technology as a school subject: the Kenyan experience, Frederic Otieno 189
16. Framework of technology education in Poland, Jerzy Ogar 197
17. International perspectives on technological literacy, Michael J. Dyrenfurth 202
18. A framework for studying technology, James L. Barnes 209
19. Technology at a Dutch school, J. van Engelen
20. Technology education in the Netherlands: off the main road, Jenne van der Velde
21. Technology education at "De Pijler" comprehensive school, Tineke Meijer
22. Summary of the papers and discussions on the first theme: frameworks for school technology, Ray Page

VOLUME 2

PATT-RESEARCH, RELATED RESEARCH AND ITS RELEVANCE

23. Technology - the discipline, William E. Dugger, Jr. 255
24. PATT research and the relevance of PATT: perspectives from developing countries especially from Africa, Raphael Kapiyo 272
25. PATT - results and the relevance of PATT, Henryk Szydlowski 285
26. Nigerian pupils' attitudes and conceptions of technology, Taju Balogun 294
27. The teachers' and pupils' opinions about the school subject "Work and technology", Grazyna Dudziak 303
28. The investigation of the general high school students' attitude towards technology, Alexandra Grodzka-Borowska 309
29. The study of the concept "Technology" by the general high school students, Danuta Oleniacz 314
30. What do adolescents think of technology, Falco de Klerk Wolters 323
31. Projection of different gender and social setting over attitudinal difference to technology, Jaghmohan S. Rajput 337
32. Research into pupils' concept of and attitude towards technology and its impact for the Kenyan school curriculum, Raphael Kapiyo 357
33. The valuation in middle school: technical education Italy, Lola Barbaferia Bardini 364
34. A study of the relationship between teachers' activities in computer education lessons and pupils' attitudes towards computers, Jeff L. Moore 370
35. Physics and technology in students' opinion, Aivo Saar, J. Hendre 379
<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>36. Scientific creativity test, Chhotan Singh</td>
</tr>
<tr>
<td>37. Summary of the second theme: PATT-research, related research and its relevance, Jeff L. Moore</td>
</tr>
</tbody>
</table>

### HOW TO MAKE TECHNOLOGY INTERESTING FOR GIRLS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>38. How can we make technology interesting for girls, Leonie Rennie</td>
</tr>
<tr>
<td>39. Making technology more attractive for girls: the teachers' view, Annita Alting</td>
</tr>
<tr>
<td>40. What can MENT do to make technology interesting for girls, Marja Brand</td>
</tr>
<tr>
<td>41. The concept of technology and the interests of young women, Ilja Mottier</td>
</tr>
<tr>
<td>42. Medical technology: a girl friendly course, Wilma Groenendaal and Marc de Vries</td>
</tr>
<tr>
<td>43. Technika 10 - Hobbyclubs for girls, Mieneke Hylkema-Knottenbelt, Margreet Nauta</td>
</tr>
<tr>
<td>44. Labor management strategies, internal labor markets and sexual division of labor, Diane Tremblay</td>
</tr>
<tr>
<td>45. Summary of the third theme: How to make technology interesting for girls, Ilja Mottier</td>
</tr>
</tbody>
</table>

### EDUCATION OF TEACHERS FOR TECHNOLOGY EDUCATION

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>46. Teachers for technology, Geoffrey B. Harrison</td>
</tr>
<tr>
<td>47. Teacher training and the concept of technology, Willem Deijsselberg</td>
</tr>
<tr>
<td>48. Directions for use of the TAS in class, Falco de Klerk Wolters</td>
</tr>
<tr>
<td>49. Teacher training based on a general technology, Horst Arp</td>
</tr>
<tr>
<td>50. Teacher training in Polytechnical Education, Dietrich Blandow</td>
</tr>
<tr>
<td>51. The fundamental categories of technics and technics-teachers' training in Hungarian universities, József Déri</td>
</tr>
<tr>
<td>52. Technology education in Hungarian schools, Ervin Szucs</td>
</tr>
<tr>
<td>53. Technological education in Scotland, R. T. Morrison</td>
</tr>
<tr>
<td>54. Training teachers for technology education: a new goal in a number of Turkish projects of vocational and technical education, A. Vural Türker</td>
</tr>
</tbody>
</table>
55. Technology at primary schools, Henk Siegers, Jan H. Raat and Falco de Klerk Wolters 598
56. Primary science and technology, Robert Harvey 606
57. Problems and perspectives of teaching technology, Peter Petrov 610

LIST OF PARTICIPANTS 639

REGISTER OF AUTHORS 650
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PATT-RESEARCH, RELATED RESEARCH

AND ITS RELEVANCE
Technology is a discipline and technology education has as its mission to ensure that all students are prepared to live in a technological world and be technologically literate. This paper has provided a background on what technology is and how it is a discipline. Cecily C. Selby, co-chairperson of the National Science Board report *Educating Americans for the 21st Century* stated that "...technology education - (is) a newcomer to the liberal arts tradition". The report went on further to recommend: "Students must be prepared to understand technological innovation, the productivity of technology, the impacts of the products of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology" (Selby, 1964-, p. 162).

Clearly our growing national need is a mandate to prepare future citizens who can cope with an ever changing future. We must develop technology as a discipline to be taught in the public schools through technology education along with science, mathematics, and English. The Task Force on Education for Economic Growth of the Education Commission of the States, in its 1983 report, does say that "technological changes and global competition make it imperative to equip students in public schools with skills that go beyond the basics" (Selby, 1984, p. 167).

Our profession is currently in its era of greatest opportunity and challenge. Philosophers, legislators, business and industry leaders, and many others are called for technological literacy as a basic and fundamental part of education. We must set as our first goal, the development of young minds, both for innovative thinking and technological understanding, who will become the leaders for tomorrow.
TECHNOLOGY - THE DISCIPLINE

Technology has been the primary component of human problem solving capability since the evolution of time. In the past century, however, technology has taken on a new importance ... that of helping humans to move from tool making and using inhabitants of this planet to beings having mastery and control over the forces of nature. Only recently, has technology been perceived as an emerging discipline.

Historically, relatively little has been written about technology as a formal, or academic discipline. Within the past decade, however, there has been a growing liturgy of writings in technology from professionals in such areas as science/technology/and society (STS), education, engineering, and science. Little formal research has been done in the discipline of technology.

What is technology?

Enquiry into the discipline of technology, due to the relative newness of the topic, must start with some reflections on what is technology. Etymologically, the roots of technology are found in the Greek words "techne" and "logos", with the first relating to the art or craft in making something (artifact) and the latter involving the understanding or the logic of that art, craft or skill. In 1778, Benjamin Franklin, one of America's most famous inventors, stated that "Human history is marked by the evolution of man's technology from the first all-purpose tools to tools of greater precision, greater variety, and greater specialization".

In his classical essay titled "Thoughts on Technology", Jose Ortega Gasset (1939) gives a philosophical understanding to the meaning of technology by defining it as "the system of activities through which man endeavours to realize the extranatural program that is himself". He viewed technology as an activity founded in human nature and the principal means for realizing this nature. His philosophy of technology is based on his existentialism view of man as a being who makes himself.

In the mid-1950's and into the 1960's, there was a very important movement to establish a discipline-based school system in the United States. During this era, Schwab stated that if we did not take the structures of the disciplines into account and make them integral to the curriculum, "there would be failure of learning or gross mislearning beyond students". Some scholars went even further than Schwab in seeing the disciplines as the
sole source of the curriculum. Phenix declared that, "The curriculum should consist entirely of knowledge which comes from the disciplines ... Education should be conceived as a guided recapitulation of the processes of inquiry which gave rise to the fruitful bodies of organized knowledge comprising the established disciplines"; Although the disciplines doctrine rejects the traditional conception of knowledge as fixed or permanent, and regards knowledge as the product of a process known as disciplined inquiry, it confines such inquiry to the boundaries of the established disciplines (Tanner, 1975, p. 12).

In his article titled "Technology Is an Academic Discipline", Edward A. Friedman (1980, p. 211) defines technology as "...systems and artefacts incorporating knowledge of the physical and social worlds which affect society's activities and organizations". Thomas R. DeGregoni (1985, p. 16) says that technology is "...in effect, a problem solving process". The Technology Panel for the Project 2061 of the American Association for the Advancement of Science (1987, p. 5) states that "Technology is the application to solve practical problems and extend human capabilities". Similarly, Pfister (1985, p. 1) says that technology is "...a form of intervention that employs tools, techniques, knowledge, resources, and systems for the purpose of affecting the human environment and its organization". The British Department of Education and Science report titled Technology in Schools (1982, p. 16) gave a definition of technology as "...concerned with meeting human need or purpose, ...the control of the environment, ...the application of scientific and other forms of knowledge to the use of physical resources, and ...a creative process of rising human knowledge and physical resources to solve problems". From a Dutch perspective, Marc de Vries (1987) states that the five general characteristics of technology are: (1) Technology is inseparable from human beings; (2) the three dimensions or 'pillars' of technology are matter, energy and information; (3) technology is closely related to science; (4) in technology there are three kinds of skills which are designing skills, practical-technical skills and skills in dealing with technical products; (5) and there is a mutual influence between society and technology.

The well known industrialist writer, Peter Drucker (1985, p. 11) states succinctly that technology is the "...applications of knowledge to human work". The Virginia Technology Education Curriculum, K-12 (1988, p. 7) defines technology as the "...study of the application of knowledge,
creativity and resources to solve problems and extend human potential”. Definitions are important as foundations on which to formulate philosophies and later build disciplines.

**Disciplines; Formal, Intellectual or Academic**

A discipline according to *A Dictionary of Education* (1981, p. 69) is "a formal area of human knowledge and enquiry, (e.g. biology, geography, etc.) systematically investigated and taught with its own learned journals, professional associations, and no doubt, a healthy brood of sub-disciplines.”

Henryk Skolimowski (1970) in a presentation to the American Industrial Arts Association Convention in 1970, stated that technology should not be treated as an object (i.e. tool, device, artifact, or thing) but as a subject with social lineage and responsibility. He said that technology is "the totality of all man-made tools, their functions, and use, the material results of their application, the social impact of these products and the influence of technological change on the life of particular individuals". In an earlier writing Skolimowski (1966) provided a scholarly discourse that "In the twentieth century, and particularly in our day, technology has emancipated itself into a semiautonomous cognitive domain". In other words, he stated that we have a subject matter area which can be considered a discipline.

In education, we have for years debated the direction of school curriculum being subject-centered. In a subject-centered approach to curriculum organization, a student merely accumulates information, in large amounts, of which she/he soon forgets or finds that it has become outdated. Under the discipline centered approach, the learner is assisted in the development of generalizations, principles, and techniques which may be applied in learning throughout his lifetime (Meagley and Evans, 1967, p. 8).

A very strong case for the use of the discipline-centered approach for selecting and organization learning experiences as presented by Saylor and Alexander (1966, p. 165) is:

By requiring the organization of knowledge a discipline simplifies it, making it more readily available for use not only by the professionals in that field but by lay persons and school pupils as well. The scholar generalizes and conceptualizes, thus reducing the need for a vast array of disparate bits of information that would be impossible to carry in memory throughout a lifetime. And such generalization is a necessary step in the organization of a discipline ...
The structure of the discipline shows the interrelationship of the field of knowledge; it unifies the field, organizing it logically so that knowledge may be used efficiently. Parts take on significance because of their relationship to the entire domain. A discipline facilitates the development of new understandings, the discovery of new knowledge to be incorporated into the system. It points the way to new discoveries by revealing the gaps in existing knowledge in a logical structure and the directions in which an extension of knowledge is possible.

In the 36th Council on Technology Teacher Education yearbook titled Conducting Technical Research, Paul DeVore states that "what has been occurring is the evolution of a new discipline, technology, which is not dependent upon nor subservient to science, as commonly known and perceived" (p. 29). He went on to say that "the discipline of technology is the systematic study of the creation, utilization, and behavior of adaptive systems" (p. 43).

From another broader perspective, Foshay (1963, 68) states that any discipline has these three primary elements:

1. It has a domain - the phenomena, or aspects of life, for which it takes responsibility.
2. It has methods or rules according to which the scholar in the discipline seeks out and handles the data given in the domain, and according to which the quality of the generalizations he reaches may be judged. Included in the method, or the rules, is an agreement on the type of generalization or output appropriate to the discipline.
3. Any discipline has a history, or a tradition, which enters into the decision on both the domain and the rules according to which it proceeds as a field of learning.

Oliva, in his book titled Developing the Curriculum (1982, p. 14) gives the following characteristics of a discipline:

1. Principles. Any discipline worth of a study has an organized set of theoretical constructs or principles that govern it.
2. Knowledge and Skills. Any discipline encompasses a body of knowledge and skills pertinent to that discipline.
3. Theoreticians and Practitioners. A discipline has its theoreticians and its practitioners.
Technology as a Discipline

Using Oliva's criteria for a discipline, let us see how technology measures up to these essential characteristics.

Principles

As Oliva stated, a major characteristic of any theoretical principle is its capacity for being generalized and applied in more than one situation. Most certainly one example is the work completed by the group of educators in the Jackson's Mill Industrial Arts Curriculum Project (Snyder and Hales, 1981) which laid an important theoretical foundation for technology education in the United States.

In Great Britain, technology has become a major component in the secondary school curriculum. In that country, it is usually referred to as Craft, Design and Technology or CDT. In 1970, a proposed theoretical model for technology for the school of Great Britain was developed by Harrison and Black and it is being implemented through a problem solving approach in most British schools.

Many states have or are in the process of adopting (or adapting) their own organized set of theoretical constructs or principles for technology education to be implemented at the local level. Good examples of these were the New York Futuring Project in Technology Education (1983), the Illinois Plan for Industrial Education (1983), the Iowa High School Industrial Technology Curriculum Technology Project (1986) and the Montana Planning Guide for Industrial Education/Technology Programs (1983). More recent examples of these are the Report of the Commission on Technology Education for the State of New Jersey (1987) and the Technology Education Curriculum, K-12 for Virginia (1988). In the latter, an example of a basic model for technology education which will be used as a theoretical construct or principle for state and local planning is shown:

A Model of Technology

![A Model of Technology Diagram]

INPUT

KNOWLEDGE

CREATIVITY

RESOURCES

PROCESS

PROBLEM SOLVING

OUTPUT

EXTEND

HUMAN

POTENTIAL

HUMAN WANTS AND NEEDS
As Oliva states (p. 15), "Curriculum itself is a construct or concept, a verbalization of an extremely complete idea or set of ideas. This technology as the key construct of the subject matter area of technology education qualifies very well under the criteria of "principle".

Knowledge and Skills

The Technology Panel of the American Association for the Advancement of Science (1987, p. 5) stated in a draft copy of a report that: "Technology is the application of knowledge, tools and skills to solve practical problems and extend human capabilities. Technology is a process, often known by its products and their effects on society. Technology is enhanced by the discoveries of science and shaped by the designs of engineering. It is conceived by inventors and planners, raised to fruition by the work of entrepreneurs, and implemented and used by society. It may enter the social system imperceptibly but given time can transform it, often in unforeseen ways.

Technology is in part a social process. Technology is supported to serve the society that generates and controls it through its private and public institutions and its people. Thus it is important to understand the interactions of technology and its various fields with human social systems and the values that societies may apply. The results and dynamics of these interactions are key to how technology affects our lives.

Technology is also a technical process. It is different from science whose role is understanding. Technology's role is doing, making and implementing things. The principles of science whether discovered or not, underlie technology. The results and actions of technology are subject to the laws of nature even though technology has often preceded or even spawned the discovery of the science on which it is based. Most modern technology, particularly that embodied in systems, is fabricated through the technical designs of engineering and enters society according to the perceived needs of the social-economic system. Thus it is important that young adults know some of the underlying basic science, mathematics, and engineering concepts and their relationship to technology; that they are familiar with the use of the basic "tools" involved, from applied mathematics to design, to computers, to hardware; and that they understand technology does not stand apart from the society it serves.

Technology is chiefly responsible for the ever increasing rate of change in the world. Such changes are vital to growth, perhaps inevitable since the
world must support a burgeoning population. Modern production demands an advancing yield of technology and change. Young adults should not believe they must passively accept or cope with whatever technology brings; rather, they should be part of its evolution. Technology is revealed by its contributions to humankind, both current and historical and by technical advances foreseen for the near future. And yet, its uncertainty, ambiguity and the always possible unexpected consequences for good or evil cannot be neglected, or minimized. Technological solutions to human problems are not unique. There are no "right" answers and choices must be made. It is vital that these choices be informed and value-based.

In his paper "Technology as Knowledge" Layton (1974, p. 31) discusses that technology has a knowledge base and is independent from science. He states that technology "...means detailed procedures and skill and their application. But complex procedures can only come into being through knowledge. Skill is the ability to use one's own knowledge effectively". Rodney Frey who recently gave an excellent presentation on "Is there a philosophy of technology?" at the 1987 Mississippi Valley Industrial Teacher Educator conference (1987, p. 22) stated that "Recently, philosophers have moved beyond considering technology as a source of questions and begun to view the phenomenon of technology as a legitimate area of study, distinct from science. As philosophers continue to study technology, our understanding of the phenomenon will deepen and our discipline, Technology Education, will benefit".

Again, DeVore (1987, p. 35) helps us draw clearer perspective on these criteria by writing that "knowledge is technology is (1) knowing that something is true in a given context and (2) knowing how to accomplish a preconceived end". He went further to say that "...technological knowledge is knowledge generated through thinking and action involved in creating adaptive systems as opposed to knowledge used to create ideological and social systems" (p. 33).

Skolimowski, a philosopher of technology, proposes that technology is a form of human knowledge and it can be best understood by the idea that technology is concerned "with what is to be" while science is concerned with "what is".

Most certainly, the criteria of the discipline of technology having knowledge and skills is most important.
Theoreticians and Practitioners

Without doubt, the discipline of technology education meets these criteria of having theoreticians and practitioners. Over the past century, our field in the U.S. has slowly been transcending from manual arts to industrial arts to technology education. Each of these subject matter areas are not totally unique and obvious overlapping has taken place. Some people would be willing to say that you may still find excellent examples of each currently being taught within a given region, state, or even a locality.

Historically, technology education began in the 1930's-1940's. The theme of the first American Industrial Arts Association Convention (now the International Technology Education Association) in 1947 in Columbus, Ohio was "A Curriculum to Reflect Technology". Since 1947, a large number of the AIAA conference themes have also emphasized technology. There were theoreticians during the decades of the 1950's - 1970's such as William E. Warner, Demar Olson, Donald Maley, Paul DeVore and Donald Lauda, who were philosophers advocating technology as the major curriculum organizers for our field.

The American Council of Industrial Arts Teacher Education (now the Council on Technology Teacher Education) has produced a number of annual yearbooks which have reflected the trend toward technology. The first graduate program for technology education was established at West Virginia University, while Eastern Illinois University began the first undergraduate teacher preparation program in technology education. A number of Technology Symposiuns have been held around the U.S. which have added impetus to the trend toward technology education.

The 1983-86 Professional Improvement Plan for the American Industrial Arts Association provided the long range direction for the association to move it into a leadership group for technology education. A major part of this plan was to establish 40 model technology education centers having exemplary programs nationwide. In 1985, the American Industrial Arts Association changes its name to the International Technology Education Association (ITEA). In 1986, ITEA developed a new four year long range plan to provide direction for our profession into the 1990's.

There are a number of classroom teachers nationwide who are changing their program to technology education. In the ACIATE 1986 yearbook Bame (p. 70), Daiber and LaClair (p. 95) provide an excellent perspective on how technology education can be implemented at the middle and high school
levels. Also the ITEA publication Technology Education: A Perspective on Implementation (1985, p. 29) gives commendable examples of practitioners from California, New York, Virginia, Colorado, and Illinois who are implementing technology education in their classroom each day. Standards for Technology Education (1985) have now been developed and are being used as a means to assess the quality of programs nationally. The National Study on School Evaluation recently revised its Evaluative Criteria (6th Edition) and it includes new standards on technology education. These criteria are being used in 95 percent of the U.S. public and private schools. Any school seeking accreditation by one of the seven regional accrediting associations must be evaluated by these criteria.

Research in Technology Education and the Pupils' Attitude toward Technology in the United States

Technology education as a discipline is regarded today as an essential element in the students' preparation for living in our society. Educators agree that technology education should not only be aimed at providing the students a factual knowledge of various items in the field of technology, but also at helping them to acquire a certain attitude toward technology. It is also important that the students get a balanced view on technology as a cultural phenomenon. This is an essential part of technological literacy which everyone needs.

Until recently, most research in the field of technology education focused on the curriculum content. Little knowledge is available of the students' ideas about technology: their concept of it and their attitude toward it.

In 1984, in the Netherlands, research was carried out into the pupils' attitude toward technology. The research was carried out at the Eindhoven University of Technology with Prof. dr. Jan H. Raat as a supervisor. The first part of this research was done by Dr. Marc de Vries among pupils of age 13/14 in secondary general education. Because of these results, a proposal was made to extend the research internationally. From 1985 to 1987, about twenty countries joined this international research, that is referred to as PATT: Pupils' Attitudes Toward Technology. In March 1986 and April 1987 international conferences were held in Eindhoven to discuss the results of PATT studies in various countries and the relevance of these results for the development of technology education in these countries. Countries that are involved now are: Australia, Belgium, Canada, Denmark,
Finland, France, Hungary, India, Italy, Kenya, Mexico, Nigeria, Poland, Portugal, Spain, Sweden, United Kingdom and the United States. As instruments for this research two questionnaires have been developed: one questionnaire for the students' concept of technology and one for the students' attitude toward technology. In addition, essay assignments are used.

Until now, only small and medium scale studies have been carried out (samples of 200-400 students per country) in the countries mentioned above. Only in the Netherlands, research has been and still is, done with samples that can be regarded as representative for the whole country. In Kenya, a large scale study is now in preparation. This study will be used as a means for establishing the preferable ways for the development and implementation of technology education in that country.

Another country in which a large scale study into the students' ideas about technology could be carried out is the U.S. In the U.S. many new initiatives in the field of technology education can be found. But there are few examples of efforts to establish the results of these initiatives on the pupils' attitude toward and their concept of technology, although these aspects are mentioned as important objectives in technology education. The PATT instruments are a powerful tool in finding out what ideas are generated in the students' minds as a result of various technology education programs. Besides that, the PATT research gives a unique opportunity to get an insight into the position of the U.S. with respect to other countries and cultures.

The Virginia Polytechnic Institute and State University has taken the initiative to promote replication of the PATT research in the U.S. Prof. dr. W.E. Dugger Jr., Program of Technology Education, the Eindhoven University of Technology, he, and Dr. E. Allen Bame, will be responsible for the replication of the PATT research in the state of Virginia. This replication will include a careful try-out of the existing PATT questionnaire for the U.S. situation (planned in March-May 1988). The design of the research includes comparisons between various technology education programs in Virginia. The replication will be carried out in August 1988 - June 1989. Longitudinal research has been planned for 1989/1990.

For a nationwide replication, the questionnaire would have to be administered in many states. When this is done, comparisons between various technology education programs within each state and comparisons between
states and international comparisons would be possible. This would yield a rich source of information for further development of the technology education programs in the U.S.

In most states, high priority is being given to the technological literacy of students and substantial funds are spent on the development of technology education programs to provide that literacy. Careful assessment of the effects of those programs are essential, which means that finances must be expended on this. The research into the students' concept of and attitude toward technology certainly must be an integral part of any sophisticated assessment of technology education programs and the development of the discipline of technology.

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PERSPECTIVES FROM DEVELOPING COUNTRIES ESPECIALLY FROM AFRICA

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Summary

Research into pupils' concept of and attitude towards technology internationally for the last 3 - 4 years has revealed various issues, problems and prospects for consideration in the development of Technology education in individual countries. Developing countries with their unique cultural contexts, different forms of technological practices and experiences (e.g. Indigenous Technology, Technology in the informal sector, Appropriate Technology, and Modern Technology) and shifts in educational practice might have a different response to Technology in Schools.

Although School Technology is an attractive educational option in curriculum terms especially with regard to National development, Indigenous technological capability and the vocational element, it entails CHANGE; Educational and Attitudinal. How PATT research results can link with actual practice on existing Technological Curriculum in Africa to effect this change remains the challenge.
PATT RESEARCH AND THE RELEVANCE OF PATT: PERSPECTIVES FROM DEVELOPING COUNTRIES ESPECIALLY FROM AFRICA

Introduction

After three to four years of PATT Research, there is no doubt that we have enriched and increased our knowledge about pupils' concept and attitudes towards Technology. There are also attempts to identify and construct viable strategies for implementing Technology in the school curriculum in different countries. However, within the framework of developing technology and understanding the demands for Technology education in different countries there are still issues and problems to be resolved. We have to ask ourselves what we aim to achieve with PATT Research and how that aim will be fulfilled and with what implications. In other words, there is need to re-examine our objectives for PATT studies, evaluate the emerging results, and identify the relevance of PATT to our particular countries. An area of questions is also whether the data so far acquired provide sufficient information to enable meaningful contribution to the development of Technology Education to be made.

In this paper an attempt is made to examine some of the challenges and issues that appear to face PATT Research if it has to make a realistic impact in enhancing technology in the school curriculum of different countries.

The system/situation in which we operate

From its inception, Research into pupils' concept of and attitude towards technology has held its validity and the noble intention of discovering pupils' ideas about and understanding of the concept technology and their attitudes/views towards it. This has mainly been so because technology, considered as the act of making and using to solve a real-life problem, has increasingly been recognized as an important, legitimate an inevitable area of study. In one of the first meetings in Africa on technology education held under the auspices of UNESCO, it was stressed that:

The introduction of technology into general education was an important element, not only in overcoming the adverse effects arising from inherited systems of traditional academic education which, it was now perceived, hindered rather than helped progress,
but in order to make education relevant in this modern technological age. It was not just a matter of adding new subjects to the school curriculum, but of changing the whole structure of the school. Nevertheless, it was beyond doubt, that if education was to make its proper contribution to national and individual development in this day and age, technology must take its place as an essential part of the education of our children."

(UNESCO, 1972, p2)

Following these meetings there have been attempts to introduce technology as a component of general education in different countries, but of course with staggering success. As the quotation indicates, the problems of implementation of the innovation are formidable and account for the limited success only in modifying the prevailing academic curriculum. Some of these problems could be accounted for by the fact that very little or no attention was placed in trying to understand how the pupils themselves perceived and interpreted technology.

Indeed a lot of what we have to do and their relative successes have to do with the systems and the situations we operate in. One of the situations has to do with education itself. In education we always try to learn and prepare for 'tomorrow' (could be the year 2000). We are therefore always into a guessing spree when setting educational objectives about what our needs for tomorrow are likely to be. To educate for facts and daily happenings have proved not enough. There is need to prepare citizens to be creative and inventive, to be able to identify problems facing humanity and attempt to construct solutions to them. It would be expected that if pupils (citizens) have not been geared to this social requirement then they need to be equipped with the right attitudes and skills to enable them to act appropriately. Of course one of the issues posed with this situation which is also likely to face technology education is one of striking functional objectives.

Apart from the fact that so far there have remained difficulties in determining differences in ways pupils and teachers think of technology, the other situation is how we perceive, and interpret the reality around us. The level of sensitivity to our environment and the possible actions we take are
crucial for technology education. Many times, because we operate in a world with many alternatives (able to buy from shop), we cease to be sensitive to the potentials of our environment and hence we are never challenged to create, innovate or invent. Many times, the majority of the population today, especially in developing countries, have the belief that solutions to problems exist already, and that it might be fruitless to attempt a solution to existing problems. As an attitudinal problem, it poses a difficult situation for the development of technology education, but is important to discover in both pupils and teachers.

Another situation that is prevalent in developing countries is reflected in the rural-urban divide, but also found between urban high income and urban low income. In both situations the level of life-challenge is different, especially with regard to solution of real-life problems and even the approaches used. Between the high income urban people and the low income urban or most of the rural population, the high income urban person is exposed to 'modernity', modern technology is in use, i.e. the push button approach. On the other hand for the low income urban persons (forming mostly the informal sector or 'Jua Kali'), they are 'problem-pushed'. In other words, you must cope with problems by doing it a lot by yourself. A lot of repair and maintenance work is done by the people themselves. They are into what might be called 'survival technology'. The end result is that in these sectors (low income urban and rural areas) there is a lot of real technology going on involving innovation, creativity and even inventions. But by their nature and organization as the informal sector, they are hardly given any recognition.

A situation that also exists in many developing countries, mainly by structure, but also found to some level in developed countries, hinges on the relationship between what happens in the classroom and outside the classroom. Many times the classroom activities are remote and unconnected to the reality outside the classroom. It also hits at the relation between the school and community in which it is located. The result of the lack of positive relationship is that there is no room or channels through which pupils' potential can be realized. The system of education has prescribed rightly or wrongly what has to be done: and many times whatever else that is done, however useful it might be is shunned or not recognized, but even
if recognized there is not much chance of advancing it further.

From these brief descriptions of the various related situations in developing countries in which we hope to implement technology education, it is important to see how PATT Research can be of help to these situations. To be able to focus on pupils' concept of and attitudes towards technology without a back-up on the various situations that exist would not yield useful contribution for the implementation of technology in schools, that being the major goal. The fact that these situations are varied, apart from broadening the work, justifies the need for a large-scale PATT Research. It is expected that through large-scale PATT Research, it will be possible to bring out a number of factors that might affect the implementation of technology in the school curriculum. It is in this way that PATT Research will become more relevant.

Uniqueness of nations

When considering PATT Research and its relevance in a developing country situation there is need to reflect on the nature of the cultural context of different nations, their uniqueness and potentials before any meaningful reform can take place. At a more general level Professor Ali Mazrui (1986) has advised that:

"Two broad principles should influence and inform social reform in Africa in the coming decades. One is the imperative of looking inwards towards ancestry; the other is the imperative of looking outwards towards the wider humanity. The inward imperative requires a more systematic investigation into the cultural preconditions of the success of each project, of each piece of legislation of each system of government. Feasibility studies should be much more sensitive to the issue of cultural feasibility than has been the case in the past. Africa's ancestors need to be consulted through the intermediary of consulting African usage, custom and tradition."

(Mazrui, 1986, p. 21)

In Africa almost everything is embedded in some custom, implying that the cultural web is still very strong. Any reform or innovation is bound to be processed through understanding the cultural connections, especially of the
particular countries if some measurable success is expected.

It may be true to say that the way countries develop, especially if they are of the same sort, can be similar but there are still many areas where they differ e.g. geography and demography, human resources, material resources, their systems of education, and even the nature of their technology and how they practice it. It could therefore be argued that technology is not culture-free. Each country will have evolved utilizing its unique technology which is indigenous to it. According to Alvares (1980):

"Different cultures have historically created their own science, generated techniques relevant to the problems encountered by them, and determined these by reference to their distinctive paradigms and meaning system"

(Alvares, 1980, pXI)

Research in pupils' concept of and attitudes towards technology is valid for the main reason that it is carried out at country level, but even then when combined for different countries the results may not be generalizable. PATT Research however, still requires to take account of the various factors that might influence the results even during the large scale studies. Cultural components come in various situations. On the relevance and rehabilitation of traditional technology Powell recounts:

"The traditional technologies used in agriculture and craft industries in developing countries incorporate the accumulated wisdom of the centuries. Before any attempt can be made at innovation, the existing methods must be carefully studied. They will invariably be found to be based on much knowledge of local climate, soils, materials and energy sources as well as to be generally well adapted to the social and cultural attitudes of the people. This knowledge must be built upon rather than replaced ..... The new technology must be the child of the old."

(Powell, 1982, p. 3)

Although Powell has rightly described the process principle of effecting technological innovation in Africa, and this might also be useful for
Technology Education, it should be noted that in developing countries, there are different forms of technological practices and experiences. In other words, in Kenya and indeed Africa, there exists a technological pluralism, i.e. traditional technology, technology in the informal sector, transferred technology, and the emerging appropriate technology. Each has its characteristics which makes it different from the others, but which also makes it fulfill only up to a point. It might be useful here to think ahead about how an African Technology or Kenyan Technology is like and how technology education in the various African countries is likely to be in terms of method and content. This is because it would have to be derived from the existing technological knowledge and skills available in the particular countries. One has also to think whether or not it will be necessary that the nature of technology in the countries be taken into account in PATT Research (especially large-scale one).

The language factor is also an important factor to consider, especially how it might promote an understanding of technology and affect PATT Research. In Kenya there are over 40 ethnic languages.

Different countries are unique to themselves. Because of their belief systems, customs and the existence of some material resources they could be highly skilled in some aspects of technology; for example, in Kenya the Western and Nyanza Provinces have a lot more pottery activity than Central Province. Yet in Eastern Province there is a lot of carving work. There are also areas in Kenya where they are specialized in metal smelting and foundry work. The same case exists as per country and within countries. PATT Research must attempt to take into account the strengths and weaknesses as related to technology in particular countries.

The practice of technology education and its demands
Through PATT Research it has been possible to gain knowledge of how pupils of different countries conceive of technology and their relative attitudes towards it. There has also been information about the extent to which technology exists in the school curricula of different countries. In general the picture that emerges from different countries and even within a country is that pupils have varying ideas about technology (Dudziak and Szydlowski, 1987; Kapiyo, 1987), technology to them means different things,
e.g. technology as research and creative work, technology as object, technology as science, technology associated with technical studies, technology as solving problems in real life, etc. Some pupils had poor understanding of it, thus giving inconsistent or meaningless response.

In many countries in Africa, since their independence, there has been a series of educational revisions/reviews aimed at improving the effectiveness of the education systems in turning out useful, self employable citizens. The tendency has been to move from the academic angle towards practical application of knowledge gained in school. In Kenya the last review led to the institution of the 8-4-4-system of education which has as its major objective practical application of knowledge to the solution of real life problems.

Similar trends have been noted in many African countries. In Zimbabwe the science syllabus is taught with emphasis on the practical study of applications of science and technology. In Zambia and Malawi attempts are made to teach school science with every day relevance. In Nigeria the technical aspect of the curriculum has been up-graded, establishing some links with industry. In general the move towards inclusion or introduction of technology in the school curriculum is prevalent in both developed and developing countries.

The fact that many governments are introducing some form of technology in their school curriculum also means that they have to develop schemes to research and monitor the progress of work. As it has been in many countries there is even an increasing need to reveal basic information about the various factors that might influence its implementation. The recipients who are the pupils and the immediate implementers who are the teachers, need critical attention, especially in discovering their ideas about technology, their attitudes/views towards it and the situations in which they have to work. Sometimes the classroom life becomes poor in technological terms, especially if it is run by a theorist or a person who believes that "to work with hands" (technology of course means much more) is inferior to working with the brain. This normally is due to ignorance of what technological tasks involve.

An important question to raise at this stage is whether and how educational
recommendations from educational reviews actually penetrate to the schools. As experience shows a lot of what is said only reaches the level of intent, embodied in documents and as statements about the aims, content and assessment of the curriculum. It is well known that the effective or actual curriculum, that is what children actually experience in classrooms, workshops and laboratories, does not always correspond to the intended curriculum (Barnes, 1982, p. 181). This, however, might be understood from the fact that very little is known about the nature, content, method and assessment of Technology by even educationists themselves. In Kenya, when you talk about technology, the tendency is to be understood as referring to communication and technology of education departments, or to a laboratory technologist or vaguely to be referring to something related to engineering. The truth is, technology still presents a big problem with its meaning to a majority of people. To those with some understanding of it, there is a tendency to detest working in its field because it has no ready answers, neither does it have right or wrong answers. And due to the poor understanding of technology, the tendency is to get some resistance in curriculum innovation to include technology education.

The implication to all these problems is to find a way of educating those related to educational development to understand considerably what technology is about. This is because there are policy dimensions which would require an appreciable level of understanding of technology.

In Kenya there are different versions of technology in the school curriculum. The art and crafts and science syllabus at the primary school are closely related to technology since they are taught through problem identification and construction of viable solutions. The science syllabus at secondary schools touches on technology-related problems but they are hardly tackled. The industrial education course is only technology oriented to some degree but not fully. Sometimes they are more technical in nature than technological. The same case is found in many countries.

Considering the many problems that arise with technology in schools one wonders how much PATT Research should aim to achieve to make a marked impact. The large scale PATT Research of course would not only reveal information about pupils, teachers and their environments, but it will
also inservice teachers and educators through discussions ans workshops. This will be an important dimension in the research as a move towards creating a better understanding of technology among a larger population. In general, issues of technology education are broad and it has many demands. The implementation of technology in any school curriculum will call for some form of change; educational and attitudinal. PATT Research has to link somewhat with existing technology curriculum to aim at affecting some change.

The need for change
Although school technology is an attractive educational option, especially when one considers its possible contributions to national development, indigenous technological capability and the vocational element, its implementation will call for educational and attitudinal change. The idea of educational change has been a problem to many. According to Fullan (1982):

"...... real change, whether desired or not, whether imposed or voluntarily pursued, represents a serious personal and collective experience characterised by ambivalence and uncertainty and if change works out it can result in a sense of mastery accomplishment and professional growth."

In the terms of technology education, there will be need for a real change and it has to be a collective experience involving different groups, i.e. pupils, teachers, educators and even policy makers. The required change might call for decisions to be made in a number of issues some of which are as follows:

- Technology education might offer open-ended problems with no right or wrong answers as opposed closed ended problems preferring children who give expected answers.

- The relationship between different subjects: The solutions to many real life problems require a multi-disciplinary approach. We therefore must discover the various ways in which technology content, method and assessment techniques adjust to the school curriculum. There is need to develop the subject area technology. A related issue here is to consider how a new subject should make entry to the school curriculum. At the moment there are complaints and it is also true that the school
time-table is full, so what approach should be used?
- Lack of student motivation: there is so much to cover in a given period, the examination also puts pressure. Failure means doom. What role does technology have, and what will PATT studies provide to help the situation?
- What strategy should be used to implement technology in schools as part of science or as a subject on its own right or as part of every subject or through the modular approach.
- Who would teach technology? Isn't pre-service and in-service of teachers of technology critical?
- Might pupils have alternative explanations to some issues to technology. What are their preconceptions of technology, and 'entering behaviour' to a technology class.

In general there are many aspects of technology education which would call for change. But to initiate change is a complex undertaking. Fullan explains that:

"When change is imposed from outside, it is bitterly resented. When it is voluntarily engaged in it is threatening and confusing. In any event the transformation of subjective realities is the essence of change........ there is a strong tendency for people to adjust to the near occasion of change, by changing as little as possible - either assimilating or abandoning changes which they have initially been willing to try, or fighting or ignoring imposed change."

(Fullan, 1982, p. 29)

The situation described above is the sort to be expected with implementation of technology education in schools. If born in mind then probably the ideas would act to shape our action. Whether developing or developed countries the situation is similar. One of the critical challenges facing PATT is the one of effecting positive change through its research results. Hence there is need to search for more strategies.
REFERENCES


PATT - RESULTS AND THE RELEVANCE OF PATT

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A. Mickiewicz University
Poznań, Poland

Summary

The basic characteristics of school curricula in East European countries is presented. Both school subjects related to technology, namely: "work and technology" and physics are discussed. Some details concerning the methods of teaching the subject "work and technology" as well as the problems of "work and technology" teachers education are presented.

PATT studies have been conducted at our Institute since 1985 and since that time we have participated in attitude studies and subsequent stages of the PATT studies at primary and at General High School. We used the PATT questionnaire and essay. The general results of these studies are presented and discussed. Some importance of the results and conclusions for our educational system and school is discussed.
1. School Systems in East European Countries

School systems of Eastern European countries are clearly structured. In this system of education, the graduates of a lower level school can continue education at any school of a higher level, for example a student who graduates from a general high school of humanistic profile can apply for polytechnics. There are, however, certain differences: e.g. the school systems of Poland, Hungary and Czechoslovakia include primary and secondary schools, while in the USSR both types are united in an 11 year comprehensive school (Fig. 1).

Figure 1.
The structure of education in East European countries.
(* University or vocational school,
** The "zero" grade is organized in school or in kindergarten)

<table>
<thead>
<tr>
<th>Age</th>
<th>Poland</th>
<th>Hungary</th>
<th>Czechoslovakia</th>
<th>GDR</th>
<th>USSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
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<td>18</td>
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</tbody>
</table>

In each country primary schools offer a uniform curriculum for all students; all subjects and courses are mandatory. The same refers to secondary schools although one may choose a particular kind of school or class profile.

There is a large variety of vocational schools of all kinds as well as high schools preparing for university studies. In such high schools a student may choose the subjects in which he takes his final exams and the school provides him/her with a widened curriculum yet only in the last year of instruction.

In the USSR the 11 year comprehensive school potentially allowing all the students to enter universities is mandatory. A limited choice of some
subjects (the so-called "facultatives") is granted in the last four years of instruction. These subjects are frequently associated with physics and technology e.g. electronic technology, telecommunication, space technology etc. and the weekly time of instruction equals that of regularly taught physics.

Unfortunately in the USSR, the GDR, and some other countries the school determines the field of further studies or a job. In Poland, young people may take such decisions by themselves, and choose their professions and field of studies bearing however full responsibility for their virtual mistakes. Universities require passing of high standard entrance exams.

2. Teaching of Elements of Technology

Elements of technology are usually introduced as a particular subject called: practical work and technology, production and school, etc. This does not imply that technology is ignored in the curricula of other subjects. In the first four years children are taught its elements during classes in environmental studies, and later mainly in the context of physics. Yet in most countries the teaching of physics is limited to "pure" physics and hardly concerns the application of physics in technology or natural science. The "practical work" is taught in all grades of the primary school. Students are usually supposed to make all kinds of things useful in everyday life. Instructors teach how to repair small electric appliances, mend and sew clothes, process groceries and prepare meals, grow plants and take care of animals. Classes include also some elements of design, scale drawing and its interpretation. Schools are usually equipped with proper workshops and tools necessary for simple works.

In Poland and some other countries the same curriculum is mandatory for boys and girls while in the USSR the curricula are differentiated. The girls' curriculum is focused on home economy, food processing and sewing, whereas boys are encouraged to work in metal and take interest in electrotechnics. In Poland, despite a uniform curriculum in many schools boys and girls have their classes separately. School authorities motivate it by the regards of efficiency since boys and girls have also separate gymnastics lessons. Moreover, the curriculum is supposed to develop self-sufficiency: girls should not be helped by boys while working on metal and in electrotechnics while boys should not count on girls in food processing.
Recently, a new curriculum of work and technology has been developed in Poland. Changes take into account job counselling, working conditions etc. Now, when the curriculum has already been introduced in the primary school, it revealed some of its weak points. Teachers have been enabled to decide about the subject matter of the classes, since, apart from manual labour, many issues may be presented in lectures. Some teachers have been overusing this form of instruction at the expense of their students' practical training (4).

In some countries the students of high schools and upper grades of elementary school are obliged to complete the practice in production. I.e. in the GDR there are organized special factories or farms where students from schools located in the nearest region are producing subjects (elements) for factories or shops. Every student has to work there some days in a month.

The school authorities in Poland (5) are trying also to organize practices for general high schools (70 hours every school year). The following profiles of the practice are proposed:
- pedagogical in kindergartens and elementary schools,
- cultural, connected with work in museums, libraries, hotels, etc.,
- administration in regional offices,
- agricultural in national or private farms,
- technological, connected with conservation of the school equipment, technical drawings etc.

3. The PATT study
The PATT pilot study has been carried out practically only in Poland and Hungary (2). The factor analysis performed for the data collected in both countries revealed 26-27 significant factors. The first 11 factors could be easily named (Table I). The greatest percentage of variance was explained by the first factor: "Interest in technology". We did not reach the full agreement of other factors, although they were similar, they differed by the sequence and comprised different items. These 11 factors included also such ones which were distinguished only in Poland (the second factor), or only in Hungary (the third factor).

We can say that the factor analysis did not reveal greater similarities between Poland and Hungary than those that had been found between the results obtained for example in Sweden and Hungary. Of course, we know
Table 1. First 11 factors in PATT pilot study in Poland and Hungary and their equivalents in second country (2,6).

<table>
<thead>
<tr>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interest in t.</td>
<td>1. Interest in t.</td>
</tr>
<tr>
<td>2. Diversity of t. in time</td>
<td>2. Girls, boys and t.</td>
</tr>
<tr>
<td>4. Sex suitability for t.</td>
<td>4. Consequences of t.</td>
</tr>
<tr>
<td>5. Sex and knowledge of t.</td>
<td>5. Importance of t.</td>
</tr>
<tr>
<td>7. Practical knowledge</td>
<td>7. Role of women in t.</td>
</tr>
<tr>
<td>10. Desinterest in t.</td>
<td>10. T. and human activity</td>
</tr>
<tr>
<td>11. Creativity in t.</td>
<td>11. T. and future</td>
</tr>
</tbody>
</table>

that according to the PATT-2 Conference, the results for all countries are similar enough to make one common questionnaire of 6 scales.

In Poland we carried out a few series of studies using the PATT questionnaire (Table 2). The studies were performed for small samples including 200-300 students coming from different regions of South-West Poland. The first two of the series of studies, given in Table 2, were pilot studies in which the first version of the questionnaire was applied. In the other studies we used the questionnaire elaborated at the PATT-1 Conference.

Table 2. Study with the help of PATT questionnaire in Poland. (The size of the sample over 200 students)

<table>
<thead>
<tr>
<th>Region</th>
<th>Class</th>
<th>Age</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Poznań city.</td>
<td>VII elem. school</td>
<td>13/14</td>
<td>1</td>
</tr>
<tr>
<td>2. Poznań region</td>
<td>VIII elem. school</td>
<td>14/15</td>
<td>6</td>
</tr>
<tr>
<td>3. Wrocław region</td>
<td>VIII elem. school</td>
<td>14/15</td>
<td>7</td>
</tr>
<tr>
<td>4. Zielona Góra region</td>
<td>II high school</td>
<td>16/17</td>
<td>8</td>
</tr>
<tr>
<td>5. Krakow city and region</td>
<td>VII and VIII elem. school</td>
<td>13-15</td>
<td>9</td>
</tr>
</tbody>
</table>

On the grounds of the obtained results we could draw the conclusions concerning the questionnaire itself as well as the school system in general. We are going to present here the important conclusions concerning the questionnaire. The value of alpha reliability coefficient was always relatively
low and not much improved by excluding one of the items. The qualitatively worst results were obtained for the students of VII grade of the primary school ((1), Table 2). We believe that the reasons were the not serious approach of the school students who still have one year to take the decision as their further education as well as the imperfections of the questionnaire which was later improved. The VIII grade students treated the questionnaire more seriously, because it concerned their present problems (6, 7).

We asked the students of both primary and secondary schools to fill out the questionnaire. Significant differences were found in the answers to particular items, therefore we could draw conclusions regarding the differences in students' attitude following from the difference in the level of education. However, the differences in average results for the whole scales were insignificant. In most cases the average results oscillate about the value 3 (undecided; see Table 3). The exceptions were the scales Interest and Consequences for which we obtained mostly positive answers.

| Table 3. The mean values for all scales in elementary and high school. |
|-----------------------------|---------------|---------------|
| Scale                      | Elementary    | High          |
| Interest                   | 2.59          | 2.72          |
| Gender                     | 2.95          | 3.01          |
| Consequences               | 2.24          | 2.12          |
| Difficulty                 | 3.04          | 3.02          |
| Curriculum                 | 2.30          | 2.95          |
| Career                     | 3.07          | 3.06          |

Besides the average one should take into account the results distribution into positive, negative and neutral. Then, one finds that the average value 3 may be a result of averaging of the extreme attitudes: the students of humanistic profile classes do not choose a profession connected with technology while their friends from the classes of mathematics-physics profile do choose them.

Table 4 provides the information about the usefulness of individual items in studies of the influence of such factors as parents' profession, class profile and sex. As follows from this table the essential factor is usually sex, to a
lesser degree the class profile and the parents' profession has practically no influence on the students' attitude. The interesting fact is insignificant influence of the respondents' sex on their opinion about gender, where the answers to only one question were different. The factors we are interested in, frequently do not influence the respondents' answer.

The PATT questionnaire can be applied in comparative studies concerning the students of different types of schools or just of different ages. However, we think that significantly more information could be obtained from the analysis of individual questions. We plan to extend our
investigations over other kinds of secondary school in Poland.

4. The Analysis of Essays

The conclusions drawn from the essays written by the respondents are very interesting. The answers of primary school students are rather short whereas the answers given by GHS students are longer and more elaborate. The essays provide valuable insight as far as the knowledge of the students about technology is concerned. They also allowed us to identify erroneous concepts as well as the problems omitted or not enough stressed in the school curricula. The results were much more differentiated by such factors as sex, class profile and even the parents' profession.

In our study we used the question formulated, in 1986, by Marc de Vries et al. (10). After the analysis of the essays we have come to the conclusion that specification of some aspects of technology in the question resulted in limiting the students' invention and steered their answers. Most probably, if the title had specified other aspects of technology (e.g. energy or raw materials) the answers would have been different. Therefore we do not know whether the results of our studies really give account of the popular knowledge about technology. In spite of their drawbacks, our studies revealed that the school programmes do not provide the exact definition of technology neither do they specify all its elements e.g. the problems of energy sources, raw materials, information. Thus, having considered all their good and bad characteristics we found these studies fruitful.

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4. G. Dudziak, "The teachers' and pupils' opinions about the school subject work and technology", paper prepared for the PATT-3 Conference.

5. Curriculum of the General High School, Ministry of Education, Warsaw,
1986.


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Summary

The paper reports the findings of the first stage of a multi-stage large scale research project designed to cover virtually all the 21 states of Nigeria.

The data were collected from some schools boys and girls in 5 states, using 3 instruments - the short essay writing, the PATT Concept Questionnaire (PCQ) and PATT Attitude Questionnaire (QAT). The results showed: (1) no significant difference between boys and girls (in favour of girls) on all scales except that of gender on the PAQ (t=5.91, p=0.00); (2) no significant differences between the age levels on all the scales of the PAQ; (3) significant differences in interest in technology on the basis of fathers' occupations (F=2.46, p=0.03); (4) that one of the states tended to have the lowest scores on virtually all the scales except that of difficulty; and (5) that technology as human activity/consequences (especially the good ones) were most frequently mentioned in the essays (44.5%), followed by items on the nature of technology (22.7%), curriculum (school and technology) (17.3%), practical/technical skills (4.8%), interest (4.6%), career (3.0%), and gender (0.2%).
NI GERI AN PUPILS’ ATTITUDES TO AND CONCEPTIONS OF TECHNOLOGY

Introduction

In a way the present study is an extension of the pilot phases which were concerned with the validation of the instruments developed for the study of pupils’ attitude to technology (PATT). In this study, we moved from one to five states. So, part of the objective of the investigation was to find out what problems might be encountered in trying to cover several states of the country. It was also intended to find out what aspects of the instruments might need adapting for nation-wide acceptability and appropriateness. For example, already Moore (1986) has suggested certain modifications to the PATT Attitude Questionnaire. And Balogun (1987) reported certain difficulties some Nigerian subjects experienced on the PATT Attitude as well as the Concept Questionnaire. However, the basic objective of the study was to obtain some empirical information on the attitudes to, and perceptions of, technology of some Nigerian pupils living in different states of the country at the time of the research. Specifically, the information was to be related to certain background variables (sex, age, parents’ occupations) of the pupils. The ultimate goal is to obtain information of value for curriculum improvement in the developing field of school technology education.

Subjects

The study was carried out in 5 (Bendel, Benue, Kaduna, Ondo, and Rivers States) out of the then 19 states (now 21). In each of the 5 states, some schools of comparable standards were selected for the study. About equal numbers of all-boys and all-girls were selected. The sampling of schools in each state does not, however, necessarily reflect the probability proportional to the number of schools in each state. Also, attempts to sample proportionally from the urban and rural areas did not materialise, principally because of financial constraints. In any case, it was not intended to generalize the findings of the study beyond the sample.

In each school, only boys and girls between the age of 12 and 14 were randomly selected from junior secondary class one to three (Grades 7 to 9). The number of pupils sampled was 542. However, because of some careless completion of the questionnaires by some of the pupils, only the responses of 460 of them were analysed for the state and sex variables, 437 for the
age variable, and 165 for the occupation of parents variable.

<table>
<thead>
<tr>
<th>Table 1. Composition of the achieved sample by State.</th>
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<tbody>
<tr>
<td>State</td>
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<tr>
<td>---------------</td>
</tr>
<tr>
<td>A. Kaduna</td>
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<tr>
<td>B. Bendel</td>
</tr>
<tr>
<td>C. Ondo</td>
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<tr>
<td>D. Benue</td>
</tr>
<tr>
<td>E. Rivers</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
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</table>

Data Collection
The data were collected through (1) pupils essays on technology, (2) the concept questionnaire, in that order. The researcher did much of the data collecting by himself - sometimes with or without the assistance of other people. The exercise was usually concluded in a little over one hour.

Data Processing
**Attitude questionnaire.** Pupils' responses to the items on the attitude questionnaire were scored and processed for output for number of pupils in subsamples, the means for each total, standard deviation, point biserial for each item, and Kuder-Richardson R for the whole set. The Kuder-Richardson R was 0.28.

The scoring was done by giving 5 points for strong endorsement of a favourable statement, 4 points for agreement and so on, with 1 point for strong disagreement. This procedure was reversed for the unfavourable statements. The sum of each pupil's scores was used as a measure of the strength of her/his attitude towards technology.

Statistics were obtained on the subscales and also for pupils of same sex, age, and state. The subscales were defined as follows (PATT Newsletter 1, 1986):

I. Interest: 1, 7, 13, 19, 25, 31, 37, 43, 49, 55;

II. Gender: 2, 8, 14, 20, 26, 32, 38, 44, 50, 56;

III. Consequences: 3, 9, 15, 21, 27, 33, 39, 45, 51, 57;

IV. Difficulty: 4, 10, 16, 22, 28, 34, 40, 46, 52, 58;

V. Curriculum: 5, 11, 17, 23, 29, 35, 41, 47, 53, 59;
VI. Career: 6, 12, 18, 24, 30, 36, 42, 48, 54, 60.

Concept Questionnaire. The responses were scored for the number of "don't know" answers as well as for the number of correct answers made by the pupils.

The Essay. The points made in the essays were related to the following dimensions:
I. Nature of technology: What technology is; has to do with machine; it is related to science, biology, chemistry, mathematics, and physics.
II. Practical/technical skills: Handling technical products; the perceived difficulty of studying technology as a school subject.
III. Technology as human activity: This relates to the economic, social, and political effects of using technology.
IV. Interest: The extent to which pupils engage in or would like to engage in technology activities outside school.
V. Career: Pupils' view of technology as a choice of career.
VI. Gender: The extent to which technology as a field of study or career is equally suitable for boys and girls, and sex differences.
VII. Curriculum: The place of technology in the school curriculum.
The frequency count of points relating to these categories was done.

Results
The attitude to technology of the respondents was measured against their sex (Table 2), age (Table 3), father's occupation (Table 4), and state of domicile or locale (Table 6).

<table>
<thead>
<tr>
<th>Scales</th>
<th>Boys (n=244)</th>
<th>Girls (n=236)</th>
<th>t-value</th>
<th>2-tail prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>SD</td>
<td>x</td>
<td>SD</td>
</tr>
<tr>
<td>I. Interest</td>
<td>37.88</td>
<td>5.24</td>
<td>37.80</td>
<td>5.63</td>
</tr>
<tr>
<td>II. Gender</td>
<td>29.04</td>
<td>5.48</td>
<td>32.39</td>
<td>6.58</td>
</tr>
<tr>
<td>III. Consequence</td>
<td>39.33</td>
<td>4.68</td>
<td>39.28</td>
<td>5.61</td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>26.91</td>
<td>4.84</td>
<td>26.93</td>
<td>5.14</td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>38.55</td>
<td>5.08</td>
<td>37.73</td>
<td>5.68</td>
</tr>
<tr>
<td>VI. Career</td>
<td>35.98</td>
<td>4.80</td>
<td>35.49</td>
<td>5.39</td>
</tr>
</tbody>
</table>
Table 4. Means, Standard Deviations, F-Values, and Significance of F by father’s occupation.

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<thead>
<tr>
<th>Scales</th>
<th>UNS (n=2)</th>
<th>SEM (n=6)</th>
<th>SKI (n=35)</th>
<th>SPS (n=75)</th>
<th>PAM (n=46)</th>
<th>PMR (n=1)</th>
<th>F-values</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Interest</td>
<td>x</td>
<td>SD</td>
<td>x</td>
<td>SD</td>
<td>x</td>
<td>SD</td>
<td>x</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>42.50</td>
<td>4.95</td>
<td>38.50</td>
<td>7.99</td>
<td>37.43</td>
<td>3.42</td>
<td>37.59</td>
<td>5.66</td>
</tr>
<tr>
<td>II. Gender</td>
<td>34.00</td>
<td>2.83</td>
<td>27.83</td>
<td>5.35</td>
<td>30.94</td>
<td>5.06</td>
<td>29.83</td>
<td>6.85</td>
</tr>
<tr>
<td>III. Consequences</td>
<td>35.50</td>
<td>0.71</td>
<td>39.50</td>
<td>6.92</td>
<td>41.43</td>
<td>4.70</td>
<td>39.36</td>
<td>6.24</td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>31.00</td>
<td>6.29</td>
<td>24.97</td>
<td>3.88</td>
<td>24.87</td>
<td>5.19</td>
<td>26.63</td>
<td>4.05</td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>42.00</td>
<td>5.66</td>
<td>39.33</td>
<td>3.50</td>
<td>38.91</td>
<td>4.67</td>
<td>38.95</td>
<td>4.90</td>
</tr>
<tr>
<td>VI. Career</td>
<td>38.50</td>
<td>4.95</td>
<td>37.33</td>
<td>7.34</td>
<td>37.40</td>
<td>4.13</td>
<td>37.21</td>
<td>5.25</td>
</tr>
</tbody>
</table>

Key:
UNS = Unskilled
SPS = Semi-professional and small business
SEM = Semi-skilled
PAM = Professional and managerial
SKI = Skilled
PMR = Professional and managerial in responsibilities
Table 3. Means, Standard deviations, F-values, and Significance of F on the attitude scales by age.

<table>
<thead>
<tr>
<th>Scales</th>
<th>12-years old (n=56)</th>
<th>13-years old (n=192)</th>
<th>14-years old (n=189)</th>
<th>F-val.</th>
<th>Sign. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>SD</td>
<td>x</td>
<td>SD</td>
<td>x</td>
</tr>
<tr>
<td>I. Interest</td>
<td>38.86</td>
<td>5.52</td>
<td>37.95</td>
<td>5.40</td>
<td>37.47</td>
</tr>
<tr>
<td>II. Gender</td>
<td>31.13</td>
<td>6.05</td>
<td>30.37</td>
<td>6.12</td>
<td>30.88</td>
</tr>
<tr>
<td>III. Consequences</td>
<td>40.32</td>
<td>5.37</td>
<td>38.64</td>
<td>5.09</td>
<td>39.34</td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>27.30</td>
<td>4.68</td>
<td>27.38</td>
<td>5.02</td>
<td>26.49</td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>39.05</td>
<td>5.38</td>
<td>38.04</td>
<td>5.47</td>
<td>37.86</td>
</tr>
<tr>
<td>VI. Career</td>
<td>35.75</td>
<td>5.32</td>
<td>35.30</td>
<td>4.82</td>
<td>35.75</td>
</tr>
</tbody>
</table>

Attitude, sex and age. With respect to sex, there was no significant difference between the boys and girls on all the scales except that of gender. On the other hand there was no significant difference between the age levels on practically all the scales. However, the highest scores on the consequences of technology were relatively high when compared with those for other scales. All of these findings were similar to last year’s (Balogun, 1987).

Attitude and Father’s Occupation. The results on father’s occupation showed significant differences on interest (F=2.45, p=0.03) and difficulty (F=3.14, p=0.01) scales, but not on others. It does appear therefore that father’s type of occupation may affect pupils’ attitude to technology.

Table 5. 2-way interactions between age and father’s occupation on the attitude scale.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Sum of Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Interest</td>
<td>256.28</td>
<td>6</td>
<td>42.71</td>
<td>1.61</td>
<td>0.15</td>
</tr>
<tr>
<td>II. Gender</td>
<td>92.23</td>
<td>6</td>
<td>15.37</td>
<td>0.35</td>
<td>0.99</td>
</tr>
<tr>
<td>III. Consequences</td>
<td>255.95</td>
<td>6</td>
<td>42.66</td>
<td>1.38</td>
<td>0.23</td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>58.84</td>
<td>6</td>
<td>9.14</td>
<td>0.41</td>
<td>0.99</td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>126.45</td>
<td>6</td>
<td>21.08</td>
<td>1.03</td>
<td>0.41</td>
</tr>
<tr>
<td>VI. Career</td>
<td>297.80</td>
<td>6</td>
<td>49.63</td>
<td>2.13</td>
<td>0.05*</td>
</tr>
</tbody>
</table>

* Significant result.
There was no significant interaction between age and father's occupation on the scales (Table 5) except on career scale \( (F=2.13, \ p=0.05) \).

<table>
<thead>
<tr>
<th>States</th>
<th>A (n=75)</th>
<th>B (n=119)</th>
<th>C (n=74)</th>
<th>D (n=114)</th>
<th>E (n=78)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Interest</td>
<td>37.89 (5.02)</td>
<td>40.07 (4.23)</td>
<td>32.57 (4.64)</td>
<td>39.40 (5.07)</td>
<td>37.10 (5.30)</td>
</tr>
<tr>
<td>II. Gender</td>
<td>32.52 (5.57)</td>
<td>32.67 (6.48)</td>
<td>28.78 (4.55)</td>
<td>30.90 (6.42)</td>
<td>27.85 (6.38)</td>
</tr>
<tr>
<td>III. Consequence</td>
<td>39.80 (5.39)</td>
<td>40.56 (3.44)</td>
<td>35.38 (4.58)</td>
<td>41.06 (5.63)</td>
<td>38.08 (4.82)</td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>25.44 (5.51)</td>
<td>28.14 (4.56)</td>
<td>29.45 (4.52)</td>
<td>25.87 (5.10)</td>
<td>25.63 (4.01)</td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>38.47 (4.88)</td>
<td>39.89 (4.66)</td>
<td>32.69 (5.00)</td>
<td>39.66 (4.85)</td>
<td>38.05 (4.79)</td>
</tr>
<tr>
<td>VI. Career</td>
<td>36.57 (4.83)</td>
<td>34.79 (4.28)</td>
<td>32.87 (4.70)</td>
<td>38.39 (5.60)</td>
<td>35.17 (4.20)</td>
</tr>
</tbody>
</table>

Figures in parentheses are standard deviations.

**Attitudes and Locality.** One of the states made the lowest score on virtually all the scales except that of difficulty (Table 6). On the whole, the consequences of technology seemed to feature most prominently in the responses of these boys and girls (Table 7). Again, this is similar to last year's finding (Balogun, 1987).

**Performance on the Essays.** The most frequently mentioned aspects of technology, from the preliminary analysis of the essays, were technology as human activity (44.5%) and the nature of technology (22.7%). There was little written about gender related issues (0.18%) and career (3.0%). Once again, these results are similar to those of last year's sample (Balogun, 1987).
Table 7. Means, Standard deviations, and rank order separate on the attitude scale for the complete sample on the scales.

<table>
<thead>
<tr>
<th>Scales</th>
<th>x</th>
<th>SD</th>
<th>Rank</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Interest</td>
<td>37.84</td>
<td>5.44</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>II. Gender</td>
<td>30.76</td>
<td>6.28</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>III. Consequence</td>
<td>39.30</td>
<td>5.16</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IV. Difficulty</td>
<td>26.92</td>
<td>4.99</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>V. Curriculum</td>
<td>38.13</td>
<td>5.40</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>VI. Career</td>
<td>35.73</td>
<td>5.11</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>VII. All Items</td>
<td>208.68</td>
<td>19.81</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Summary of the essays by percentage of frequency of mention and state.

<table>
<thead>
<tr>
<th>States</th>
<th>A (n=89)</th>
<th>B (n=131)</th>
<th>C (n=99)</th>
<th>D (n=123)</th>
<th>E (n=100)</th>
<th>Total (n=542)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Nature of Technology</td>
<td>22 (24.7)</td>
<td>44 (33.6)</td>
<td>12 (12.1)</td>
<td>45 (36.6)</td>
<td>62 (62.0)</td>
<td>123 (23.4)</td>
</tr>
<tr>
<td>II. Practical/technical skills</td>
<td>3 (3.4)</td>
<td>9 (6.9)</td>
<td>5 (5.1)</td>
<td>5 (4.1)</td>
<td>4 (4.0)</td>
<td>26 (4.9)</td>
</tr>
<tr>
<td>III. Technology as human activity</td>
<td>17 (19.1)</td>
<td>95 (72.5)</td>
<td>39 (39.4)</td>
<td>82 (66.7)</td>
<td>8 (8.0)</td>
<td>241 (44.5)</td>
</tr>
<tr>
<td>IV. Interest</td>
<td>6 (6.7)</td>
<td>5 (3.8)</td>
<td>7 (7.1)</td>
<td>7 (5.6)</td>
<td>-</td>
<td>25 (4.7)</td>
</tr>
<tr>
<td>V. Career</td>
<td>4 (4.5)</td>
<td>9 (6.9)</td>
<td>1 (1.0)</td>
<td>2 (1.6)</td>
<td>-</td>
<td>16 (3.0)</td>
</tr>
<tr>
<td>VI. Gender</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 (1.0)</td>
<td>1 (0.18)</td>
</tr>
<tr>
<td>VII. Curriculum</td>
<td>6 (6.7)</td>
<td>25 (19.1)</td>
<td>36 (36.4)</td>
<td>23 (18.7)</td>
<td>4 (4.0)</td>
<td>94 (17.9)</td>
</tr>
</tbody>
</table>

Figures in parentheses are percentages.
Conclusion
On the whole, the mean scores for all of the various (sex, age, state) groups can be said to be above average on most of the scales, bearing in mind that the maximum possible scope on each of the scales is 50. Thus, we can say that their interest in technology and their attitude towards technology in the school curriculum is reasonably fair, so far as their attitudes on the forced choice items are concerned. However, with respect to their spontaneous or open-ended responses, they tended to write more about technology as a human activity with all its especially pleasant consequences and the nature of technology than about anything else. Finally, the fact that there are some similarities in the responses of this sample and those of the last one suggests, perhaps not surprisingly, that there are some commonalities between the two samples. We need to do more work at more sophisticated level in order to know more about the feelings and perceptions of Nigerian pupils towards technology for the better engineering of their learning experiences in this field and their technological literacy in general.

References
A revised Likert questionnaire for the attitude scale PATT Newsletter 01, 7-9, 1986.
THE TEACHERS' AND PUPILS' OPINIONS ABOUT THE SCHOOL SUBJECT "WORK AND TECHNOLOGY"

Ms. Grazyna Dudziak
A. Mickiewicz University
Poznań, Poland

Summary

A very short description of physics and technology curricula in grade eight of primary school and in General High School is presented. The opinion of teachers (5 interviews) regarding the contents and way of carrying out the curriculum of the subject "Work and Technology" is described. The pupils' opinion on the following topics of technology lessons are presented:
- the concept of "technology",
- which lessons on that subject have you found the most interesting (why),
- which lessons on that subject have you found boring (why),
- what changes, in your opinion should be introduced into the subject.
Short descriptions of technology lessons are included: making of an adapter (8 grade) and cooking (6 grade).
THE TEACHERS' AND PUPILS' OPINIONS ABOUT THE SCHOOL SUBJECT "WORK AND TECHNOLOGY"

1. Introduction
PATT research should be developed in four sub-streams [1]. We have chosen small scale studies with short questionnaires, meant for teachers orientation in pupils' attitudes to their lessons and to clarify the reasons for low interest of pupils in technology lessons, in spite of a great interest in technology in general [2].
The second main question formulated before these studies concerns the reason for the fact that girls are less interested in technology than boys. The study of teachers' and pupils' opinions about the subject "Work and Technology" has been conducted in the last (VIII) grade of primary school (age 14-15) and grade II of General High School (age 16-17) in Poznań. Courses in physics and technology are well correlated. As regards VIII grade physics curriculum, it covers mainly electricity and magnetism phenomena (70% of lessons). The technology curriculum includes classes in electrotechnics and electronics (essential parts of the devices, rules of construction and control systems, measurements of electric quantities). The considered problems are related to electric appliances, phonographic equipment and engines.
Besides the technology courses elements of the history of technology, methods of nature protection and electric energy resource problems are included. The second grade physics curriculum at High General School is similar to that of grade VIII of primary school. Its main part is devoted to electricity (70%). The same similarity holds between technology curricula but more complex problems are solved and electronics is taught in grade III.

2. Evaluation of technology lessons by teachers and their pupils
Teachers of technology have much freedom in choosing the way of carrying out the curricula. This subject at school is taught by teachers of various educational backgrounds and self-disposition to theoretical and practical work in different areas. We interviewed some of them and made the questionnaire inquiries among their pupils.
A. The first teacher.
He graduated from high technological school and additionally prepared for
teacher profession at a pedagogical training course. He is extremely fond of
electronics and his opinion about technology at school is as follows.
The subject technology should be one of the most important, next to Polish,
mathematics, physics and chemistry, according to him two different
technology curricula should be set up; one related with home keeping and
one hard technology oriented, which should be voluntary chosen by pupils.
Traditional technology lessons should not give place to the exercises with
computers. He has a well equipped classroom thanks to his own effort and
interest in practical training in technology. I visited a lesson and gathered
the pupils’ (15 girls) opinions on his lessons. The questionnaire contains
questions about interest in and the proposed improvements to technology
lessons (see summary).
In spite of his traditional attitude towards girls in technology, most of the
girls found his lessons on phonographic equipment, home equipment and
motorcycle interesting. They mentioned mainly the following reasons: this
kind of knowledge is useful in life, easy to understand and exciting. The
most controversial subject is about the motorcycle. The girls are not
indifferent to it; half of them considered it interesting and the rest found
it boring. One fourth of the girls did not like the lessons about electric
motor driving and control. Also one fourth of them suggested that more
practical tasks should be undertaken but the same percent of girls found
their previous practical exercises (making a lamp, a tester, soldering) boring.
The girls (70%) proposed more lessons about cooking, but this proposal was
suggested by the teacher.

B. The second teacher.
She graduated in physics and was engaged in research work for many years
at our University. In her opinion no difference should be made between
girls and boys as far as technology teaching is concerned. She noticed
during her career, that both sexes are glad to carry out practical tasks and
there is a lot of joy when their products operate. She organized a hobby
club making tapestry which is joined by girls and boys as well. Like the
first teacher, she has made great effort in order to have well-equipped
classrooms. She sets a high value on electronical set-ups with multiple
choice and use (nonsoldered junctions).
The questionnaire inquiries reveal that most of her pupils (girls and boys) do not like lessons on electric circuits. In their opinion these lessons are a repetition of physics, involve calculations (sometimes difficult) and this kind of knowledge will not be useful in their life. Both, girls and boys were interested in lessons on electric home equipment. Boys like lessons on engines. These lessons are less attractive for girls, but still 30% of girls found them interesting. Almost all the pupils propose doing more practical tasks and they mean making some equipment used in everyday life, doing measurements and taking to pieces some more composed objects in order to learn their construction.

A striking result is that 70% of girls would prefer to have the curricula different from those of boys. This proposition was suggested even by those girls who claimed to be interested in engines.

I attended one lesson (making of an adapter) in this class. Pupils were working in voluntary created groups of three. However, a noticeable fact was that there was a boy in each of the groups. They had known that the teacher would praise them for quickness and adequacy. The teacher was observing their work and sometimes loudly criticised not correct execution. The pupils revealed great joy in this competition.

C. The third teacher.
In the same school where the second teacher works, I inquired pupils who have been taught by another teacher. The teacher was not willing to give an account of his work. His pupils (boys) unanimously complained on his lessons as they wrote down a lot of theoretical knowledge, in their opinion, not useful in their future life. Some of them proposed to change the teacher. They remembered better lessons with a previous teacher.

D. The fourth teacher.
We carried out small scale studies among II grade pupils of G.H.S. since we had learnt from traditional PATT studies (see Table 1) about a significant difference between general interest in technology and in technology lessons. The situation is even worse as far as physics is concerned.

On the other hand, we know that physics is regarded as one of the most difficult subjects at G.H.S.
Table 1. Interest in physics and technology of pupils at G.H.S. (S-subject, L-lessons).

<table>
<thead>
<tr>
<th></th>
<th>Physics</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>girls</td>
<td>boys</td>
</tr>
<tr>
<td>Physics</td>
<td>3.09 (S)</td>
<td>2.40 (S)</td>
</tr>
<tr>
<td>Technology</td>
<td>3.14 (L)</td>
<td>2.79 (L)</td>
</tr>
</tbody>
</table>

What are the reasons for this significant difference in interest between the subject and the lessons?

We interviewed a teacher and did the questionnaire inquiries. He carries out practical lessons in such a way that each pupil has assigned a project (to design and execute) in the beginning of a semester.

Our study has revealed that girls are interested in technical drawing (50%), electric home network, light sources and soldering (30%), as these subjects were practical and they could see the possibility of applying this knowledge and skills. Girls do not like lessons on electric equipment and motors (60%); rather unimportant and too theoretical for them.

We hope that the situation will improve as soon as new handbooks (already prepared) have been printed since the teachers will not have to supply theoretical background during the lessons. Old books printed 10 years ago went out of use.

It was easy noticeable that girls and boys were interested in the subjects which provided them with theoretical knowledge and practical skills that could be directly applied in everyday life.

Most pupils preferred the lessons during which they could carry out practical work by themselves.

Undoubtedly, a lot of girls consider the lessons on cooking and sewing more attractive than the lessons related to hard technology. The lessons on cooking and sewing were obligatory for both sexes of V and VI grade.

However a significant percentage of girls (about one third) finds the hard technology subjects interesting and sometimes related to their hobbies.

We may suppose that teachers seldom ask pupils for their opinions on the lessons. This supposition followed from the fact that all teachers inquired were very much interested in the results of the questionnaire among their students.
References

THE INVESTIGATION OF THE GENERAL HIGH SCHOOL STUDENTS' ATTITUDE TOWARDS TECHNOLOGY

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Summary

The investigation was carried out among second grade students of the General High School in Zielona Góra, age 16-17. The answers to the attitude questionnaire proposed in the "Report of the PATT Conference 1987", p. 117 were collected from over 400 pupils of the classes of mathematical and physical profile and humanistic profile. 6 Additional questions were asked. They were aimed at evaluating the interest in physics and its correlation with the subject "Work and Technology".

In analysis of the results the authors have taken into regard the students' sex, the choice of their faculty, and the profession of their parents making use of the attitude scales given in PATT Newsletter 01.
THE INVESTIGATION OF THE GENERAL HIGH SCHOOL STUDENTS' ATTITUDE TOWARDS TECHNOLOGY

1. The aim of studies
The studies aimed at determining the High General School (HGS) students' attitude towards technology within the following scales: interest, sex, consequences, difficulty, curriculum, career.
At the same time we wanted to find the influence of the following factors on the attitude:
- the sex of respondents,
- the profile of education at HGS,
- the profession of the students' parents.

2. Organization of the studies
The inquiry was carried out in the centrally-western region of Poland, in Zielona Góra district. The inquiry was carried out in 6 HGS, among them 3 in Zielona Góra and 3 in little towns. The respondents were 425 students of II grade (age 16-17), studying the courses of mathematical-physical and humanistic profiles (Table 1).

| Table 1. Students division according to sex and profile of studies. |
|---|---|---|---|---|
| Sex | Profile |
|     | boys | girls | mat.-phys. | humanistics |
| N%  |
| 288 | 68   | 137   | 226         | 199         |
| 32% | 53   | 47    | 47%         | 32%         |

In the studies we used the Questionnaire for the attitude elaborated for the PATT-2 conference and we added six questions about interest in physics [1].

3. The attitude of students towards technology
The results were grouped according to the 6 scales and then, we calculated the mean value and distribution of the results (Table 2). When the question was a negative theses, the confirmative answer (1 or 2) was reversed and the score (5 or 4) was assigned to it.
Table 2. The mean value and the distribution of results in 1-6 scales.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean</th>
<th>1-2</th>
<th>3</th>
<th>4-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>2.72</td>
<td>52</td>
<td>17</td>
<td>31</td>
</tr>
<tr>
<td>Sex</td>
<td>3.01</td>
<td>36</td>
<td>19</td>
<td>45</td>
</tr>
<tr>
<td>Consequences</td>
<td>2.12</td>
<td>70</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Difficulty</td>
<td>3.02</td>
<td>27</td>
<td>24</td>
<td>39</td>
</tr>
<tr>
<td>Curriculum</td>
<td>2.95</td>
<td>42</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>Career</td>
<td>3.06</td>
<td>34</td>
<td>30</td>
<td>36</td>
</tr>
</tbody>
</table>

1-2 - positive attitude  
3 - lack of opinion  
4-5 - negative attitude

The mean values in individual scales are set around 3 which is the score of neutral attitude. The exception is the scale consequences. However, mean values alone do not reflect the real students' attitude. Therefore, for the sake of better illustration the results distribution is presented.

**Interests**

Slightly more than half of the respondents (52%) show interest in technology. However, a considerable group of respondents are not interested in technology (31%). Boys reveal significantly (T-test) greater interest, except for the interest in old machines and visiting factories in which all pupils are interested but not very much (mean 3.3).
It can be noticed that girls do not like reading technological magazines, repairing home equipment and are not interested in joining a hobby club technology oriented. The students of math.-phys. profile courses showed significantly greater interest in technology in their answers to questions 13, 38 and 43.

Sex
The majority of respondents think that a profession related with technology may be also suitable for girls. This opinion was independent of the respondents' sex and the profile of their education.

Consequences
According to considerable majority of respondents (70%) technology provides a high standard of living and determines the development of the country. Only 13% of respondents is aware of the danger technology may bring. These opinions were equally shared by boys and girls, independently of the profile of their education.

Difficulty
Only 27% of respondents claim that a profession related with technology demands that one should have particular capabilities and requires difficult training. This opinion is mostly shared by girls. The other respondents have no opinion (24%) or think that everyone is intellectually able to study technology. The opinions were independent of the profile of education.

Curriculum
42% of respondents approve of the content of the curriculum programme devoted to technology, however the majority of them are boys. Broadening of the scope of technology taught at school would be gladly approved of by a small number of male respondents (mean 2.59) but it would not be approved of by a comparable number of female respondents (3.16). Both sexes claim the lessons rather important (2.65) but boys attach significantly more importance to them (2.34).
Although the lessons on technology are rather believed to prepare for good professions (2.67), a part of the respondents claim that the lessons are not needed by everyone (2.58).
Career

We obtained the greatest number of neutral answers to this question: 30% of the students have not yet decided their professional plans. They are students of II grade and the full period of education at HGS covers 4 years. This kind of schools are meant to prepare the students for university level studies. The number of respondents who would like to have a profession related with technology is almost the same as those who wouldn't. The most of girls decidedly answered "no" to the question about probability of choosing a profession related with technology (4.20). Although they do not claim that this kind of work is boring (girls 3.21, boys 3.69) and even say it might be interesting (2.28), but they are not convinced whether such a profession will ensure their future (2.93).

4. Conclusions

The sex of respondents has been found to influence significantly the students' answers to the questions in the scales: interest, career and curriculum.

The profile of education was found to influence the students' answers. The most pronounced influence was revealed in the answers concerning the career. Students of math.-phys. courses are more apt to choose a career related with technology.

Having checked the significance of difference in the attitude towards technology between the students whose parents' profession is related with technology and those whose parents work in other professions we found that this factor does not have a significant influence.

References

1. PATT-Newsletter 01, June 86, Eindhoven University of Technology.
THE STUDY OF THE CONCEPT "TECHNOLOGY" BY THE GENERAL HIGH SCHOOL STUDENTS

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Pegagogical University
Zielona Góra, Poland
Henryk Szydlowski, Grazyna Dudziak
A. Mickiewicz University
Poznan, Poland

Summary

Students of the second grade of General High School were subjected to essay investigation. They were asked to answer the question: "What do you think technology actually is?". The questionnaire provided us also with the information about the subjects' sex, profession of his/her parents and the kind of faculty he/she had chosen. The influence of the above mentioned factors on the formation of the concept "technology" among students was analysed. The differences between colloquial understanding of the notion "technology" and definition given in Polish encyclopedia are discussed.
THE STUDY OF THE CONCEPT "TECHNOLOGY" BY THE GENERAL HIGH SCHOOL STUDENTS

1. Subject of study and the sample
The aim of our study was to find out what the word "technology" means for the students of II grade of General High School (age 16-17) [1]. The material for our study was collected in the form of essays at General High School in Zielona Góra. We obtained a total number of 202 essays including 151 answers from girls and 51 from boys, among them 97 were students of the classes of mathematical - physical profile and 105 of the classes of humanistic profile. We also inquired about the parents profession, 89 girls and 24 boys had one or two parents working in a profession related to technology.

In the essays students were asked to answer the following questions [2]:

a) What do they understand by the word "technology", what comes to their minds when this word is spoken?
b) Is technology important or not?
c) It is good or bad in itself?

The time for answering these questions should not exceed 45 minutes. Individual answers covered, on the average, one A4 page.

2. General characteristic of results
We analysed the answers separately for the pupils of the classes of mathematical - physical profile and those of humanistic profile. In each of those two groups we distinguished subgroups according to the sex of the pupils and the profession of their parents. The results are presented in Table 1 and Table 2.

Significant difference in understanding the notion technology was observed between the students of humanistic profile course classes and mathematical - physical profile course classes. Students of the courses of mathematical - physical profile are obviously more interested in technology and they, moreover, have more contact with the problems of technology.

The parents profession has also been found to have an influence on the understanding of this notion.

The students essays were analysed from the points of view of the following problems they mentioned [3]:

I. research and creative work,
II. technology as an object,
III. technology as a science,
IV. technology in school curricula,
V. the interest in technology,
VI. the consequences of technology development.

WHAT DO STUDENTS THINK TECHNOLOGY IS

Table 1. The results for Mathematics and Physics Profile.
(The results are given in percents. T - one or both parents profession is connected with technology, N - parents profession is not connected with technology, AvG - average for girls, AvB - average for boys, Tot Av - average for all students of the profile. In lines signed I, II, ... is given the total percentage of students who have given one or more elements a, b, ...).
### IV. TECHNOLOGY IN SCHOOL CURRICULA

<table>
<thead>
<tr>
<th>Concept</th>
<th>Girls</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tr>
<td>T N AvG</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t. lesson &quot;work &amp; t.&quot;</td>
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<td>8 8 8.0</td>
<td>11.0</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>t. lessons are boring</td>
<td>6 14 10.0</td>
<td>0 8 4.0</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t. also physics lesson</td>
<td>3 0 1.5</td>
<td>0 0 0.0</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>operation of devices</td>
<td>36 9 22.5</td>
<td>0 0 0.0</td>
<td>11.2</td>
<td></td>
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### V. THE INTEREST IN TECHNOLOGY

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<td></td>
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<tr>
<td>I am not interested</td>
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<td>15.5</td>
<td></td>
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<td>0.0</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>only boys are interested</td>
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<td>8 0 4.0</td>
<td>3.5</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>I am interested</td>
<td>36 24 30.0</td>
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### VI. THE CONSEQUENCES OF TECHNOLOGY DEVELOPMENT

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<td></td>
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<td>24 0 12.0</td>
<td>6.7</td>
<td></td>
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<td>48 36 42.0</td>
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<td>39.0</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>is necessary</td>
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### NUMBER OF RESPONDENTS

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### Table 2. The results for Humanistic Profile.

(T, N, AvG, ..... see Table 1)
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<th>Boys N</th>
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<td>18</td>
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<td>23.0</td>
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<tr>
<td>b. inventions</td>
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<td>10</td>
<td>18</td>
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<td>13.5</td>
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<td>32</td>
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<td>63</td>
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<td>19</td>
<td>63</td>
<td>45</td>
<td>54.0</td>
<td>36.5</td>
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<td>8</td>
<td>18</td>
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<td>18</td>
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<td>21</td>
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<td>8</td>
<td>8</td>
<td>18</td>
<td>9</td>
<td>13.5</td>
<td>11.0</td>
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<td>d. science about inventions</td>
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<td>6</td>
<td>0</td>
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<td>IV. TECHNOLOGY IN SCHOOL CURRICULA</td>
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<td>25</td>
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<td>18</td>
<td>22.5</td>
<td>23.5</td>
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<tr>
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<td>16</td>
<td>8</td>
<td>12</td>
<td>9</td>
<td>9</td>
<td>9.0</td>
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<td>12</td>
<td>12</td>
<td>0</td>
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<td>0.0</td>
<td>6.0</td>
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<td>9</td>
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<td>9.0</td>
<td>7.0</td>
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<td>1</td>
<td>27</td>
<td>18</td>
<td>22.5</td>
<td>11.5</td>
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<td>V. THE INTEREST IN TECHNOLOGY</td>
<td>36</td>
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<td>30</td>
<td>9</td>
<td>9</td>
<td>9.0</td>
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<td>0.0</td>
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<td>4</td>
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<td>c. only boys are interested</td>
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<td>4</td>
<td>2</td>
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<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>d. I am interested</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4.5</td>
<td>2.5</td>
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<td>100</td>
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<td>90</td>
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<td>0.0</td>
<td>3.0</td>
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<td>b. causes pollution</td>
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<td>38</td>
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<td>18.0</td>
<td>28.0</td>
</tr>
<tr>
<td>c. causes arms race</td>
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<td>20</td>
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<td>0</td>
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<td>8.0</td>
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which they mostly consider boring. From among the pupils of humanistic profile courses 22% girls gave negative opinions about the lessons claiming that they are purely theoretical concerned with the principles of operation of various devices and equipment. Quite different is the opinion shared by most of the boys, in particular by the pupils of mathematical - physical courses. Moreover the students of this profile courses are aware of the relation between technology and physics, show the proper way of understanding the notion technology. Thus, we notice a correlation between the profile of education and the interest of the students.

V. The interest in technology. In general, the obtained answers suggest that the students are interested in technology, new inventions, computer science, TV and radio programmes concerned with technology. For a significant group of boys technology is fascinating and attractive. Girls are in general less interested in technology. The answer "I am not interested in technology" was obtained in 20% of the girls and in 0% of the boys. Only a significant percent of girls claimed that they would like to work in a profession related with technology, like their parents. A significant difference in interest was found between the students of humanistic profile courses and mathematical - physical profile courses. The interest in technology is more pronounced in the students whose parents have some kind of technological education or work in profession related with technology. For example the number of girls whose parents' professions are not related with technology and who would answer "I am interested in technology" was 0%.

VI. The consequences of technological development. Most respondents associated technology with modern development and progress. All of them claimed that technology is indispensible and the world without it is hard to imagine. The students of both profiles gave the same interpretation of the role of technology, but the answers of boys, particularly those who studied in mathematical - physical profile courses, contained more elaborate and developed opinions. In general, technology was praised to be responsible for growing standard of living, for facilitating man's life, for enabling to carry out the tasks that not a long time ago had been possible only in dreams. According to 20% of respondents, technology is a tool for better understanding of the world and enabling to discover the unknown. It is considered a tool in itself, however the respondents were aware that
3. Analysis of results

I. Research work. Two questions have been considered within this problem: inventing and constructing of new devices and improvement of those already available. Significant difference in understanding those two questions has been noticed between the students whose parents' profession was and wasn't connected with technology this difference was noticeable both among the students of humanistic profile courses and mathematical - physical profile courses. Those whose parents work in professions related with technology tend to estimate higher creative aspects of work in technology.

II. Technology as objects Boys' and girls' answers frequently included the statements saying that technology helps solving problems, makes man's life easier and the standard of living higher. Owing to technology a man can do some work quicker and in a more precise way. Technology is associated with all kinds of devices met at home, at school or at work as well as with modern means of transportation. These associations have been more frequently found in the answers of students of humanistic courses, where girls prevail. The students of mathematical - physical courses associate technology also with industrial devices and machinery, with computers and electronics, as well as with new inventions. It should be mentioned that this aspect of technology appeared more frequently in boys' answers. It is also worth noting that technology was associated not only with its modern forms by a greater number of those who attend mathematical - physical profile courses.

III. Technology as a science. We wanted to know if the students see a relation between technology and other sciences and whether they considered technology to be a science. The students of mathematical - physical profile courses had a greater tendency to claim that technology is a science. They also more frequently were aware of the fact that technology is based on sciences whereas this relation was vague in the answers of those of humanistic profile courses. Other conceived relations were those between technology and economy as well as inventions. These relations were emphasized more often in the answers of students of mathematical - physical profile courses, for example. However, all respondents agreed in believing that technology is one of the factors determining our future.

IV. Technology in school curricula. For many respondents, mainly girls, technology is mainly associated with the lessons on "work and technology"
nowadays technology was being more frequently misused. According to 25% of respondents a man has become a slave of technology and technology has become in a way dangerous to people because its development results in destruction of natural environment as well as in development of war industry. Only 3% of respondents claimed that the development of technology may be an indirect cause of unemployment in capitalistic countries. The students of mathematical - physical profile courses additionally pointed to positive consequences of development of technology like, for example, the achievements in medicine and the application of technology in protection of the natural environment.

4. Analysis of results

The contents of essays illustrates the colloquial understanding of technology. We will try to compare it with the definition given in Polish encyclopedia [4]; different from that which is valid in Western countries [3]:

"Technology is the whole of means and man's work being a part of man's activity related with production of material goods. Development of technology is based on discovering and applying natural laws, energy (water, coal, oil, nuclear energy) and raw material (metal ores, fibres, ceramic materials) resources. As an applied science it is based on the achievements of theoretical sciences, such as mathematics, physics etc."

According to this definition one can distinguish the following elements included in that definition: 1) means of production, 2) man's work, 3) production of material goods, applying of: 4) natural laws, 5) energy and 6) raw material, 7) basis of theoretical sciences such as mathematics and physics.

In more than 90% of the students' essays we find the element (1) - means of production (see II Tab.1 and 2). There is no statement that the background of technology is man's work (2) and production of material goods (3). We suppose that for most students it is so obvious that they do not write about it. Our opinion is confirmed by the result that 30 - 40% of respondents underline the creative aspects of man's activity (see I in Tab.1 and 2). Technology as a science (4, 7) is recognized by 70 - 80% of mathematical - physical profile courses students, but only by 30 - 40% of humanistic one (see III in Tab. 1 and 2). Relatively large percentage (97%) is talking about the consequences of technology (see VI in Tab.1 and 2), both about positive and negative aspects. But this aspect was suggested in
the questions given as the aim of the essay. The students' essays do not take into account energy (5) and raw materials (6) and information as an essential part of technology. Some students are identifying technology with lessons of "work and technology" (see IVa in Tab.1 and 2), which were concerned with operation of devices (IVd).

In the Polish language the same work "technic" means also manual dexterity in various works. It is interesting that the students do not mix these two notions; nobody has used the second meaning in this essay.

We conclude, that the colloquial understanding presented in students' essays does not contain all aspects of technology. School curricula and syllabuses do not devote much space for exact definitions, the very bright curriculum of "work and technology" does not underline all aspects of technology. But still it is very interesting that in spite of a great emphasise given to technological jobs and practical work characteristic for various professions students do not tell much about connection of technology and man's activity, production of goods, energy, or raw materials.

References
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WHAT DO ADOLESCENTS THINK OF TECHNOLOGY?

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Summary

In 1987 a research was carried out in the Netherlands into the attitude towards technology of 16 to 18-year-olds. 1257 Pupils of grade 4 of senior secondary and pre-university education, and 1171 first grade students of senior vocational training took part in this research.

The research was carried out by means of the PATT-questionnaires. The scales of the (international) PATT-research have been maintained as far as possible. On the basis of common items comparisons with research that has been carried out before is possible.

The independent variables in the research are: 'sex', 'age', 'home environment', 'professional aspirations' and 'school type'. Each of these variables separately appears to have a significant influence on the scores of concept and attitude scales. When the variables are regarded as a whole, so that their relative influence on the attitude towards technology becomes clear, it appears that a great deal of variance (60%) remains unaccounted for.

Apart from a description of the results as regards content there will also be attention in the paper for the internal structure of the attitude and concept questionnaire. It is suggested that for the concept scales a Guttman scale model might be a more suitable model than a Likert scale model.
WHAT DO ADOLESCENTS THINK OF TECHNOLOGY?

Introduction
In this paper the results of the research into the attitude towards technology and the concept of technology of pupils of 16-18 years old is summarized.
It is important to get a good insight into the attitude towards technology because it tells us something about the behaviour that can be expected. It is unlikely that pupils with a (relatively) negative attitude towards technology will choose a technical training or profession later on.

The research was carried out among 1257 pupils from secondary general/pre-university education and 1171 pupils from senior technical training (STT), senior service and health care training (SSHT) and senior economic and administrative training (SEAT) or senior training for the retail trade (STRT). Most pupils from senior secondary (SSE)/pre-university education (PUE) who took part in the research were from grade 4 (1192), the pupils from senior vocational training were all from grade 1.

The research is focused on two questions:
1. What is the concept of and the attitude towards technology of fourth grade pupils from secondary general/pre-university education and of first grade pupils from senior vocational training?
2. What factors have an impact on the attitude towards technology?

Design and instruments of the research
The research has been carried out by means of questionnaires. These questionnaires consist of three parts: (1) background questions, (2) attitude questions and (3) concept questions. The background questions were asked to get information on the pupils (sex, school, parents' profession etc.). The attitude and concept questions are statements about technology and the pupils can indicate to what extent they agree with these statements. The statements were carefully selected and the answers give a good insight into the attitude towards and the concept of technology. With other age groups these statements were also used (pupils aged 13-15) and will also be used (pupils aged 10-12), so that comparisons can be made.
From research that has been carried out earlier it became evident that the attitude towards technology consists of the following aspects:
- interest in technology,
- consequences and importance of technology,
- difficulty and accessibility of technology as training and profession,
- technology at school,
- technology as a profession.

Each of the statements refers to one of these aspects. A number of statements which together measure one aspect of the attitude towards technology is called a scale (for example the interest scale). For each statement there is an option of 5 answers, running from 'totally agree' to 'totally disagree'. The answers are converted into scores and for each scale the mean scores of a group of pupils are calculated. The most positive attitude score is 1 and the most negative attitude score is 5.

By means of a factor analysis and item analysis the 6 aspects are validated. The internal structure of the attitude questionnaire is good.

To measure the pupils' concept of technology we formulated statements that are based on a number of (widely used) characteristics of technology. The statements refer to:
- the relation Technology and Society (19 items),
- the relation Technology and Science (6 items),
- the relation Technology and Skills (7 items),
- the relation Technology and Matter, Energy and Information (5 items).

In the answering of the concept items a differentiation, as was possible with the attitude items, is not possible. The pupils may choose from only 3 answers: 'agree', 'disagree' and 'don't know'. We did this because the items measure more knowledge than attitude or feeling (cognitive versus affective). Here too the answers are converted into scores. Does a pupil answer according to a characteristic of technology then the answer is marked correct. The scores run from 0 to 1, and 1 is the highest possible score.

As for the attitude items scales were made of the concept items. However, as opposed to the attitude items, not all concept items appear to be (statistically) suited for scales.

These scales are necessary though to carry out certain statistical calculations, particularly to investigate the relative influence of variables
(research question 2). By means of a probabilistic Guttman scale analysis (according to Mokken) it appears to be possible to make a Guttman scale for each of the characteristics of technology, a scale with a fair to good internal consistency (for all scales $H_i > 30$). All concept items were used for the description of the attitude towards technology and the concept of technology (research question 1).

By comparing the mean scores of groups of pupils it is possible to gain insight into the concept of technology and the attitude towards technology. Scores in themselves do not mean much, only in a comparative sense can they get a certain value. The results should be interpreted this way. Naturally it is possible to compare an infinite number of pupils. Although for a teacher it might be interesting to compare at class-level or even at pupil-level, for our purpose the following comparisons are relevant: In what respects are boys and girls different? Do pupils from different types of schools also have a different concept of technology and a different attitude? Do pupils with a technical home environment have a more positive attitude towards technology? Is a positive attitude towards technology accompanied by ambition for a technical profession? This way it is also checked implicitly what the influence is of separate variables (such as sex) on the concept of technology and the attitude towards technology, after all if boys and girls have the same score it is evident that sex does not have an influence.

We also investigated the 'relative' influence of various variables on the attitude towards technology. We also investigated the relation between the concept of technology and the attitude towards technology. We expected that the concept of technology would influence the attitude towards technology in a positive sense: in other words that pupils with a relatively better concept of technology will also have a relatively more positive attitude towards technology. This is very important if we would want to bring about certain changes in attitude.

The concept of and the attitude towards technology of 16-18-year-old pupils

General conclusion
It is not simple to typify the entire group of pupils of 16-18 years old unequivocally. The differences between all kinds of groups are too large to
Mean score of boys and girls on the INIEREST-scale

Mean score of boys and girls on the ROLEPATTERN-scale
Mean score of boys and girls on the CONSEQUENCES-scale

Mean score of boys and girls on the DIFFICULTY-scale
Mean score of boys and girls on the TECHNOLOGY & SKILLS-scale

Mean score of boys and girls on the TECHNOLOGY & PILLARS-scale
Mean score of boys and girls on the TECHNOLOGY & SOCIETY-scale

Mean score of boys and girls on the TECHNOLOGY & SCIENCES-scale
do this. Thus the boys from one school for senior technical training score 2.29 on the interest scale whereas girls from grade 4 secondary general education score 3.60 on the same scale.

We put some results (scale scores of boys and girls from different school types) in histograms in order to obtain the best possible idea of the results. From these histograms we can draw the following conclusions with reference to the group of pupils of 16-18 years old:

- on the whole the attitude towards technology is moderately positive: the pupils are extremely positive about 'girls in technology', fairly positive about the importance of technology, moderately positive about the accessibility (difficulty) of technology as a training and the interest in technology is neutral to even negative;

- the concept of technology is fairly good, it is better than the concept that pupils of 13-15 years old have of technology: the relation between technology and skills is seen well by pupils of 16-18 years old, for them technology is obviously more than just equipment. In first instance technology is often associated with equipment, though, and it is far less seen as a societal product. The overall scores on the scale Technology and Society are rather low. On the whole the pupils score fairly well on the scales Technology and Sciences and Technology and Pillars, but here too there are large differences between various types of school.

Another indication of the concept that pupils have of technology becomes evident from the answers to the background question to define the concept 'technology'. Evidently pupils have enormous difficulty with this. Some of them state (and maybe justly so) that technology is so comprehensive that it is impossible to give a definition of it. If one has a try anyhow it appears that one scores hardly or not at all on any of the characteristics of technology. Pupils score most often on the characteristic Technology and Skills.

**Boys and girls**

Boys have a better concept of technology and a more positive attitude towards technology than girls.

On the concept scales the differences between boys and girls are extremely unequivocal: on all concept scales the mean score of girls is far lower that that of boys. Particularly on the scale Technology and Society there are substantial differences between boys and girls. The difference in scores is
partly explained by the fact that girls far more often than boys use the answering category 'don't know'.

The fact that boys have a more positive attitude towards technology is mainly explained by the fact that they are more interested in technology: both on the interest, school and career scale the boys' score is distinctly more positive. On other scales the differences are smaller or even to the advantage of girls (on role cast). Furthermore it is striking that the more positive score of boys on the consequence scale is caused by the girls choosing more often the neutral answering category, and not by the girls scoring more negatively. Probably the girls have much more doubts than boys about the relation between technology and society and the consequences of technology. The notion that technology itself is not a positive or negative thing, but that this is determined by the things people do with technology, is perhaps cherished more by boys than by girls.

School types
The histograms on the previous pages also show that pupils from different school types have different mean scores on the scales. Pupils from first grade senior technical training and fourth grade pre-university schools have the most favourable score: they have a more positive attitude towards technology and a better concept of technology than pupils from the other school types. This leads us to the conclusion that the general level of knowledge (pre-university education) and specific knowledge (senior technical training) results in a better concept of technology and a more positive attitude towards technology.

In this respect it is striking that the 65 pupils who studied the course Medical Technology did not score better than the other pupils (with physics as an exam subject). (This does not imply that the course may not have resulted in an improvement of the concept of technology and the attitude towards technology.)

Home environment
Pupils from a 'technical environment' (members of the family working in technology, with a talent for technology, and a lot of equipment at home) appear to have a more positive attitude towards technology and also a better concept of technology. This can be seen very clearly in the
Students with (1) and without (2) a technical HOME-ENVIRONMENT

\[ \begin{array}{cccccccccccc}
\text{INIT-1} & \text{INIT-2} & \text{ROL-1} & \text{ROL-2} & \text{CON-1} & \text{CON-2} & \text{DIF-1} & \text{DIF-2} & \text{CUR-1} & \text{CUR-2} & \text{CAR-1} & \text{CAR-2} \\
2.27 & 2.08 & 2.22 & 2.45 & 2.8 & 2.9 & 2.69 & 3.14 & 2.91 \\
\end{array} \]

Students with (1) and without (2) a technical HOME-ENVIRONMENT

\[ \begin{array}{cccccccccccc}
\text{TEASo(1)} & \text{TEASo(2)} & \text{TEASc(1)} & \text{TEASc(2)} & \text{TEASk(1)} & \text{TEASk(2)} & \text{TEAPI(1)} & \text{TEAPI(2)} \\
0.78 & 0.72 & 0.74 & 0.69 & 0.73 & 0.62 \\
\end{array} \]
histograms on the previous page.

Ambition
Pupils who say that they have the ambition to choose a technical profession later on appear to have a far more positive attitude towards technology and also a much better concept.
Independent from 'sex' and 'school type' the variable 'ambition' has an influence on the attitude towards technology. Girls from non-technical school types with an ambition for technology score more positively on attitude and concept scales than girls from the same school types without this technical ambition.

Age
It is possible to compare the scores on the attitude scales of pupils from grade 2 secondary general/pre-university education, grade 2 junior vocational training, grade 4 senior secondary/pre-university education and grade 1 senior vocational training. On the basis of this comparison we can say something about the influence of the factor age on the attitude towards and the concept of technology. Although we assumed that the attitude towards and the concept of technology would remain rather stable, it appears that some changes do occur:
- compared with pupils of 13-15 years old there is a distinct improvement in the concept of technology of pupils of 16-18 years old;
- compared with grade 2 secondary general/pre-university education the attitude towards technology of pupils from grade 4 senior secondary/pre-university education becomes less positive: on all scales pupils of 16-18 years old score less positively. It is possible that pupils of 16-18 years old have a somewhat more critical and differentiated attitude towards technology than pupils of 13-15 years old;
- if we compare grade 2 junior vocational training and grade 1 senior vocational training it appears that our assumption was correct: the attitude scores of comparable school types (junior/senior technical training, junior domestic science training/senior service and health care training and junior/senior economic and administrative training) appear to be the same.

Factors that determine the attitude towards technology
In the previous section we saw that various factors each have their own
influence on the attitude towards technology:
1. sex;
2. level of knowledge (school type);
3. home environment;
4. ambition.
A fifth factor that may influence the attitude towards technology is the concept of technology. This is an important factor because it can be manipulated by means of education.

We first of all investigated whether there is a relation between the concept of and the attitude towards technology. This really appears to be the case: there is a relation, or correlation, of .41 for grade 4 senior secondary/pre-university education and of .31 for grade 1 senior vocational training. From a statistical point of view these are rather strong relations.

We then investigated which characteristics of technology correlate most strongly with the attitude towards technology. It appears that the characteristic 'Technology and Society' correlates most strongly with the attitude towards technology. But the other three characteristics of technology have an important impact on the attitude towards technology too. The other way round there appear to be meaningful correlations between aspects of the attitude towards technology (particularly interest) and the concept of technology.

With these results of the research we still do not know what relation there is between concept and attitude. Is the correlation of .41 completely accounted for by the influence of the concept on the attitude or the other way round or is there perhaps an equal mutual influence?

To check this the causality (cause-consequence) between the concept of and the attitude towards technology has been investigated.

To assess the causality we first of all determined the relative influence of the five factors or variables on the attitude towards technology. The pupils' score on the definition of technology was also counted as one factor.

The collective influence of all tested variables is 40%. This means that we can account for 40% of the attitude towards technology. In order of importance there are: sex (20%), ambition (12%), concept of technology (7%) and school type, definition and home environment (< 1%).

On the basis of these results we made a causal model with three variables: sex, concept and attitude.
The most important result of this model is that we can show that there is indeed causality between concept and attitude. 83% of the relation of .41 between concept and attitude is determined by the causal relation concept-attitude (the path coefficient for concept-attitude is .34).

References
PROJECTION OF GENDER AND SOCIAL SETTING OVER ATTITUINAL DIFFERENCE TO TECHNOLOGY

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Summary

The present study is concerned with senior secondary level students' attitude to technology. The sample has been drawn from rural and urban settings, covering 1167 respondents, both male and female. The National Policy on Education (1986) has given a serious thought towards generating awareness to technology among school goers. The text of the policy makes it quite plain that the modern technology must reach out to the most distant areas. Before any new change is introduced by bringing technology as a part of school content, it would be most desirable to have a feel of pupils' opinion about technology. This will provide a guideline for the curriculum planners on the subject of technology. The present work is a four dimensional study on the attitudinal aspect of urban boys-urban girls; rural boys-rural girls; rural boys-urban boys; and rural girls-urban girls. It is quite interesting that not much difference could be seen among these groups on different aspects of technology contained in the questionnaire.
PROJECTION OF GENDER AND SOCIAL SETTING OVER ATTITUDINAL DIFFERENCE TO TECHNOLOGY

Prologue
The Indian society alongwith its entire fabrics is undergoing remarkable changes and the social scenario of the 21st century will present altogether a new portrait in which the life pattern of an average Indian will undergo considerable transformations. The forthcoming society will totally be a technologically dominated one. Consequently appropriate mental readiness and tuning of attitudes accordingly is in want at the present moment to cope up with the changing shades of the future social needs. This demands a drift from the traditional outlook.

The destiny of the nation is shaped in the classrooms. While attempting to introduce technological changes, we should bear in mind that the existing school system should make a real promise to our younger generation to meet the future challenges of a complex society. This predominantly falls under the per view of formal system of schooling.

Quite often some fundamental issues are raised about the relevance and the functionality of newly conceived curriculum, proposed by the policy makers at different platforms. Probably we are failing in our endeavour to inculcate a desirable attitude to technology, both through our content and approach. In the majority of the cases, the most of awareness on technology takes place outside the school. However, this state of affairs should not be permitted to continue indefinitely.

What should our school do?
To meet these challenges in the school system, efforts have to be made at an early stage of schooling so that the growing children should properly conceptualise the intrinsic spirit of technology. The school has to set a stage for clearing away the mystery surrounding technology, by proposing courses which are available to all without any discrimination. It is high time in a developing country like India, to expose our young crop to fundamentals of Technology. Much exposure has already taken place because of mass media but now we are required to give it a formal shape, so that in course of a decade or so pupils may appreciate that every technological
product has been invented to meet a specific need of 'mankind', they may
develop in them an ability to configurate and design technical products and
may appreciate the immense influence of technology in daily life. The
present study relates to the +2 grade school goers' attitude to technology
with special reference to Madhya Pradesh, the biggest state (in area) among
the 25 states of the Indian Republic. The theme of the study assumes
special importance with the execution of our recent Education Policy (1986)
which lays specific stress to science and technology courses at school stage.
It seems plausible that within a span of five years or so the conventional
school curricula will undergo a drastic change in the country. Developing of
technical skills will occupy a core place in the total school schedule, in
view of nature of requirement in the twentyfirst century.

Concept first or attitude first?
Attitude refers to how one feels, thinks and reacts to those objects with
which one is constantly interacting in one's daily life to meet one's ever
increasing requirements. Conceptualisation is a higher mental process
involving the knowledge of the object, its understanding and also its
application.
In underdeveloped and developing countries there may be a difference of
opinion about the priority between the attitude and concept. Our experience
in India, especially with the rural lots makes us think that attitude could
precede concept.
After experiencing the difficulties in the rural areas on 'Concept
Technology' it was decided to concentrate our efforts to investigate only
the attitudinal aspects rather than plunging into the more complicated area
viz. Concept of Technology at the initial stage. More than 70% of the
population of India is scattered in the rural pockets. A study of their
attitudes, in the first phase, would provide a fertile land to probe into the
complex problem of 'Concept Technology'.

Main Task
To be precise the main issue taken up for investigation is worded as
follows:
A PROJECTION OF GENDER AND SOCIAL SETTING OVER ATTITUDINAL
DIFFERENCE TO TECHNOLOGY.
The paper deals with:
1. Geographical aspect: to what extent the attitude to technology varies in different geographical locations - urban and rural,
2. Gender aspect: to what degree the attitudinal aspect varies genderwise.

Rationale of the Study
This is a pioneer study of its own nature in Indian context in which the rural ingredients have also been incorporated. The ever varying social climate of Madhya Pradesh which is endowed with immense natural resources and has become the point of attraction for the entrepreneur to exploit its resources to an optimum point, creating a vast awareness about Industrial Technology which is absorbing a bulk of rural population. Since the State is incubating large as well as small scale industries, an awareness and attitude has to be developed to extract the maximum use of its reservoirs. The futurological considerations strongly prompt the impact of Technology and its consequences on human society at large. Moreover, it would generate logical thinking among pupils. It would help them to make a judicious use of technological products. It will also generate a concern for natural environment around them which is being polluted by technological consequences.

Operational definition - Attitude
The technical term used in the present paper refers to opinion, disposition, manifestation in thinking, doing or feeling.

Sample, its selection and the characteristics of the respondents
For investigation, a total sample of 1167 respondents were selected from the major industrial towns, and ten villages of Madhya Pradesh. The details are given in Tables 1 and 2 below.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Town Symbols</th>
<th>No. of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T1</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>T2</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>T3</td>
<td>97</td>
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<tr>
<td>4</td>
<td>T4</td>
<td>79</td>
</tr>
<tr>
<td>5</td>
<td>T5</td>
<td>83</td>
</tr>
</tbody>
</table>
Table 2. Rural Sample Distribution.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Town</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V1</td>
<td>23</td>
<td>18</td>
<td>41</td>
</tr>
<tr>
<td>2</td>
<td>V2</td>
<td>19</td>
<td>16</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>V3</td>
<td>15</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>V4</td>
<td>28</td>
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<td>49</td>
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<tr>
<td>5</td>
<td>V5</td>
<td>17</td>
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<td>V7</td>
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<td>17</td>
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<td>8</td>
<td>V8</td>
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<td>V9</td>
<td>23</td>
<td>15</td>
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<tr>
<td>10</td>
<td>V10</td>
<td>26</td>
<td>18</td>
<td>44</td>
</tr>
</tbody>
</table>

| Total  |      |      |       | 379   |

Sample Characteristics

1. All the respondents belonged to Govt. institutions.
2. All of them were in 12th standard i.e. age group 16+ (school terminal stage).
3. They happened to be from the lower and middle income groups.
4. All were preparing to appear in the second public examination in March/April, 1988.
5. This is the batch appearing in the 12th standard according to the new curriculum in the state. Earlier it used to be eleven years schooling only.
6. They belong to various cultural groups, and different communities.

Tools and constraints

While administering the Likert scale it posed some problems to the pupils in the rural settings. Attention is to be drawn to the following:

1. The investigator's presence was found necessary for clarifying various items and terms used time and again as some of the items were totally alien to them.
2. Mailing device could not work effectively in the rural schools.
3. Though the questionnaire was translated in Hindi, the language of the land, but dialectal variations made it difficult for students to understand the items properly. It would not be out of context to mention here that
there are 15 languages recognised by the Indian Constitution. Moreover, the dialect variations are so much that it changes every 15th kilometer.

4. Village students are not exposed to questionnaire filling practices, therefore they were a bit hesitant and sceptical.

In the scale itself there is a duplication of one item, viz. 10th and 15th. (PATT Workshop no. 1, Lesley H. Parker, Leonie J. Rennie, Appendix). However, the questionnaire was used as it was; we did not prefer to make changes at our end.

Delimitations of the paper
The present investigation was subject to the following delimitations:
1. Out of 46 districts only 5 were included in the sample.
2. Nearby villages were taken up for the study purpose.
3. Only science students constituted the whole sample.
4. Two parameters viz. gender and geographical location were taken up.
5. Data from the tribal area could not be included for want of sufficient number.

Major hypotheses
In view of the scheme diagram, the following null hypotheses were formulated:
1. (Ho) Urban boys and girls do not differ in their attitude to technology.
2. (Ho) Urban boys and rural boys do not differ in their attitude to technology.
3. (Ho) Urban girls and rural girls do not differ in their attitude to technology.
4. Rural boys and girls do not differ in their attitude to technology.

Statistical Exercise
The domains of comparisons can be seen at a glance in the following scheme diagram.

![Scheme Diagram]

U r b a n

R u r a l

Boys

Girls

↑

← →

↓

← →

↓
For the statistical treatment for the analysis of attitude of different categories of respondents the following formula was applied:

for the contingency table

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where \( N = N_1 + N_2 + N_3 + N_4 + N_5 = Ta + Tb \) for our data.

While computing the we have taken the liberty to include the frequency of non responses, under the category 'Undecided'. It may not be surprising if some eye brows are raised on this approach. In fact, ours too were not an exception to this but the comparison with and without this liberty yielded no statistical difference on the interpretation. As a consequence our initial hesitation to do so could not survive long. We now rather strongly feel that this strategy may be tried by others too who use test. The values on the 78 items of the attitude questionnaire are presented in Findings.

**Findings**

To test the attitude on different items of the questionnaire a broad classification approach was adopted. Items of similar nature were clubbed together and categorised in broad classes (see next page).

In what follows, we have used the following codes:

1. * Significant at 5% level
2. ** Significant at 1% level
3. *** Significant at 0.1% level
4. 'No star' Not significant.
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Urban boys' and Urban girls' attitude to technology

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Rural boys' and Rural girls' attitude to technology

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**Class VI - Global Significance**

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Rural boys' and Urban boys' attitude to technology

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### Class V - Prospects

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Rural girls' and Urban girls' attitude to technology

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### Class IV - Competency

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### Class V - Prospects

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### Class VI - Global Significance

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<tr>
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</table>
Discussion
In the comparison between urban boys and girls on their attitude as far as importance of technology is concerned, not much difference was found genderwise. However, it is an encouraging sign in developing countries' context, girls have more firm conviction on certain items as compared to their male counterparts.
On the nature aspect of technology almost the same picture emerges i.e. gender did not contribute to any significant difference in disposition.
The finding reveals that both boys and girls in the urban areas have the same degree of interest in technology of course with slight disagreement in only two items.
In the competency part both the groups of the respondents feel that the fair sex is no way less behind the boys. But it seems that the male ego has played its role in their responses as the frequency is comparatively less for 'strong approval' or 'strong disapproval'.
Regarding the prospects of technology as well as their future career boys and girls do not disagree much.
In the global context sexist difference does not occur in two items. Male and female both are in agreement that advanced technology can render a lot to developing countries, and that developing countries should develop their own technology. But whether the modern technology should be adopted in one stroke before applying it, the opinions are divided. Girls stress this need, whereas boys have expressed their opinion with reservations.

Pupils' attitude - Rural Boys Vs Rural Girls
As far as the importance of technology is concerned, there is no departure at all as was in the case of urban boys and girls. It may safely be concluded that social setting does not have much repercussion on the attitudinal aspect.
On the nature, interest, competency and prospects aspect of technology too the same picture emerges. But as far as global significance of Technology goes both boys and girls show an agreement on all the issues related to it.

Attitude - comparison between rural boys and urban boys
With the exception of competency, nature, global significance of technology, in the rest of the three areas the picture is almost the same.
Attitude - rural girls compared with urban girls
Here too boys and girls are found to be on parallel lines. However, regarding global significance unlike in the case of urban and rural boys, the geographical locale has not brought significant difference in case of female respondents.

Epilogue
The technological movement which has virtually revolutionized entire Indian social spectrum, has gone into the poor homes, and middle class families are practically invaded by its current. India is a unique example of natural complexities. If one part of the country is facing drought, other parts are deep down in floods. To meet these natural challenges technology has come to our rescue time and again. This has generated a positive attitude and a firm faith in it. By the end of the century, it is evident that in most of the cases, most of the people, most often will be embedded into the galaxy of technology.
TECHNOLOGY EDUCATION RESEARCH PROJECT

RESEARCH INTO PUPILS' CONCEPT OF AND ATTITUDES TOWARDS TECHNOLOGY AND ITS IMPACT FOR THE KENYAN SCHOOL CURRICULUM

Dr. Raphael, J.A. Kapiyo
The Appropriate Technology Centre for Education and Research
Kenyatta University

Introduction
As a result of an exchange of ideas between the Appropriate Technology Centre for Education and Research at Kenyatta University and the Section Physics Education of the Eindhoven University of Technology, a research and development plan for Technology Education in Kenya is proposed to cover a period of 2½ years and it will employ full three persons: two local researchers and one local secretary. The project will be carried out by the Appropriate Technology Centre (Kenyatta University, Nairobi) under the supervision of Dr. Raphael J.A. Kapiyo of the Appropriate Technology Centre, in cooperation with the Vakgroep Didaktiek Natuurkunde of the Eindhoven University of Technology (Eindhoven) Prof.dr. Jan H. Raat, Drs. Falco de Klerk Wolters and Dr. Marc de Vries. In this project it will be investigated, what knowledge of, skills in and attitude towards technology Kenyan youth has. The results of this pupils oriented research should contribute to the development of Technology Education in Kenya, particularly in view of the recent introduction of the new 8-4-4 System of Education since 1985.

PATT-research
Until about five years ago, more attention was devoted to research and development in Science Education than in Technology Education. Now all over the world a great deal of attention is paid to technology education. Here we are concerned with a new subject for 12-15 year olds in General Education, so 'technology' as a generally formative subject. But at the same time this subject gives professional orientation.

At the moment there are three international circuits concerned with the subject technology: ITEA (International Technology Education Association), IIEET (International Institute for Educational Technology) and PATT (Pupils' Attitude Towards Technology).
PATT is the largest circuit for research and development work, with 20 countries involved. PATT contributes to the new subject technology by means of research into pupils' conceptions of and attitudes towards technology.

In the PATT-research we can roughly distinguish two types of research: large scale and small scale research. So far PATT-researches were set up and executed on a small scale. In this respect one should think of samples of 200 to 300 pupils with employment for 1 person during 3 months. Both the instruments and the processing were 'standardized' (the PATT-group in Eindhoven self carries out large scale research with among others 4 samples of about 2000 pupils/students each of the ages groups 13-14 years, 16-17 years and 10-12 years old).

At the PATT-2 Conference in April, 1987, several participants indicated that they would like to do research on a large scale. This will involve representative samples, more than one instrument, planning for more than one year. Such researches require a lot of preparation, particularly to attune to existing PATT-research form a methodological point of view. Large scale projects will take place in Blacksburg, Virginia, U.S.A. and in Bhopal, India.

**PATT-research in Kenya**

Right from the start Kenya was involved in the PATT-research. Two staff members of the Appropriate Technology Centre, Dr. Raphael Kapiyo and Fredrick Otieno, already executed several 'small scale' researches into the conceptions of and attitudes of Kenyan pulls towards technology. In the report books of the first two conferences the contributions of these PATT-participants can be found (we refer to PATT-Report 1987, vol.2, p.89 and 378). From these small scale researches it became evident that it is difficult to measure contextual factors such as the pupils' home background, the level of expectation and aspiration, the school system and regional and other socio-geographical differences by means of standardized questionnaires. Particularly rural-urban dichotomies and the various school types form a problem in this respect.

**Proposed Large Scale Research in Kenya**

(1) Relevance

In case of a broader research structure there are several possibilities to
take specific Kenyan circumstances into account. However, the most important reason for large scale research is not a methodological one. The main reason is to contribute directly to technology education. This means to stimulate technology as a profession and as a training. Until recently pupils from technical (vocational) schools were looked upon as 'failures' and at the 'academic' secondary schools no technology was taught. Technology at school had a low status. With the introduction of the new educational system in 1985 (the 8-4-4 system) emphasizing practical application of knowledge to the solution of problems, room was created for this subject technology of which Industrial Education is an aspect as well. Now government documents mention 'technology education' as being one of the most important elements of the new educational system. This in relation to acquisition of useful skills and creativity necessary for Economic Development. Unfortunately there is lack of good course material, good teachers. A problem also is that many schools and pupils still have a conservative attitude towards technology education.

Furthermore 'Technology' courses as they exist under Industrial Education and other technical subjects need improvement to emphasize creativity, design and inventiveness rather than the undue concentration on technical skill development.

Another important factor that influences the successful implementation of the educational programme for technology is the counting in of large differences in 'entering behaviour' at the beginning of the technology lessons.

From small scale researches it already became evident that even pupils of the same cultural settings have different conceptions of technology. Also differences between girls and boys seem to be crucial.

Therefore the central question in this large scale research project is:

What is the entering behaviour of girls and boys as regard the concept of and attitude towards technology and how can one take this into account in the technology curriculum?

The specific contexts of pupils are the starting point of the research.
(2) Research design

Kind of research
The study will basically be a survey type, utilizing questionnaires, essays and interviews to determine the concept of and the attitude towards technology of primary and secondary school students. There will also be (structured) interviews to assess teachers’ attitude and concept towards technology.

The sample
(a) Factors/independent variables to take into account are:
(i) Age of pupils (13-18 years)
(ii) Sex (Male or Female)
(iii) School type (Low/Medium/High cost schools)
    Harambee
    Government maintained
    Private
(iv) Rural/Urban
(v) Eco-zones (Highlands, Coastal, Lowland, Semi-Arid)
(vi) Curriculum; Different school subjects preferences and students achievements (e.g. in science)
(vii) Teachers

(b) Sample size
Kenya has about 3,000 secondary schools and about 13,400 primary schools. A sufficient and manageable representative sample size will be: 1% of secondary schools (30 schools) and .25% of primary schools (30 schools). In each school of the sample only one class of 40-50 pupils would be considered. This would lead to a sample of 3,000 pupils. There will be a balance between the variables (see also appendix 1).

Instrument development
The instruments already in use, developed by the Eindhoven PATT-research group, will be scrutinized, then adopted for the Kenyan situation. The revision of the existing PATT-research instruments (see PATT-Report vol.1 and 2, pages 19 and 86, 1987) will be done with the information of:
- 50 interviews with pupils,
- interviews with experts (Bureau of Educational Research, Kenya Institute of Education).
The information of the 50 interviews will also be used to validate the categorizing system for the essay analyses.

After the revision the adopted questionnaire can be tested with a small sample group. This pilot group will be 10% of the final sample group: 3 primary and 3 secondary classes (total 300 surveys). The testing means that issues of validation and reliabilities will be taken into account. Adopting the interactive approach, the results of testing (including the essay analyses methods) will be incorporated into the final version to be used in the survey.

Also some questions for semi-structured interviews with teachers will be prepared.

**Administration and processing**

The study will be carried out with Form II (age 16/17) in the secondary school and standard 7 and 8 (age 13/14) at primary schools. The number of girls and boys will be made equal, and also the teachers mentioned above will be represented in the sample.

The teachers of the sample schools will be interviewed, and their students asked to fill in the questionnaires and also produce a written response about their concept of technology.

The administration of instruments will have to be done in person because it has always proved to be very difficult by post.

The results will be analysed by computer using SPSS-programmes. Multiple regression analyses will be the main technique to be used in the processing of the data.

**3) Time Frame**

The planning below is based on two persons with Master degree and one secretary with access to transport facilities.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature study</td>
<td>3</td>
</tr>
<tr>
<td>Revision of existing instruments</td>
<td>3</td>
</tr>
<tr>
<td>Testing new instruments and reporting of the results</td>
<td>6</td>
</tr>
<tr>
<td>Sampling of schools (making appointments selecting)</td>
<td>1</td>
</tr>
<tr>
<td>Administration of the questionnaires/essays/interviews</td>
<td>8</td>
</tr>
<tr>
<td>Processing of data</td>
<td>5</td>
</tr>
<tr>
<td>Report</td>
<td>4</td>
</tr>
</tbody>
</table>

The total time is 30 months, this is 2½ years.
(4) Intended outcomes

The outcomes will be:

1. After one year a report of the instrument development.
2. Two workshops a year for curriculum developers and for teacher trainers, to discuss the results in the light of promoting technology education.
3. A final report with clear recommendations for curriculum development and for teacher training in the field of technology education.
4. Articles in Scientific educational magazines.
5. Co-operation of ATC with the Eindhoven PATT-group.

During this project there will be a close co-operation between Appropriate Technology Centre and the Section of Physics Education (Eindhoven University of Technology).

The Eindhoven PATT-group (Prof.dr. J. Raat, drs. F. de Klerk Wolters, dr. M. de Vries) will advise on the methodological and management aspects of the research. As much as possible a similar methodological procedure will be followed as in other large scale PATT-researches.

For this reason each year there will be a visit during 8 days of one person from Nairobi in Eindhoven and of one person from Eindhoven to Nairobi.

Advise will incorporate issues in:
- the instrument development,
- the processing of the final data,
- the progress of the project.

During PATT-Conferences reports of this project will be presented and discussed. By this co-operation hopefully a link will be established between Appropriate Technology Centre and Eindhoven University for a longer period.

Final remarks

This research proposal has been written by Dr. Raphael J.A. Kapiyo (Appropriate Technology Centre Kenyatta University) and by Prof.dr. Jan H. Raat and drs. Falco de Klerk Wolters (Eindhoven University of Technology) in the period 20-27 October, 1987, during their visit at the Kenyatta University.
Appendix 1

Travel/Accommodation

Schools to be visited:

<table>
<thead>
<tr>
<th>ECO-ZONE</th>
<th>COMPOSITION</th>
<th>NO. OF SCHOOLS</th>
<th>TRAVELL/Accomodation</th>
</tr>
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<td>Nairobi</td>
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</tr>
<tr>
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<td>R/Valley Central</td>
<td></td>
<td>1 Nyeri (4 days) + 200 km.</td>
</tr>
<tr>
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<td>Eastern</td>
<td></td>
<td>1 Meru (4 days) + 200 km.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 x 100 kms. daily</td>
</tr>
<tr>
<td>Coastal</td>
<td>Mombasa (Kilifi)</td>
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<td>2 Mombasa (10 days) + 500 km.</td>
</tr>
<tr>
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<td>1 Kisumu (2 days) + 500 km.</td>
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<tr>
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<td></td>
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<td>1 Kakamega (5 days) + 500 km.</td>
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</tr>
<tr>
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<tr>
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<td>N/Western</td>
<td></td>
<td>1 Isiolo (2 days) + 200 km.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Kapenguria (2 days) + 200 km.</td>
</tr>
</tbody>
</table>

Total number of schools to be visited: 60 schools.
30 Primary and 30 Secondary schools.
The total number of kilometers for travelling is 15,000, this is 6,000 kilometers per year.
The total number of staying overnight is 50, this are 20 stayings overnight per year for 2 persons.
THE VALUATION IN MIDDLE SCHOOL: TECHNICAL EDUCATION ITALY

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Summary

While the planning of teaching-learning routes is, by now, a consolidated habit for the teacher of technical education, the construction of tests is something new. The contribution gives some explanations of how it is possible to carry them out, through appropriate questionnaires or tests, the first inquiry to check the starting levels, the formative valuation during the learning procedure, the final verification.

The problem of valuation, which through the report card has received an institutional recognition by the article 9 of the Act no. 517 of August 4, 1977, can and must be articulated in different moments that we shall examine later. In the Technical Education report card everything required to formulate a judgement helps a lot the formative value of the discipline itself.
THE VALUATION IN MIDDLE SCHOOL: TECHNICAL EDUCATION ITALY

Making and planning the testing
While the planning of teaching-learning routes is, by now, a consolidated habit for the teacher of technical education, the construction of tests is something new. The contribution gives some explanations of how it is possible to carry them out, through appropriate questionnaires or tests, the first inquiry to check the starting levels, the formative valuation during the learning procedure, the final verification.

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The four points of the report card
The first among the four points which have been proposed ("understanding of the technical language and the different methodologies") shows how the technical education, as well as all the other subjects of study, needs a specific language which must become familiar to the student.

The second point ("acquisition of knowledge also by observing and practising technological processes"), as the superficial factual knowledge tradition supported by a mnemonic and "bookish" learning has by now faded, shows how it is validly and constructively possible to reach a great number of knowledges through the study, observation, analytical consideration of productive systems.

The third point ("creative-operative skills in planning processes"), lets us understand the pupils' capabilities in solving questions through solutions concretely realizable.

The fourth point ("single and/or group realization capability") is about the analytical and verificational abilities of pupils, both working alone or in a team. An essential device to organize a planned valuation in Technical Education can be represented by setting taxonomies in order to identify the teaching aims and to offer several practical advantages as, for instance, orientate the teaching towards a planning and realization which becomes the sure and essential premiss and the key presupposition for the correct
definition/statement of the valuation question.

The three stages of the valuation: at the beginning, during the learning, at the end.
We shall practically discuss a formative valuation "in fieri", which can be reached through subsequent verifications in the sphere of pupils' acculturation procedure where there are elements (school, family teachers, students, etc.) and actions (verification moments).
It must be said that the valuation system can be, after all, an efficient element of self verification for the teacher that will be able, according to the results of the teaching process, to introduce the appropriate changes or corrections to his or her school teaching.
First of all we must valuate the starting levels, that is the pupil's starting situation at the moment he or she begins to attend the middle school for a term of three years: in this first planning phase it is necessary to consider how the elementary school attendance for a term of five years, the family presence, and the social-environmental conditions have influenced the pupil, besides his or her natural and driven faculties. Then, through the reception of stimulations, the acquisition of suitable information and the performances the pupil can obtain, we have the elaborative-creative-productive process which is the first answer verifiable with the planned aims.

![Diagram](attachment:image.png)
It is clear that the elements or better the protagonists in this phase are essentially the pupils.

The third fundamental phase consists of the operating presence of everybody who, each in his/her own field, contributes to the verification of the pre-established aims. It is always in this phase that, in case of negative results, we intervene through recovery actions. On the contrary, in case of a positive verification, we shall directly have a learning consolidation.

**Questionnaires and testing for the single didactical units verification**

The first inquiry, in order to check the starting levels, as well as the final valuation can be done through questionnaires and tests, formulated through a series of various items concerning one or more planned didactical units.

**Questionnaires:** they are formed by a series of questions formulated according to a strict logical-sequential order with closed answers and short (yes, no, I don't know), open questions and ampler answers and structured questions with answers led through the different solutions which were already clearly formulated.

**Testing:** the test develops through a series of items with unambiguous answers. The qualifying aspect of the test is due to lack of ambiguity and therefore to the objectivity in examining the given answers.

The various answers can be:

a. true/untrue: the choice between two solutions, one of them true and the other one untrue.

b. Completions: put the right terms in the pre-established gaps.

c. Correspondences: through the associative technique we must juxtapose the various terms, for example, of two lists of elements.

d. Multiple choices: the choice must be done among a certain number of proposals of which only one is correct while the others (disturbing elements) are not. The disturbing elements, must not only make the choice harder, but they are very good to emphasize and verify the difficulties and ambiguities associated with learning.

**Examples:**

a. true/untrue: the cotton is extracted from the seed nap.

- true
- untrue

b. Completions:

The cotton is the most important among .......... fibers.

It is a plant belonging to .......... family. The length of cotton
fibres is called .......... . The .......... are utilized together with linters of picking and of the manufacturing to produce cotton wadding and .......... .

c. Correspondences:
- linters
- keratin
- polymerization
- weft
- testurization
- sericin

<table>
<thead>
<tr>
<th>synthetic fibres</th>
<th>cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>silk</td>
<td>wool</td>
</tr>
<tr>
<td>warp</td>
<td>synthetic yarns</td>
</tr>
</tbody>
</table>

d. Multiple choices:
The cotton is a fibre extracted from:
- a plant stalk
- the seed nap
- leaves.

<table>
<thead>
<tr>
<th>pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>learning describers</td>
</tr>
<tr>
<td>He/she knows the origin and the characteristics of textile fibres.</td>
</tr>
<tr>
<td>He/she can tell the products of spinning basing himself/herself on the technical and marketable goods.</td>
</tr>
<tr>
<td>He/she shows he/she can distinguish and classify by handling materials.</td>
</tr>
<tr>
<td>He/she has understood and used proper technical words and language.</td>
</tr>
<tr>
<td>He/she knows the meaning of ...... and shows to have understood the essential things.</td>
</tr>
<tr>
<td>He/she can use the learned methodologies in new situations.</td>
</tr>
</tbody>
</table>
On the previous page you saw the Table of the learning degree valuation of a didactical unit ("acquisition of the concept of "number" as a paradigm that may be found in various technological areas")

Satisfactory +

Unsatisfactory -

The recovery activities and the class organization are planned on the basis of verification data, bearing in mind that all the pupils must be engaged and that each pupil must carry out activities concerning those pre-requisites not completely assimilated. There will be a moment called "precocious recovery" in the phase of pre-requisites and a recovery consolidation, when the teacher gives the recovery/consolidation activities, according to the indications obtained from the verification data.

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Fratini, T., Tiriticco M., La valutazione nella scuola dell'obbligo, Tecnodid, Napoli.
A STUDY OF THE RELATIONSHIP BETWEEN TEACHERS' ACTIVITIES IN COMPUTER EDUCATION LESSONS AND PUPILS' ATTITUDES TOWARD COMPUTERS

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Summary

A 206-item Checklist completed by 253 teachers was used to investigate classroom activities in the teaching of Computer Studies to pupils age 14-16 years. Cluster analysis was used to derive 19 Activity scales from the Checklist responses, each scale measured teachers' use of a particular group of classroom operations. An eight scale questionnaire assessing attitudes towards computers was answered by 1163 fifth-year pupils drawn from 102 classes. Only four Teacher Activities recorded two or more significant correlations with pupils' attitudes. Multiple regression analysis was used to investigate the composite relationships between teachers' use of the 19 Activities and pupils' attitudes. The average proportion of the attitude score variance predicted by the eight regression equations was 9%, it varied from 22% for the scale Threat to zero for both of the scales Career and Leisure. The discussion links the weak relationship between classroom activities and pupils' attitudes with teachers' lack of academic and teaching qualifications in Computer Studies. The implications of the findings for the wider introduction of Technology into the school curriculum and the training of the necessary teachers are indicated.
A STUDY OF THE RELATIONSHIP BETWEEN TEACHERS' ACTIVITIES IN COMPUTER EDUCATION LESSONS AND PUPILS' ATTITUDES TOWARD COMPUTERS

Introduction
Recent proposals on a National Curriculum for state schools in England and Wales make it likely that technology will become a compulsory subject for all pupils and that it will include a study of computers and their uses. Results of a recent study of the correlation between teachers' activities in Computer Studies (CS) lessons and pupils' attitudes toward computers may therefore be of interest to a wider group of technology teachers.

The research instruments
The study was based on a self-report questionnaire completed by Computer Studies teachers and an attitude questionnaire completed by their pupils. In research based on self-report instruments teachers are asked to complete a questionnaire or to write an account of their lesson immediately after its completion. Hook & Rosenshine (1979) in a review of the use of teacher self-reports found responses were affected by social and other pressures and concluded "one is not advised to accept teacher reports of specific behaviours as particularly accurate". Newfield (1980) found that the accuracy of teacher reports was markedly improved if the teacher responded to a list of 50-60 subject-specific items. The increased accuracy of composite measures agrees with an earlier finding by Shavelson & Dempsey-Atwood (1976).

The process of design and development of a self-report questionnaire and the choice of activities within it are determined by the purpose for which it is intended. When the purpose of the study is to obtain objective information about a new or relatively unresearched field (such as Technology Education) it is necessary to avoid imposing a classification that may restrict teachers' responses or bias findings.

Christal (1970) and Youngman (1982) have shown that it is practicable to analyse the content of industrial and teaching jobs without the use of pre-emptive classifications. The two main features of these studies were the instruments, large checklists of work operations, and the analytical
technique, cluster analysis to categorise first the operations and then the workers. Because checklist items are brief and capable of being read and answered quickly, a checklist can contain many more items than would be feasible in other forms of questionnaire or inventory. The feature of being able to use many items is particularly valuable when a wideranging subject is to be covered.

In the absence of knowledge of Computer Studies teaching, teachers themselves were used to supply the information needed to construct the checklist items. Twenty teachers of Computer Studies were individually recorded for 30-40 minutes talking about their work, their classroom activities and any other work arising from their Computer Studies responsibilities. A total of 1184 operations were identified and, after some grouping and rewording, were used to produce a Pilot Checklist of 361 items. Each item was a separate and identifiable teaching operation. Responses from 128 teachers were used to check the method of analysis and to refine the instrument to give a revised Teacher Checklist of 206 items. Each item required teachers to give the response "1" if they used the operation in the course of their Computer Studies teaching, the response "0" if the operation was not used.

**Samples and Analysis**

Copies of the Teacher Checklist were sent addressed to "The Teacher of Computer Studies" in 800 randomly chosen schools in England and Wales. Computer Studies is a two-year optional course taken, usually by more-able pupils, for examination at age 16+. According to data quoted by Wellington (1987) about 550 of these schools might be expected to teach Computer Studies. A total of 253 completed Checklists were returned.

Cluster analysis identified nineteen groups of teaching operations with similar response patterns. These groups of **Teaching Activities** contained from 5 to 15 teaching operations. For each Activity an Activity Score was calculated by summing the responses to the separate operations within the activity and dividing by the total number of operations within the activity. For each teacher 19 Activity Scores were calculated to show their classroom activity.
Of the teachers returning a completed Checklist, 102 also allowed one of their fifth-year classes to complete the Computers and Robots Attitude Questionnaire (CARAQ) (Moore, 1985). The CARAQ measures pupils' attitudes on the scales of Employ, Future, threat, Social, Career, Leisure and School. For the present study an additional scale Satisfaction was added to the questionnaire. Within each of the 102 classes, about half the pupils answered the CARAQ, the others answered scales not described here. The sample of 1163 pupils contained 32% of girls, close to the figure of 30% shown in national statistics for Computer Studies examination entries in 1984 and 1985.

Results
Analysis of the personal data supplied by the teachers showed that about one-quarter were female indicating that CS is not a wholly male preserve as is sometimes claimed. The median length of total teaching experience for the sample was about nine years whilst for Computer Studies teaching it was close to five years. These data suggest that many teachers began teaching CS after some years in another subject. Four-fifths of the sample also taught mathematics. Data on the academic and teacher training qualifications of the sample showed that the majority of teachers were neither qualified nor trained in CS, only 13% had a degree or equivalent qualification in computing and only 20% had formal teacher training in this subject. This level of teacher expertise contrasts with other secondary school subjects such as science in which the majority of teachers have both a degree and specialist training.

A description of the 19 Activity Scales and statistics on Teachers' Activity Scores are given in Table 1. The mean scores cover the range 251/1000 (Activity 10, Use of Computer hardware) to 806/1000 (Activity 7, Use of non-computer AV-aids), they are all close to the scale mean suggesting the 19 scales have sufficient range to discriminate between the preferences of different teachers. The Cronbach alpha reliability values are moderately high for scales of about 10 items each thus confirming the usefulness of composite measures of behaviour. A simple varimax-rotation factor analysis which yielded two orthogonal factors accounting for 75.4% and 19.3% of the Activity Score variance was interpreted as showing the 19 scales probably measure a single construct.
<table>
<thead>
<tr>
<th>Scale No.</th>
<th>Activity-scale description (based on item content)</th>
<th>N of items</th>
<th>Mean /100</th>
<th>Alpha Rel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>General teaching via books and pupil programming on micros.</td>
<td>11</td>
<td>608</td>
<td>0.552</td>
</tr>
<tr>
<td>2.</td>
<td>General teaching via tests, making notes from books, and use of videos.</td>
<td>13</td>
<td>508</td>
<td>0.742</td>
</tr>
<tr>
<td>3.</td>
<td>Differentiation of pupil work via individual exercises, materials.</td>
<td>11</td>
<td>650</td>
<td>0.718</td>
</tr>
<tr>
<td>4.</td>
<td>Teacher interest in pupils' career &amp; leisure interests during &amp; after lessons.</td>
<td>9</td>
<td>713</td>
<td>0.696</td>
</tr>
<tr>
<td>5.</td>
<td>Use of pupil-centred &amp; pupil-directed study exercises.</td>
<td>9</td>
<td>628</td>
<td>0.689</td>
</tr>
<tr>
<td>6.</td>
<td>Use of new teaching ideas from other teachers, courses, journals.</td>
<td>10</td>
<td>778</td>
<td>0.753</td>
</tr>
<tr>
<td>7.</td>
<td>Use of wallcharts, TV and videos, other non-computer audio-visual aids.</td>
<td>10</td>
<td>806</td>
<td>0.676</td>
</tr>
<tr>
<td>8.</td>
<td>Concern for and use of microcomputer network, wordprocessors.</td>
<td>11</td>
<td>664</td>
<td>0.739</td>
</tr>
<tr>
<td>9.</td>
<td>Microelectronics; demonstration and pupil use, course attendance.</td>
<td>10</td>
<td>292</td>
<td>0.842</td>
</tr>
<tr>
<td>10.</td>
<td>Use of computer hardware and other peripherals for teaching.</td>
<td>15</td>
<td>251</td>
<td>0.697</td>
</tr>
<tr>
<td>11.</td>
<td>Use of worksheet-based exercises, routine keyboard exercises.</td>
<td>12</td>
<td>299</td>
<td>0.662</td>
</tr>
<tr>
<td>12.</td>
<td>Pupils talk to class, demonstrate programs etc., provide resources.</td>
<td>11</td>
<td>325</td>
<td>0.751</td>
</tr>
<tr>
<td>13.</td>
<td>Pupils encouraged to find out about computers through personal contacts.</td>
<td>11</td>
<td>396</td>
<td>0.735</td>
</tr>
<tr>
<td>14.</td>
<td>Teacher concern for provision of hardware resources and up-to-date information.</td>
<td>14</td>
<td>554</td>
<td>0.724</td>
</tr>
<tr>
<td>15.</td>
<td>Teacher demonstration and pupil-use of software packages.</td>
<td>10</td>
<td>555</td>
<td>0.798</td>
</tr>
<tr>
<td>16.</td>
<td>Teacher involvement with computer-based school administration.</td>
<td>5</td>
<td>520</td>
<td>0.803</td>
</tr>
<tr>
<td>17.</td>
<td>Use of micro for data handling, use of commercial packages.</td>
<td>10</td>
<td>397</td>
<td>0.725</td>
</tr>
<tr>
<td>18.</td>
<td>Concern for computing as an academic study, courses for other staff.</td>
<td>7</td>
<td>441</td>
<td>0.614</td>
</tr>
<tr>
<td>19.</td>
<td>Use of simulation materials, demonstration of LOGO, CAD, teletext, etc.</td>
<td>7</td>
<td>389</td>
<td>0.757</td>
</tr>
</tbody>
</table>

Table 1. Description of the 19 Activities derived from the checklist responses with statistics of the Activity-scale scores.
Table 2. Summary statistics of respondents to the Computers and Robots Attitude Questionnaire.

<table>
<thead>
<tr>
<th>Scale Name</th>
<th>N of items</th>
<th>Scale-range</th>
<th>Mean</th>
<th>SD</th>
<th>Alpha rel.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>22.66</td>
<td>6.32</td>
</tr>
<tr>
<td>Employ</td>
<td>11</td>
<td>11</td>
<td>55</td>
<td>32.56</td>
<td>7.91</td>
</tr>
<tr>
<td>Threat</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>28.63</td>
<td>7.54</td>
</tr>
<tr>
<td>Future</td>
<td>9</td>
<td>9</td>
<td>45</td>
<td>24.42</td>
<td>5.71</td>
</tr>
<tr>
<td>Social</td>
<td>11</td>
<td>11</td>
<td>55</td>
<td>31.80</td>
<td>7.11</td>
</tr>
<tr>
<td>Career</td>
<td>7</td>
<td>7</td>
<td>35</td>
<td>20.04</td>
<td>6.98</td>
</tr>
<tr>
<td>Leisure</td>
<td>7</td>
<td>7</td>
<td>35</td>
<td>19.73</td>
<td>6.89</td>
</tr>
<tr>
<td>School</td>
<td>9</td>
<td>9</td>
<td>45</td>
<td>19.63</td>
<td>5.74</td>
</tr>
</tbody>
</table>

Based on responses of 1163 students.

Statistics summarising the pupils' responses to the eight attitude scales are given in Table 2. The values for the internal reliabilities of the scales confirm they are suitable for group work whilst the mean inter-scale correlations are low enough to show the scales probably measure distinct though related attitude dimensions. Analyses not detailed here indicated the scales distinguished amongst pupils according to gender, experience of using a home-computer and the number of science and technology subjects being studied.

Multiple regression analysis was used to study the relationship between teachers' activity scores (the predictor variables) and the class means of pupils' attitude scale scores (the criterion variables). A separate regression equation was calculated for each attitude dimension, the significance level for the inclusion of the Activity variables in each equation was set at 0.05.

Regression analysis results given in Table 3 show that only 14 of the possible 152 activity-attitude correlations reached the 0.05 level of significance. Ten of the Teacher Activity Scales had no significant correlation with any attitude dimension. In the table underlining is used to indicate the Activity variables included in the regression equation for each attitude variable. A positive correlation indicates that an increase in the Teacher Activity is associated with more favourable pupil attitudes on the
The table shows that seven Teacher Activities are included in none of the regression equations and that a further eight Activities are used in the equation of a single attitude only. The four Activities having most effect

Table 3. Correlations between pupils' attitudes towards computers and teachers' Activity-scale scores.

<table>
<thead>
<tr>
<th>Teachers' Activity scales</th>
<th>Pupils' Attitudes to computers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satis.</td>
</tr>
<tr>
<td>01 Gen. Tch.; books</td>
<td>-106</td>
</tr>
<tr>
<td>02 Gen. Tch.; notes</td>
<td>-011</td>
</tr>
<tr>
<td>03 Diffn of work</td>
<td>-004</td>
</tr>
<tr>
<td>04 Interest in C/L</td>
<td>131</td>
</tr>
<tr>
<td>05 St.controlled exs</td>
<td>044</td>
</tr>
<tr>
<td>06 Ideas from other T</td>
<td>110</td>
</tr>
<tr>
<td>07 Non-comp AV aids</td>
<td>-001</td>
</tr>
<tr>
<td>08 Use micro, networks</td>
<td>140</td>
</tr>
<tr>
<td>09 Microelectronics</td>
<td>* 212</td>
</tr>
<tr>
<td>10 Computer hardware</td>
<td>124</td>
</tr>
<tr>
<td>11 Worksheet exs</td>
<td>-111</td>
</tr>
<tr>
<td>12 Student involvment</td>
<td>118</td>
</tr>
<tr>
<td>13 Student contacts</td>
<td>015</td>
</tr>
<tr>
<td>14 T resource concern</td>
<td>159</td>
</tr>
<tr>
<td>15 Use of CAL packages</td>
<td>* 171</td>
</tr>
<tr>
<td>16 T. does sch. adm.</td>
<td>* 196</td>
</tr>
<tr>
<td>17 Use of dp packages</td>
<td>128</td>
</tr>
<tr>
<td>18 INSET, help other T</td>
<td>* 214</td>
</tr>
<tr>
<td>19 LOGO, CAD, teletext</td>
<td>048</td>
</tr>
</tbody>
</table>

R² regres. equation % 10 15 16 22 7 zero zero 4
Multiple correlation 315 392 400 465 270 000 000 000 205
F-value of regres. eq. 016 006 <001 <001 024 --- --- 040

Notes: Decimal points omitted.
* significant at p = 0.05, ** p = 0.01.
Variables retained in the regression equation are underlined.
Variables are: SATISFACTION, EMPLOY, THREAT, FUTURE, SOCIAL CAREER, LEISURE and SCHOOL.
on pupils' attitudes are: Teacher interest in pupils' career and leisure (Act. 4), Use of pupil-directed exercises (Act. 5), Use of microelectronics modules etc. (Act. 9) and Teacher concern for provision of resources (Act. 14). The first two of these are concerned with teacher-pupil relationships, the others with resources. The table shows that a higher level of pupil self-direction is associated with a lower level of attitude on three scales.

The $R^2$ values show the regression equations account for 10% or less of the score variance on five of the eight attitudes. The average value of $R^2$ on all scales is 9%, indicating that teachers' classroom activities have only a small effect on pupils' attitudes. On the scales of Career and Leisure the $R^2$ value is zero showing pupils' attitudes on these dimensions are wholly unaffected by teachers' classroom activities as measured by the 19 Activity scales.

Discussion
It may come as a surprise and as a disappointment to Computer Studies teachers to find that their classroom behaviours have only a slight effect on pupils' attitudes toward computers and their uses. It may be particularly surprising to learn that although Computer Studies as a subject appears to have strong vocational links, lesson activities are not linked to pupils' views of a computer-based career. This result suggests that some changes in lesson content or teaching methods in Computer Studies may be needed to maintain an adequate flow of young people into computer related jobs and professions.

Results of the study are relevant to Technology Research and studies of the teaching of Technology such as will be described at the PATT-3 conference. The study has shown that by adopting a checklist approach it is possible to derive a reliable and easy to use instrument for the measurement of classroom processes. In contrast to observational methods, the use of a checklist avoids the need to make a priori assumptions about the subject and significant classroom interactions.

One explanation for the absence of a strong classroom effect on pupils' attitudes may be linked to the low level of teacher qualifications and training. If confirmed, this finding could have important implications for the
wider introduction of Technology into the school curriculum and the involvement of teachers whose expertise lies in other subjects. The study suggests these teachers will need additional training and that this should give particular attention to the use of technical resources and teacher-pupil interactions. Further research is needed to identify and later evaluate additional changes in teacher training that may lead to the desired improvement in pupils' attitudes. Associated studies might also determine how pupils' attitudes in other subjects linked to technology are related to classroom activities.

References


PHYSICS AND TECHNOLOGY IN STUDENTS' OPINION

A. Saar, J. Hendre
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Summary

Since 1983 a research group "Applied Physics in the Students' Life Activity System" in the Department of Physics at our institute has been studying students' attitudes towards learning activity, especially towards physics and technology. The questionnaire was carried out during the school years of 1975/76, 1978/79, 1984/85. On the latter occasion 1870 students, 1084 girls and 796 boys took part in it, from 9 to 11, i.e. 14 to 17 years of age, from all the regions of the ESSR. The report will show some of the most essential results of the questionnaire. Similarly to many countries science is loosing its reputation at our schools. A great percentage of students disliking physics as a subject was revealed, rising in 10 years from 15.1 to 25.5 per cent. A more detailed analysis showed that girls constituted the majority of those disliking physics. Technological news is of no interest to 3.3 per cent of boys and 43.4 per cent of girls. 56.7 per cent of boys wish to connect their future job and speciality definitely with technology.
PHYSICS AND TECHNOLOGY IN STUDENTS' OPINION

The scientific and technological progress has been so rapid over the last few decades and has involved most of the spheres of surrounding life to such an extent that it is impossible to ignore its influence on the student's learning activity any more. On the other hand pedagogical research has entered such a phase that it is possible to consciously consider the influence of the student's environment on him. In order to consciously direct the interaction of personality and environment it is necessary to know them. We must be able to describe the student's life activity system. From 1975 to 1985 a questionnaire containing about 540 questions was carried out during 3 different school years in order to establish all possible activities and students' attitude to different fields of life and culture. The present report will show some of the most essential results involving the position of physics and technology in the students' assessment (in case no comparative data have been given, the results reflect the last year of questioning) [1].

What is the students' attitude to learning physics?
In the questionnaire the students had to name the school subjects 1) they like, 2) they study more than required in the curriculum, 3) they dislike. A great percentage of students disliking physics as a subject was revealed, rising in ten years from 15.1 to 25.5 per cent. A more detailed analysis showed that girls constituted the majority of those disliking physics. Thus in Tallinn the disinclination to study physics can be traced among 11.7 per cent of boys and 41.4 per cent of girls. In smaller towns the figures are smaller, 8.9 and 29 per cent respectively. From the point of view of unpopularity physics (25.5) is followed by chemistry and mathematics in Estonian schools, 13.4 and 12.2 per cent respectively. The number of these students who like physics was small and dropped in 10 years from 6.4 to 3.9 per cent. Similarly the decade showed a decrease in the number of those students who on their own studied physics out of class, namely from 6.0 to 4.1 per cent. The data have been confirmed by the Ministry of Education of the ESSR. It should be pointed out that during the entrance exams to universities students try to avoid physics exams when choosing a speciality.

The answer to the question "Are there any subjects where you do not do your homework?" showed that the homework in physics is always done by
15.7 per cent, whereas girls and country school students are more diligent. The analysis of the interrelations of teachers and students reveal that, all the subjects included, the relations with teachers are considered good by 56.9 per cent of students and only 2.0 per cent regarded them bad. On this background the students' relations with teachers of physics are the worst: 37.9 per cent declare them to be good, 53.7 per cent of students claim them to be middling and 8.2 per cent of them consider them bad. Compared to the other teachers, the indices are the worst but not markedly, compared to chemistry (44.6; 48.6; 6.4 per cent) and mathematics (45.7; 47.1; 6.8 per cent) teachers. It should also be noted that in the school year 1978/79 the relations with physics were good with 55.1, middling with 36.8 and bad with 7.6 per cent.

17.2 per cent of students claim themselves to be highly capable, 70.6 per cent average and 11.3 per cent say that they have no abilities for sciences. Here the expected difference between boys and girls attracts attention. For example in Tallinn 30.2 per cent of boys and 9.6 per cent of girls regard themselves highly capable of studying sciences. In country schools the difference is smaller, 16.1 and 11.5 per cent respectively. Most of country schools students consider their abilities average for sciences (75.9 per cent of boys and 78.4 per cent of girls). The corresponding indices for the humanities are considerably higher.

Physics is the scientific basis for technology. Therefore physics taught at school will have a decisive role in achieving polytechnical education. Knowledge of physics, practical skills and experience gained by students are mostly polytechnical by nature. But still the main point in the realisation of the polytechnical principle, as stressed in the theory of polytechnical instruction is the connection between teaching and practice. During studying this is mainly expressed in the field of technology. Therefore the students' attitude to problems of technology is of interest.

The answer to the question "Are you quick-witted in technology?" revealed that 18.8 per cent of students regard themselves over the average, 52.3 per cent think that they are average and 28.6 per cent consider themselves below the average. As expected, boys and girls assess themselves differently. 34.2 per cent of boys and 3.4 per cent of girls claim to be gright in technology whereas 10.3 per cent of boys and 45.7 per cent of girls say that their understanding of technology is below the average. The number of those boys and girls who consider it average is almost equal
(53.7 per cent of boys and 50.9 per cent of girls). Accordingly the number of boys bright in technology is ten times bigger than that of the girls. Technological brightness is closely connected with a desire to make something with one's own hands, apply one's knowledge and brightness in practice. It is obvious that mostly boys practise technology. The results of the questionnaire show that technology is practised:
1) often, by 41.4 per cent of boys and 1.9 per cent of girls,
2) sometimes, by 42.9 and 17.1 per cent respectively,
3) never, by 14.9 and 79.5 per cent respectively.

Boys living in the country show more interest in it than town boys (the difference is 6 per cent). The former mostly go in for it at weekends, when the town boys' interest in it drops considerably compared to the ordinary school days. The girls' practical involvement in technology seems mostly to be connected with the needs to repair household gadgets or the ability to drive a car or a motorbike.

The questionnaire contained the question "To what extent are you interested in and try to be informed (i.e. read periodicals, listen to the radio, watch TV, etc.) of the following spheres: 1) technological news, 2) achievements of exact and natural sciences?". It appeared that technological news is of no interest to 3.3 per cent of boys and 43.4 per cent of girls, 13.5 per cent of boys and 37.5 per cent of girls take an occasional interest in them, 29.6 per cent of boys and 11.9 per cent of girls try to be informed of the basic problems and 53.0 per cent of boys and 3.0 per cent of girls claim to be deeply interested.

The interest in exact and natural sciences is not so very much different among boys and girls, but with boys the interest is much smaller than in technology, 16.5 and 53.0 per cent respectively.

The boys' interest in technology is confirmed by the great number of readers of the magazine "Technology and Production" among them.

The analysis of the data obtained shows that 56.7 per cent of boys wish to connect their future job and speciality definitely with technology. Only 12.5 per cent of them don't think it important. Of girls only 2.7 per cent think of their future profession in terms of technology. It is interesting to note that country girls do it more often (4.4 per cent).

Judging by all the facts brought above it can be concluded that physics as a basis for technology plays an important part in the students' life activity system, but as a subject its reputation is falling among secondary school
students and is disliked by every fourth student. There is a great number of methods (contemporary teaching materials, the unexpectedness of laws and conclusions, interesting experiments, etc.) to secure the interest in physics but the interest aroused is very quick to disappear. In order to grant a more stable interest, a lasting positive motivation towards the learning materials should be created.

Relying on the boys' interest in technology that surpasses their interest in physics tenfold, it can be stated that problems of technology and applied physics may become a source of positive motivation in getting acquainted with the problems of theoretical physics.

Attention should also be paid to a valuable resource in granting students' interests. This is adequate goal setting in teaching. In the schoolyear of 1985/86 a school experiment in goal setting in teaching mechanics within the range of the eighth form physics was carried out in Estonian schools [2].

Generalizing the results of the experiment, it can be said that all (or almost all) the students acquire the learning material better when the goals are known exactly: there are goals to attain the minimum level of knowledge, these goals are well presented by the teacher and their attainment is granted by the organizing work of the teacher. The goals were set on the basis of Blooms's taxonomy. The experiment showed that besides the direct rise in the effectiveness of teaching the adequate goal setting makes it possible to investigate the correspondence of the school programme to the students' possibilities.

References

A test has been developed to identify the potentiality for scientific creativity among 14/15-year-old students. This test, with slight modifications, can also be used for selecting students with a technological bent of mind. The test is measuring scientific creativity and not creativity in general. While framing the following decisions were taken:

1. The items should be of open-ended type, capable of producing more than one category of correct responses including one or more novel response/responses.

2. The content of each item should be based around 4 selected abilities of 'observing minutely', 'analyzing', 'imagination' and 'transformation'. The choice of these four abilities for providing content to items was governed by the fact that these are not only involved in one way or the other in the scientific process but are also operational among youngsters.

3. Only these items should be subjected to item-analysis for final selection which are capable of eliciting not less than 4 categories of responses.

4. Items possessing either low difficulty value or of low discriminative value should be considered unfit for inclusion in the final form of the test.

5. The response to an item may be examined in terms of two abilities of 'flexibility' and 'novelty' only.

Based on the above considerations, only 29 items were retained to constitute the final form of the test.
SCIENTIFIC CREATIVITY TEST

Need for the Test
The technological developments of the present age are throwing new socio-economic challenges all over the world. Only the nations endowed with creative talents are able to meet these challenges but the other ones are finding this struggle quite hard to cope with. Scientific creativity has, therefore, acquired a crucial role in the life of all the nations. As such, the need for early identification of scientifically creative youngsters and their proper nurture has become a matter of significance for every nation from the point of view of their survival.

In view of the above, the need for a creativity test can hardly be over-emphasized. No doubt, a few creativity tests have already been developed. These tests can be grouped under three major categories: Guildford-tests, Torrance-tests and Wallach-Kogans' tests. In fact, the latter two are the modification or extension of the first one but none is a specifically scientific creativity test. Moreover, there exists a great deal of controversy regarding the efficacy of these tests. Guildford's and Torrance's tests are said to suffer from the defects of weaker correlation among their own different sub-tests in comparison to the correlation between the creativity tests concerned and IQ test and therefore, appear to be slightly different from IQ tests.

Though Wallach and Kogan claim their tests to be free from the shortcomings of Guildford's and Torrance's tests due to difference in administration-procedure (provision of playful atmosphere and liberal time to the subjects), Guildford has adversely commented on them. According to him, the use of liberal time by the subject is likely to affect the character of the test and the variable that it measures. With respect to the playful atmosphere, he is of the opinion that a test is a test even when it is called a game. Further, the relaxation expected to be experienced by the child in a game like situation is largely counter-acted by the conditions of individual testing with the tester present and taking notes. He further argues that due to unrestricted time available to the subjects, Wallach-Kogan's test-scores should correlate higher with IQ-scores than do customary DP test-scores but it does not happen. Thus, it is an indirect evidence against the conclusion that Wallach-Kogan's tests measure anything creative.
The reasons of weakness of these creativity tests are perhaps an inappropriate criterion, poor selection of abilities to be tested or low reliabilities of criteria or of tests or of both.
Under the background, the author embarked upon the construction of a suitable test for the identification of potentiality for scientific creativity among 14/15-year-old students on the eve of completion of their general education course.

**Important Features of the Present Test**

There is a general belief that differentiating scientific creativity from general creativity is not needed. However, this belief is not shared by some researchers, according to whom, scientific creativity has some specialities of its own which are different from the creativity in other areas. It is strongly believed that the distinguishing characteristic of science is to relate the facts of investigation and to wave them into a comprehensible whole. It is a unique attribute of science and is generally not applicable to other areas of activities.

The present author is also of the opinion that scientific creativity is different from creativity in other areas. As an example, for a poet to be creative, he must be highly imaginative. The abundance of fantasy is the prime requisite for him. So is the case with an artist. On the contrary, more imagination and fantasy alone will not be of much help to a creative scientist. To achieve something novel, creative out of his imagination, speculation or guess, he must be capable of observing minutely analysing, imagination and transformation, elaboration, generalising etc. However, while selecting abilities, their being operational among students must be ensured.

From the above discussion, it becomes obvious that while developing a tool for measuring scientific creativity, the process involved in a scientific enquiry must be properly dovetailed to the factors identified to be clearly linked with creativity. Keeping in mind the above considerations, the following decisions were made to be followed while framing the items for the test:

1. The items should be of the open-ended type, capable of producing more than one category of correct responses including one or more novel response/responses.
2. The content of each item should be based around 4 selected abilities of 'observing minutely', 'analysing', 'imagination' and 'transformation'. The
choice of these four abilities for providing content to items was governed by the fact that these are not only involved in one way or the other in the scientific process but are also operational among youngsters.  

3. Only these items should be subjected to item-analysis for final selection which are capable of eliciting not less than 4 categories of responses.  

4. Items possessing either low difficulty value or of low discriminative value should be considered unfit for inclusion in the final form of the test.  

5. The responses to an item may be examined in terms of two abilities of 'flexibility' and 'novelty' only. Based on the above consideration, only 29 items were retained to constitute the final form of the test.

Reliability

The present test being a 'power' test, its reliability was determined by employing the following three methods:  

1. Test-retest method  
2. Split-half method  
3. KR$_{20}$ method.  

The reliability coefficients obtained by the above three methods were found to be above 0.85 in each case.

Validity

In order to determine the validity of this test, the product moment coefficient of correlation was computed between the scores of 100 students on this test and their average scores of two consecutive school examinations in all the science subjects taken together.  

The value obtained was 0.61.

Norms

The percentile norms and T-score norms considered to be the most appropriate for the present test were computed on the raw-scores of 1082 students studying in different types of schools (Government, Private, urban, rural).

Conclusion

From the preceding discussion, one can easily discern that maximum care has been taken to make the scientific creativity test a highly reliable and valid instrument for the identification of the scientifically creative students.
of secondary stage of general education. This test can also be fruitfully employed for the selection of students for science streams. Being an aptitude test, with slight modification, this test can also be adopted for selecting students with a technological bent of mind.
SUMMARY OF THE SECOND THEME: PATT-RESEARCH, RELATED RESEARCH AND ITS RELEVANCE

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Introduction
The original purpose of this presentation was to summarise group discussions on the papers presented under this theme. Because of the interest of participants and the order of paper presentations there was relatively little discussion of some papers in this theme. For this reason the presentation has been widened to include three headings. First, a consideration of the written comments summarising the groups discussions. Next, a reminder of some of the results in the papers presented in this Theme, and, finally, some personal views about the possible future development of research studies.

It is useful to remember Dr. Deijsselberg's representation of technology as an elephant. He gave us a picture of isolated groups of researchers working on different parts of the animal and arriving at different conclusions. Part of the researchers' task is to reconcile the measurements and impressions of different groups. In this task they may be helped by a knowledge of the methodology and results of studies made on other "animals" i.e. in other curriculum areas. This is one reason why we must pay attention to attitude measurement and related studies in science, mathematics and so on.

Comments from the Discussion Groups
One group felt it was self-evident that teachers have an effect on pupils. They were not able, however, to go on to say whether all teachers have the same effects on all pupils. The discussion comments of this group showed they accepted the need for further research to reveal the classroom activities, the teacher training and the curriculum contents that have the desired affects on pupils' learning.

Several groups questioned whether "computers" and "computer technology" were a part of Technology as understood at this conference. Possibly the
"elephant" analogy can be used to help us avoid time wasting arguments about meanings and definitions. Even if "computer technology" is a separate subject, its classroom interactions with pupils and teachers are likely to be so similar to those in Technology that results obtained in that field may be used as indicators for PATT-related research.

The importance of teacher expertise was raised in some groups. Participants questioned the need for teachers to be "experts". "Was it necessary", some groups asked, "for teachers to be experts even at the lower levels of technical of general education?". This and similar questions were raised before the presentation of Professor Harrison. He appeared to stress the importance of teachers having a skill in at least one area of their technology teaching. Participants in the groups mentioned may have different views after listening to Professor Harrison. The present speaker knows that one way of making teachers confident of their computer skills is to get the teachers to use the computer for some purpose. The nature of the use is unimportant, it can be wordprocessing, a personal diary, or anything. If the teacher is a user of the computer he or she has the confidence to approach others as an equal, they feel they have "joined the club" as computer users. Support for this view came from one Discussion Group who doubted that teachers could teach (effectively) about Technology that they themselves did not use or take part in.

The need for active teacher involvement with the technology they are teaching was made many times in the account of the training of teachers for Primary School Technology given by the team from Devon, England. After that presentation none of us can doubt the high-level of the expertise of the Devon teachers who attended the course even if their subject matter would not be found in the vocational school curriculum.

On the subject of attitudes, the Discussion Groups raised questions about the importance of attitudes to the learning of Technology, the influence of teachers on pupils' attitudes, and some issues of the different attitudes of boys and girls toward different parts of Technology. The variability of results were mentioned with the results from Poland being quoted as an example. (These showed that boys and girls had the same attitudes on three of the six scales and markedly different values on the other three scales.)
Two groups made mention of social and other variables they thought might influence pupils' attitudes to Technology and that had not yet been thoroughly investigated. Although these questions were raised, the reports give no indication that answers were found. Perhaps all Groups would have agreed that there is a need for further research and I shall offer some comments on this in the final part of this talk.

Some comments on the papers presented in this theme.
The team from Poland led by Professor Szydlowski reported on a carefully planned and executed multi-part study. Their samples covered a range of ages and school types, both questionnaires and essays were used. Their findings confirmed results reported at PATT-2 and are generally similar to those in other countries. In addition to gender differences on the CAREER, INTEREST, and SCHOOL scales, the results for Polish students show significant differences between the attitudes of pupils on different courses of study. On some items students following a less-technical or less-scientific course gave more favourable responses, on other items the opposite effect was found.

Professor Balogun presented results gathered personally from pupils samples in five states of Nigeria. Two features of his study merit comment. In the essay answers, his respondents included many references to the importance of Technology for "human life". The other feature of the study was the low reliability of the scales as measured from the responses. The reason for this is not known, Professor Balogun has said he thinks it is unlikely to be a fault of the questionnaire administration.

Falco de Klerk Wolters makes the valuable and often overlooked point that one set of results does not permit us to make general statements about pupils' attitudes. Whether the results are "high" or low" depends as much on the items as on the pupils' attitudes. Information is gained from comparative studies of gender or course groups, the effects of teaching, age and so on. He goes on to report the use of a relatively new statistical technique which (unlike simple correlation) can give the direction of a relationship between variables. It has been shown that in Falco's samples, students' cognitive knowledge of Technology concepts had a strong effect on their attitudes whilst their attitudes had only a weak effect on their knowledge.
A personal view of possible future research

I begin by showing a model that may prove useful to guide future attitude research in Technology Education. The model was first proposed by Haladyna et al. (1983) for studies of pupils' attitudes toward science.

A feature of the model is the distinction made between exogenous variables (those outside or not under the control of the school) and endogenous variables which can be manipulated to promote favourable outcomes. In the model shown here Outcomes includes both cognitive and attitude effects. Dr. Rennie introduced us to a version of this same model in her presentation.

I think we shall need to make more use of models of pupil-teacher-curriculum interactions in future research studies. Use of a model such as that shown here makes clear the multi-variable relationships that help to determine pupils' attitudes and other learning. The model helps us to understand the need for careful control of variables when making intergroup
comparisons. It is, for example, necessary to control both exogenous and endogenous variables when studying the effects of different curricula in vocational and non-vocational schools.

I have delayed until this point mention of Dr. Deijsselberg's work on the development of the TAS questionnaire. Briefly this questionnaire permits classteachers to carry out small-scale studies and thus to determine for themselves the effects of alternative teaching methods and materials. This instrument supported by a simple to use statistics package for the school microcomputer offers many possibilities for the development of curriculum materials and investigations of classroom activities and teacher training. Through the use of TAS it may become possible to associate particular teaching materials, experiences or learning to specific parts of pupils' attitudes. This knowledge would enable us to design and teach courses that would meet the needs of identified groups of pupils, e.g. older girls, pupils from "non-technological" backgrounds. As an additional benefit, involving teachers in research in their own classrooms may prove to be an effective in-service training exercise.

The small size of samples available to individual teachers should not be a great problem. Effects that are important educationally are likely to be detectable at the class-level. One job of the central PATT group may be to undertake meta-analysyses of the small-scale studies.

My third suggestion concerns the study of the direction of the relationships between attitudes and other variables. I suggest that establishing the causal direction between variables should be incorporated within the aims of future PATT-linked research programmes.

Finally, a comment about the context of PATT-research. At this Conference-Workshop there have been pleas for and attempts to provide a definition of Technology that will be acceptable to, and adopted by, everyone. I wonder whether this universal definition is necessary. Perhaps it will be a sign that Technology has come of age when the search for a single, simple and all-embracing definition is abandoned. If we look outside our own subject, we do not see scientists talking about the meaning of science and the nature of science as a discipline. Instead, scientists accept
their considerable differences and get on with their work within a paradigm that describes rather than prescribes. Let us agree that despite differences of content, level and approach we are all technologists. Even if we cannot give a simple explanation of our subject, we share common interests and concerns about which we can and should communicate.

I hope we shall be doing that at PATT 4 next year.
HOW TO MAKE TECHNOLOGY ATTRACTIVE FOR GIRLS
HOW CAN WE MAKE TECHNOLOGY INTERESTING FOR GIRLS?

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Summary

It is important that pupils learn about technology in school. Machines are increasingly taking the place of manual workers and manufactured materials are replacing natural fibres and building materials. Technological advances in transport and communication mean people, products and information move quickly. All of these changes mean that people need to understand more about technology and how it affects their lives. They need to know about the positive effects and the limitations of technology. Perhaps most of all, people must recognise that technology is a component of every occupation. People who close their minds to technology, may find they are closing the doors to job opportunities. Women and men both deal with technological products everyday of their life, but there seems to be a belief that the designing, using and maintaining of these products is more appropriate for men than for women. Research in the PATT project, other projects in Europe and in other parts of the world, consistently report that girls are less interested in technology than boys. If girls have an inadequate technological education they may be inadequately prepared for a career and to make their best contribution in adult life.

This address will consider the reasons why there is unequal interest and participation of girls and boys in technology education. Ways of overcoming this unbalance will be suggested, so that there will be a more equal participation of boys and girls in technology.
HOW CAN WE MAKE TECHNOLOGY INTERESTING FOR GIRLS?

Before we can propose an answer to the question which forms the title of this address, we need to answer another question. Why do we want to make technology interesting for girls? I think that the answer must be based on the assumption that if girls are more interested in technology they will become more involved and successful in technology education at school, and, as a consequence, become more informed about technology in their lives and more likely to consider a vocation which is associated with technology. The reasons why these attitudes and skills about technology are important have already been discussed in this, and previous PATT Conferences, so I will refer to them only briefly here.

Pupils should learn about technology for at least four reasons. First, pupils need to become informed consumers, and thus safe users of technological products and processes. Informed consumers have skills to enable the evaluation, selection and maintenance of products to suit their needs, and they will not feel threatened by the increasing pace of change and bewildering array of new products. Second, technology education assists in understanding our world. Because technology is a human activity, it intervenes in all aspects of society, in industry, construction, agriculture, medicine and communication, for example. Because technological applications are linked to all of the sciences in one way or another, technology education can emphasise and give relevance to scientific knowledge. In fact the divorcing of technology from science in schools has been blamed, in part for the swing away from science (Yager, 1984). Not the least important link between technology, science and society concerns the ways in which we manipulate our environment and our understanding of the limits which must be observed. Third, because the practice of technology is a problem-solving process (designing, building, testing, modifying products and processes) with many possible solutions, the opportunity exists for anyone to make a contribution to better technology. Even if they don't make a contribution, pupils learn to be independent and find ways of solving their own practical problems. Fourth, technology education can open pupils' minds to a wider range of career and vocational opportunities. All professions involve technology, and the avenues of employment which are expanding tend to be those which are overtly technological in nature.
If technology education is so important, then clearly girls need to experience it, but so too do boys. Why are we not concentrating equally on them? We find the answer in the Proceedings of the last PATT Conference (Raat, de Klerk Wolters & de Vries, 1987).

From the beginning of the PATT-research it was clear that there are differences between girls and boys with reference to their concept of and attitude towards technology. Therefore the position of girls deserves special attention in the development of technology education (p. 82).

If girls and boys are to benefit equally from technology education, then attention needs to be paid to differences which may affect educational outcomes. What are these differences?

**Differences between Boys and Girls**

**Overview**

Studies in many countries associated with the PATT research have shown repeatedly that, on average, girls have less positive attitudes than boys on scales measuring interest, careers and consequences of technology; girls are perceived by boys to be less able in technology; and boys have higher scores on scales measuring understanding of the concept of technology (Raat et al., 1987). Three points can be made about these findings. First, they are consistent with other research using different instruments. In Western and developing countries a consistent picture of gender differences is evident - many papers at the recent Fourth GASAT (Girls and Science and Technology) Conference bore testimony to this (Daniels & Kahle, 1987). Second, the pattern of gender differences in attitudes to technology education parallels that in physical science education and in the rapidly growing field of computer education. Third, these differences in attitudes reflect differences in participation, not only in subject choice at school, but in professional occupations and the skilled workforce. I am sure you are familiar with statistics for the workforce in your own country. Perhaps I will mention only that in Australia, in 1986, the ratio of males to females employed as chemists, engineers, geologists, physicists and geophysicists is 6:1; for engineers, the ratio is nearly 36:1 (source: Australian Bureau of Statistics, 1988). The small number of women in the science, engineering and technological workforce has economic and political importance.
Insufficient numbers of physical scientists and engineers are being trained in Australia to maintain the workforce at its present level. Australian society cannot afford to continue the educational and social practices which deter 50 percent of the potential workforce from taking up careers in science, technology and engineering.

These three points about differences between males and females are empirical issues, but there is a fourth, methodological point which relates to the measurement of the attitude. This point concerns the different patterns of responses to the scale items, which I believe represent a fundamental difference in the "world-view" many boys and girls have about technology. These differences throw additional light onto our ideas about making technology interesting for girls, as I will demonstrate a little later. Over the last twenty years considerable progress has been made in changing the composition of science classes at school and the workforce. In Australia, for example, the percentage of female engineers increased from 0.51% in 1976 to 2.72% in 1986. This fivefold increase over a decade can be attributed to an increasing awareness of, and determination to remove, the barriers to female participation. Australia is not a leader in its efforts to get girls into science and technology and keep them there. Similar efforts are being made all over the world. Contributions to all previous GASAT Conferences give examples of gender imbalances, in fact one aim of the GASAT movement is to improve the opportunities and support for women in science and technological careers. There is now available a wide research-based literature describing the lessons of the past and actions for the future so the tradition of "science for boys" can be left in the past.

Now we have technology education, a subject which is new to the school curriculum. It is, as de Vries pointed out at the second PATT Conference, a subject without a tradition (de Vries, 1987). We have the opportunity to build this curriculum in such a way that it will be interesting and appropriate for both boys and girls. How can this be done?

Difference in achievement?
I want to set aside achievement as a necessary component of gender differences in technology education. There is no long history of the superiority of boys in achievement in technology education as has been reported in science education by major international surveys of achievement.
such as the IEA Survey (Comber & Keeves, 1973). Whilst differences are still reported in large surveys such as the National Assessment of Educational Progress in the United States and the Assessment Performance Unit in the United Kingdom, it is becoming increasingly clear that these differences are specific rather than general, and though consistent, tend to be small (see, for example, the meta-analysis results of Steinkamp & Maehr, 1983, 1984). Importantly for technology education the differences tend to be in the physical science areas, particularly physics. You will be familiar with the persuasive arguments by researchers such as Erickson and Erickson (1984), Johnson and Murphy (1986), and Kahle and Lakes (1983) who suggest that these differences can, at least in part, be accounted for by different out-of-school experiences. Further, the growing body of literature based on classroom observations indicates that quite different learning opportunities commonly exist for girls and boys, particularly in the secondary school (see, for example, Kelly, 1987; Tobin, 1986; and contribution to the GASAT Conferences).

A study by Parker and Offer (1987) has illustrated that gender differences in science achievement are not inevitable. Parker and Offer examined the science achievement of the entire population of 15-year-old pupils in Western Australia at the end of their compulsory schooling. Boys and girls studied the same compulsory science curriculum and there was no gender difference in average science achievement. However, beyond this point, study in science is optional, and the stereotypical pattern of participation quickly appeared among those pupils who continued in school (Parker, 1986). If, on average, girls and boys are equally able, then their choice of science subjects must be made on affective rather than cognitive grounds, so it is appropriate that we pay attention to pupils' attitudes.

Differences in Attitudes.
We are assuming that girls' attitudes put them at a disadvantage compared with boys. As we examine the nature of these attitudes we must consider whether the differences appear to be fixed, or whether they are flexible. Fortunately, there is evidence that girls do not hold fixed, negative perceptions and beliefs about technology. Confirmation of this is given by Grant and Harding (1987) who draw attention to the interpretations placed upon scores on Likert-type rating scales in which the "undecided" category
attracts a considerable proportion of the responses. A scale used by Grant and Harding to measure attitudes to science and technology produced total scores suggesting that girls held the more negative attitude. An examination of the responses when categorised as 'positive', 'negative' or 'not sure', revealed that boys chose the positive and negative categories more often than did girls. Girls were more likely to choose the 'not sure' category and in follow-up interviews, they tended to explain their choice in terms of "it depends on the circumstances". Rather than regard this as a negative attribute, Grant and Harding (1987) consider this approach to be a healthy questioning of "the values embodied in science and technology and the uses to which they are put" (p. 342).

To determine whether a similar pattern of response might be present in the PATT research, I re-examined data collected in Perth for the first International PATT Conference that 27 of the 78 items we trialled had a mode of 3, the "undecided" category. In fact 47 of the 78 items attracted more than 20% of the responses into the undecided category. The contributions to the second PATT Conference (Coenen-van den Bergh, 1987) contain three papers reporting item response data for the PATT Attitude Scale. Inspection of these data show that a response rate exceeding 20% in the undecided category occurred in 29 of 40 items for the sample in Belgium (Claeys, 1987); in 10 of 60 items, in the data from India (Rajput, 1987), and in 39 of 59 items in a Polish sample (Szydlowski & Dudziak, 1987). The high percentage of "undecided" responses can make summed scores difficult to interpret when different subgroups of the population use

| Table 1. Gender Differences in Choice of the Undecided Response Category for PATT Attitude Scale |
|---------------------------------|-------------|------------|-------------|---|
| Items on which                  | Girls more | Boys more | Total       |
|                                 | undecided  | less than 5% | undecided  |
|                                 |            |            | Items      |
| Parker & Rennie (1986)          | 60         | 13         | 5           | 78 |
| Claeys (1987)                   | 20         | 15         | 5           | 40 |
| Rajput (1987)                   | 18         | 37         | 5           | 60 |
the undecided category in different ways. To determine whether there were different proportions of girls and boys choosing the middle category, I looked again at the Perth data. Examination of the data for the individual items revealed that on 65 of the 78 items administered there was a difference of at least 5% between the numbers of boys and girls choosing the "undecided" response. On 60 of these 65 items, more girls than boys chose this category. These figures are reported in Table 1.

Claeys (1987) and Rajput (1987) reported response patterns separately for boys and girls. The number of items on which there was a difference of at least 5% between boys and girls choosing the undecided category are reported in Table 1. The pattern of greater indecision by girls is present in all three samples. In each set of data, boys were noticeably more undecided on only five items. Interestingly, all five of these items in the Parker and Rennie data, four in the Claeys data, and one in the Rajput data referred to the participation of girls in technology.

To look even more closely at this pattern, I selected two items which appeared on both the trial questionnaire (Parker & Rennie, 1986) and the attitude scale used by Claeys (1986) who reported response patterns with item wording. One item is relevant to this theme of this address - "I am not interested in technology" and the other is a consequence item asking opinion about "technology has brought more good things than bad things". The response patterns are reported in Tables 2 and 3 respectively, and it can be seen how use of the undecided category has great potential to influence the significance of differences between boys and girls.

<table>
<thead>
<tr>
<th>Table 2. Response Patterns for the PATT-Attitude Questionnaire Item &quot;I am not interested in technology&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Parker &amp; Rennie (1986) Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Claeys * (1987) Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
</tbody>
</table>

* Means and t calculated from reported frequencies
** p < .01
Table 3. Response Patterns for the PATT-Attitude Questionnaire Item "Technology has brought more good things than bad things"

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parker &amp; Rennie (1986)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>25</td>
<td>28</td>
<td>27</td>
<td>6</td>
<td>14</td>
<td>2.57</td>
<td>0.38</td>
</tr>
<tr>
<td>Girls</td>
<td>17</td>
<td>33</td>
<td>41</td>
<td>6</td>
<td>3</td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td><strong>Claeys * (1987)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>28</td>
<td>37</td>
<td>22</td>
<td>5</td>
<td>8</td>
<td>2.28</td>
<td>3.47**</td>
</tr>
<tr>
<td>Girls</td>
<td>10</td>
<td>20</td>
<td>54</td>
<td>11</td>
<td>5</td>
<td>2.81</td>
<td></td>
</tr>
</tbody>
</table>

* Means and t calculated from reported frequencies
** p < .01

If it can be assumed that the respondent understands the question, there are three ways to interpret a response in the undecided category. First the respondent may not hold an opinion, perhaps because of indifference or simply because the issue has not previously been considered. Second, the respondent may have an opinion but does not want to admit to it, perhaps through lack of confidence. Third, the respondent may have mixed feelings and needs more information before making a decision. This is the interpretation made by Grant and Harding (1987). That girls tend to be more indecisive than boys in their responses to the PATT attitude items is consistent with the psychological/development theories which link choice of science to a preference by boys to have things "cut and dried" (Head, 1980) and to have objective views of the world and a sense of control (Harding & Sutoris, 1987). Girls on the other hand, are more likely to be person-oriented and view issues with a greater sense of complexity. This, together with the well-documented finding of relatively lower levels of self-confidence in girls, is ample explanation for the reluctance of girls more than boys to commit themselves to an opinion on issues they have not considered or about which they do not feel well informed.

The findings from the PATT research and the interpretive discussion above have clear implications for our quest to make technology more interesting for girls. We know that girls are less decided about technology than boys, and so we have the opportunity, with careful teaching, to enable girls to become more informed and so develop the positive attitudes we consider
important. Certainly on some items more girls than boys have responded in a negative way. But on many items, inspection shows that the apparently negative opinion of girls may be accounted for by their high choice of the undecided category. Thus whilst girls may have less positive attitudes, comparatively few actually have negative attitudes, and that must be encouraging news.

**Making technology interesting for girls**

Pupils' attitudes towards, perceptions about, and achievement in technology education are determined by five interacting variables. These are pictured in Figure 1. As we examine what steps we can take to make technology education equally effective for girls and boys, we should make clear just what we can and cannot do. There are some variables which are relatively fixed, over which we have no immediate control. Our efforts should be directed towards those variables which are alterable (Bloom, 1980) and which we can change. I will give a brief overview of each variable in turn, and spend most time on classroom experiences because it is here that our efforts can have most effect.

**The Nature of Technology**
Like science, technology is socially constructed. Technology cannot be changed without concomitant change in science and society. Change is slow but certain. So whilst curriculum developers and teachers in schools cannot change technology, they can control the way in which technology is presented in classrooms, and so there is where their efforts must be focussed.

**Societal and Parental Influences**
The expectations of society and parents exert a continuous influence on pupils and how the schools operate. Research in science, computer, and mathematics education (Eccles (Parsons), 1984; Fitzgerald, Hattie & Hughes, 1986; Kahle, 1985; Kelly, 1987; Sanders & Stone, 1986) indicates that these influences do not generally favour the participation of girls in these subjects. The curriculum developers and teachers cannot alter the expectations of society and parents in a short space of time, but over time these expectations are slowly becoming more favourable to girls.
Attributes of the Pupil
The attitudes, perceptions, beliefs, skills and abilities pupils bring to the
classroom are a consequence of their previous in-school and out-of-school
experiences. Because pupils' entry characteristics are based on history, this
complex of variables is unchangeable. The teacher does have control over
the pupils' classroom experiences, and in planning, must take pupils' past
experiences into account.

Attributes of the Teacher
The teacher's own attitudes, beliefs, perceptions, experiences and
expectations about technology and pupils will affect the pupils' classroom
experiences. Unlike the preceding variables, research shows that this
variable is alterable. Contributions to past GASAT conferences, for example,
contain reports of interventions which were successful in changing teachers'
attitudes.

Teacher training, both preservice and inservice, is an important part of an
effective technology education, but it is not our purpose to discuss this
here. However, teachers must believe that technology education is equally
important for girls and boys, and expect them to participate equally and
successfully in lessons. Teachers must make this clear to pupils by the way
they organise their classes (even in such mundane things as job allocation)
and the manner in which they counsel pupils in subject choices and career
guidance.

Classroom Experiences
What happens in the classroom is the main focus of our efforts to make
technology education effective because many of the variables which operate
in the classroom are alterable by the teacher. The sum effect of our
efforts is the result of the interactions between at least four clusters of
variables. These are the nature of the curriculum materials, the learning
activities, pupils' opportunities for participation, and pupil assessment and
feedback.

The curriculum materials. The curriculum is discussed as part of the
classroom experiences because, although it may be developed outside of the
classroom where it is shaped by external forces, such as societal and
political pressures, its effect is determined by its actual implementation in the classroom. The lessons learned from science education offer good advice to the approaches taken to develop curriculum in technology education (see, for example, Smail, 1984; Ditchfield & Scott, 1987).

Because technology permeates our lives through its applications, it is sensible to plan courses in technology education from a social and human perspective. Science has often been taught from scientific principles, divorced from real world issues. This is one of the reasons girls have been turned off - they see science as remote from everyday concerns and so not relevant to them (Kelly, 1982). Rather than teach technology from a knowledge base, values and issues can be a starting point. Just one example is the development of a topic based on safety and accident prevention in children's playgrounds. Grant and Givens (1984) describe how a course began with this issue and incorporated relevant knowledge of matter and energy and skills related to design, construction, evaluation, decision-making and communication.

Besides the basic approach taken by the curriculum materials, their presentation is important. In her report of the HANDROVER project here at Eindhoven, Mottier (1987) describes an excellent set of guidelines for sex equitable curriculum materials. Teachers also must follow these guidelines in their own presentation to the class so that technology is seen to be a part of life equally for men and women.

The final point to be made about curriculum materials relates to the equipment to be used. We know girls have different experiences in handling tools and materials in their out-of-school activities. Teachers must make sure that girls can use all of the equipment and materials as well as boys, and, if necessary, provide non-threatening opportunities for them to learn. Often this is just a matter of forethought. I remember observing in a classroom where pupils were set the task of making a switch and building it into an electric circuit. The wire provided was covered with plastic insulation, some of which had to be removed in order to make electrical connections. The boys used their teeth and finger nails to remove the insulation. The girls had more regard for their teeth and worried about breaking their finger nails. Finally many went to the boys for help and
some did not complete the task. If the teacher had thought to provide a pair of wire strippers, an unnecessary barrier to girls' successful participation in the activity would have been avoided.

Nature of learning activities. Pupils in technology classes, as in every class, will have a variety of interests, aspirations, background experiences and learning styles. Perhaps the most important thing about learning activities is that they be varied, so there is something to suit every girl and boy. Activities based on technological applications need to be balanced between boys' and girls' interests and experiences, so that people-contexts as well as mechanical and industrial contexts are covered. Further, just as girls may need extra encouragement and support to engage in activities associated with boys' "traditional" interests, such as looking at motors or circuits, so too may boys need encouragement to engage in activities they perceive to be more suited to girls - activities related to home making, for example.

Opportunities to design and carry out activities are very appropriate for technology and allow pupils to gain confidence in their abilities. Such activities are especially important for girls. Teachers need to provide opportunities for pupils to work together as well as individually to let girls take advantage of their enjoyment of communication, and to help all pupils to improve their social skills with team work and cooperation. Opportunities should be provided for pupils to express their ideas and results both orally and in written form in their own language.

The overriding consideration is that the variety and presentation of activities can suit each pupil, each can feel able to be involved and competent to succeed. In the early parts of the course, girls may need extra assistance and encouragement to use new methods and materials, but there is evidence that given this "catch up" help girls are soon able to participate as effectively as the boys (see, for example, Catton, 1982; Rennie, Parker & Hutchinson, 1985).

Opportunities for student involvement. Theoretically, every pupil has an equal opportunity to be involved in the lesson activities. In practice, this often does not occur. Classroom observers (Kelly, 1985; Tobin, 1986) and alert teachers (Catton, 1982) report how boys take a disproportionate
amount of the teacher's time and assume priority over equipment. As well, they often push girls aside and make disparaging comments about their efforts. The contributions to past GASAT conferences provide many examples of these behaviours in science, technology, computing and mathematics lessons. Many teachers are oblivious to these inequalities and some even add to them. For example, the teacher who failed to provide the wire strippers in his electricity class had a habit of saying "go and ask the boys" when girls had problems. Since some boys were having problems themselves, and many of the girls were coping well, it would have been sensible to name a pupil who was coping and refer the girls to him or her. This avoids the hidden message that boys can cope but girls cannot.

Why do teachers allow these inequities to occur in their classroom? The answer is, that in most cases, they just do not realise what is happening, and often react with concern and a desire to change when alerted to the problem. Teachers would be wise to reflect on how they distribute their time in the classroom, and how pupils interact with each other. Do boys and girls have equal access to teacher help? Do pupils working in groups share the roles of leader, experimenter, recorder, and observer? Do pupils have opportunities to develop both independence and the capacity to work cooperatively with each other?

It requires very skilful teachers to build the kind of learning environment in which boys and girls support each other, and expect and help each other to succeed. Nevertheless such teachers are required if pupils' opportunities for involvement are to be truly equal.

**Student assessment and feedback.** Just as pupils benefit from a variety of learning experiences, so do they benefit from a variety of assessment procedures. There is some evidence that boys are favoured by multiple choice tests and girls are favoured by essay type questions, because it gives them flexibility to explore the complexity of a problem (Harding & Sutoris, 1987). In a subject like technology, tied as it is to social issues with no one correct answer, such flexibility is important. An important consequence of the multiplicity of equally correct answers to problems, especially to problems of design, is the de-emphasising of competition. This is important for two reasons. First, girls seem to prefer cooperative rather than
competitive environments, and second, research in motivation to learn clearly establishes cooperative learning methods and assessment as favouring the development of intrinsic motivation and self-direction in learning (see, for example, Brophy, 1983).

Another change to traditional assessment methods which will favour both boys and girls is to remove the focus off assessment for grading purposes and to place the focus on assessment for diagnostic purposes. Skilful use of diagnostic feedback and assistance to pupils developing skills for self evaluation helps boost their confidence and feelings of competence.

The frequency and type of reinforcement provided in the classroom affects pupils' self-confidence and the attributions they make about their successes and failures. Boys tend to be punished for their misbehaviour and praised for their good work. Girls are more often praised for their good behaviour and when reprimanded, it is usually for poor work. This pattern is liable to teach boys they are good at work, and if they do poorly it is through lack of effort. On the other hand, girls learn that their work is not always adequate and if their effort is not to blame, the fault must lie within themselves. Thus they lose confidence in their ability and, unlike boys, tend to underestimate their successes and overestimate their failures (see, for example, discussions in Dweck & Elliott, 1983; Maehr, 1983). The implication of this is that teachers must think carefully about the reward structure in their classrooms. Do they praise girls for good ideas as well as effort and neat work, and do they praise boys for effort and neat work as well as their ideas? Rewards and punishments should be consistently awarded, regardless of pupils' gender.

Concluding Comments

Even if teachers and curriculum developers make all the changes I, and others suggest, we will not see rapid change. It is important not to become discouraged when change is not observed overnight. Remember, that the variable of societal and parent pressure still operates outside of the classroom and it changes but slowly. On the issue of change, I agree with Kelly (1987) who writes:

The best route forward may well be through the 'ripple effect' -
making teachers aware that there is a problem, that as professionals they should be concerned about it, and that someone, somewhere has good ideas about what to do. But it is a long slow process. (p. 9).

In my discussion, I have referred to girls and boys in general terms. I do not imply that all girls are the same and that all boys are alike, for they are not. There are many girls who will work in technology with interest and active enthusiasm, and there are many boys who will seem disinterested and reluctant to work. Nevertheless, there is overwhelming evidence that, in general, girls view science and technology in one way, and boys in another way. Further, there are in general, parental and societal pressures which tend to maintain these stereotypical views. Yet there is no good reason why girls and boys should not, in general, be equally interested and involved in technology education.

I was pleased that the topic chosen for my address was "How to make technology interesting for girls", rather than "How to make girls interested in technology". The latter statement makes it seem there is something wrong with girls. I don't believe there is, they simply have different "world-views", they prefer to be more considerate and perhaps more critical, rather than negative in their opinions. I don't think we need to change girls. Surely it is more reasonable to examine technology, and to see that it is presented in such a way that both girls and boys can relate to it. This brings me to my final point. In making technology interesting for girls we are not attempting to design a separate curriculum for girls, rather we are simply attempting to establish better teaching practices, and that will be beneficial for both girls and boys.

References


differences in mixed-sex and single-sex groupings in science lessons. 


MAKING TECHNOLOGY MORE ATTRACTIVE FOR GIRLS:
THE TEACHERS' VIEW

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Eindhoven, the Netherlands

Summary

In this paper part of the results of interviews with 100 teachers in different subjects at Senior Technical Training will be reported that can be relevant to the question how to make technology more attractive for girls. The focus will be on aspects of curriculum and didactics and on several forms of positive action. After a short presentation of the method of research the teachers' opinions will be reported and discussed. It turns out that teachers have contradicting opinions about making technology subjects attractive, especially for girls, but that most of them pay (some) attention to societal aspects of technology that are relevant for STT-pupils in general. Male teachers at schools with female teachers have a more positive attitude towards several proposed positive action measures than teachers at schools without female teachers.
MAKING TECHNOLOGY MORE ATTRACTIVE FOR GIRLS: 
THE TEACHERS' VIEW

Introduction

There have been many studies on the subject of how to make physics attractive for girls. In the Netherlands, de Leeuw and others (1986) have formulated criteria for a 'girl-friendly' physics curriculum and didactics. She argues that attention should be paid to the relationship between physics and daily life, society and job-choice. Also texts should be formulated in such a way that girls' self-confidence is not undermined and differences in interests and experience with physics between boys and girls must be taken into account in physics lessons and text books. Also teachers should not make negative remarks about girls' abilities in physics and technology as this undermines girls' self-confidence.

There are several reasons why it is important to ask teachers, and teachers in technical training in particular, for their opinion on measures to make technology more attractive for girls.

1. The underlying reason why technology should be made more attractive for girls is the hope that this way more girls will choose a technical training and technical jobs, in their own and in society's interest. But a technical training and technical jobs often have a "macho" image that intimidates girls.

So it is important to know whether in teaching practice at technical schools starting-points can be found to counteract this negative image (of course with the condition that 'girl-unfriendly' teaching practice is counteracted).

2. Teachers in technical training, especially the teachers of practical- and theoretical technical subjects form a group of experts on subject-matter and applications of technology in society. They might have practical and useful ideas and suggestions for the development of a technology curriculum in other forms of education, that also meet the criteria of attractiveness for girls.

3. If changes in school-policy or curriculum and didactics should be made, it is necessary to know teachers' opinions about and attitudes towards those changes. Their cooperation is indispensible for changes to be successfully implemented (Fullan, 1982).

These considerations form the background for this paper.
Design and method of research

The overall aim of our research was to get a precise description of the position of girls in STT, as it is now. On the basis of such a research measures can be formulated to take away barriers that girls encounter in technical training.

The groups we studied were:
- girls (N=83) in electro-technics (N=44), construction engineering (N=27) and mechanical engineering (N=12),
- pupils (N_boys=886, N_girls=10) in the same fields of study,
- teachers (N=100), in electro-technics (N=20), construction engineering (N=20), mechanical engineering (N=20), physics (N=10), mathematics (N=10), modern languages (N=11) and sociology (N=9). The teachers formed a randomly selected representative group on variables like age and teaching experience. There were 8 women (none in technical subjects) among them, divided over 6 schools.

In the period October 1985 - February 1986 we visited 10 schools, spread over the country, to collect our data. The teachers were evenly distributed over the 10 schools.

Our research had an explorative character, since information about the things we wanted to know was scarce and anecdotal. We decided to use interviews with open and half-open questions for the girls and the teachers and a questionnaire with a 5-point scale for the large group of pupils. Interviews and questionnaire have first been tried out in pilot-studies and were adjusted if necessary. During the interviews notes were taken and a cassette-recorder was used to check the notes afterwards. The interviews lasted about 30-60 minutes.

The interviews with the teachers

The interviews with teachers covered many different subjects:
- personal and professional background,
- general school-policy,
- teaching-goals, didactics and curriculum,
- expectations and attributions towards girls and women in science and technology,
- experiences with girls in teaching at STT,
- treatment of and behaviour towards girls,
- experiences with job-preparation of girls in the practical year,
- opinion on positive action measures.
The data analysis

The rough data from interviews were categorized in a first round, and a code was assigned to every category. In a second round the categorization was checked and some categories were formulated more adequately. Next another co-worker, who had not cooperated in the research and did not receive anymore information than the code-book (code-numbers + categories) coded a random sample of 8 interviews. The reliability coefficient was 0.71 (Weesie & ten Brummelhuis, 1985) which is reasonable compared to an \( r_{it} = 1/7.2 = 0.14 \) with random assignment, with a mean of 7.2 categories per question.

Results

First the results on didactics and curriculum will be reported and then the results on positive action measures, in relation to the presence of female teachers at school.

Curriculum and didactics

a. Girls, technology and society

We asked the teachers: "Sometimes it is said that especially girls would like technological subjects more if more attention was paid to 'technology and society'. What do you think of this statement?"

At first 30% agrees, 27% disagrees and 36% does neither agree nor disagree. The rest (7%) does not answer.

When asked to explain their answer many teachers try to balance it carefully, exceptions are mentioned or it is emphasized that one does not want to generalize on the basis of experiences with only a few girls:

"I find it difficult to give an answer. I have nothing to do with technics. I might intuitively agree with the prejudice (i.e. the statement) but I cannot reason it out. Just write down, don't know, otherwise I might start talking nonsense." (male teacher of sociology)

Many teachers seem to think about the issue for the first time. Some others have a clear idea however:

"This statement is undoubtedly true. I think because pure technology is very limited. That could be compared to full-time housekeeping. I looked after my children for 3 years. Then one goes out of one's mind because one's world becomes so small. But that would also have happened if I'd had a purely technical job. I am a kind of outsider here at school. The subject I teach is rather general. Then when I hear what teachers talk about in breaks...that is so very limited, there are so many more important things in life..." (female teacher of physics and chemistry)
Teachers explain why they do or do not agree. A categorization of their answers is shown in Table 1.

Table 1. Teachers' explanation why they agree or disagree with the statement that technical subjects become more attractive especially for girls if more attention would be paid to "technology and society".

<table>
<thead>
<tr>
<th>Agree:</th>
<th>% of teachers</th>
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<tbody>
<tr>
<td>(N=68)</td>
<td></td>
</tr>
<tr>
<td>1. Assumptions about and/or experiences with female students are in agreement with the statement</td>
<td>22.0</td>
</tr>
<tr>
<td>2. For girls in general the statement is true because of their specific interests, socialization or nature</td>
<td>15.0</td>
</tr>
<tr>
<td>3. Other agree</td>
<td>7.0</td>
</tr>
<tr>
<td>Disagree</td>
<td></td>
</tr>
<tr>
<td>4. Assumptions about and/or experiences with female students are not in agreement with the statement</td>
<td>18.0</td>
</tr>
<tr>
<td>5. Technical subjects would become more attractive for every pupil, girls and boys</td>
<td>22.0</td>
</tr>
<tr>
<td>6. There are other reasons why so few girls choose technical subjects or a technical training</td>
<td>7.0</td>
</tr>
<tr>
<td>7. Technology is already part of society, no extra attention need be paid to &quot;T &amp; S&quot;</td>
<td>7.0</td>
</tr>
<tr>
<td>8. It is not useful to pay attention to &quot;T &amp; S&quot;</td>
<td>3.0</td>
</tr>
<tr>
<td>9. Other disagree</td>
<td>4.0</td>
</tr>
<tr>
<td>10. Other unspecified</td>
<td>6.0</td>
</tr>
<tr>
<td>Total (1.11 answer per teacher)</td>
<td>111.0</td>
</tr>
</tbody>
</table>

To illustrate some of the categories in Table 1 we cite from interviews and give some comments (category 1):

"Yes, that is remarkable. Just this morning Rianne wondered why she had to program a computer-controlled CNC-machine. She said, 'What do I profit from this, let me just work on a conventional machine, that goes as quick and I don't get all these problems. If it's true what everybody says then in the future they don't need technical people anymore, everything will be done by machines.' Well I spent some time talking this over with her, because I think things are not quite the way she sees them...But it is remarkable that she mentioned this because boys just adore all these technical things...But she thinks, 'Oh my, this is going to cost jobs and then I will be without work in the future.'" (male teacher of mechanical engineering)
Comment:
This teacher bases his opinion on personal experience with a girl. He also seems to appreciate it that one of his pupils is not blind to some negative aspects of technological developments. At least, he spends some of his time discussing with the girl and shows this way that he finds her point of view worthwhile even though he does not agree with it.
Another teacher sees some danger in attributing to girls in general a greater interest in societal aspects of technology. His answer is representative of the fourth category:

"I can imagine the statement could be true, but it generalizes too much. That would be because girls like to see the service aspects of the building sector but I can imagine very well that a girl just wants to be general foreman. I think one compartmentalizes people with this statement. Why couldn't a girl be just a good foreman?"
(male teacher of construction engineering)

Comment:
Anyone who has seen the film 'Rosy the Riveter' will understand how stressing it is for women with "male" interests not to be accepted for what they are. So this teacher raises a point we must not overlook when we state that more attention to societal aspects makes technology (or physics) more attractive for girls and women. A certain group of women might experience this as prejudice.

A teacher of physics states (category 8):

"It sounds nice, but the statement is not true. I don't believe in it. One can make 'Technology and Society' very interesting, but in technical studies one encounters exact and tough subjects in which students do not recognize the relationship between technology and society. Then they have to be interested in doing science and if this is not so it gets difficult."
(male teacher of physics)

Comment:
In her speech at the "Women Challenge Technology" Conference (Elsinore, 1986) Isabelle Stengers argued that doing science - solving complex problems, thinking things out - is a pleasure in itself. She rejects the idea that this would be different for women or men. From the rest of the interview with this teacher it becomes clear that he thinks the same. He gives the impression of being a very enthusiastic teacher who wants to share with his pupils the beauty of doing physics and he also fulminates against a former school-leader of his who tried to demotivate girls' choice of physics.
b. Technology and society in practice at senior technical schools

We also asked the teachers if they paid attention to societal aspects of technology in their lessons. Most of them (74%) said they did on occasion, some of them did it often. More often mentioned subjects are in Table 2. Especially effects - both positive and negative - of automation are treated. One teacher of electronics would like to have a book on this subject he could use in his classes.

Table 2. Examples from teachers of aspects of technology and society that are mentioned in their lessons.

<table>
<thead>
<tr>
<th>Subject</th>
<th>No. of times mentioned</th>
<th>% of teachers (N=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>Future work-situation (Collective agreements, applying for a job, cost vs quality discussion)</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Environmental pollution</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Energy supply</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Actuality</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Armament</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Technology in service of the handicapped, elderly, ill etc.</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other examples</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>Total (1.34 answer per teacher)</td>
<td>100</td>
<td>134</td>
</tr>
</tbody>
</table>

Teachers who want to go deeper than an incidental or superficial treatment of societal aspects of technology sometimes encounter pupils' resistance:

"Of course one has to take the age-level into account. (Pupils') level of knowledge is very conservative and very outspoken. Like 'All squatters should be shot dead...' If one wants to talk about declining fossil fuels in relation to increasing output, or about astronomy and the computation of time, or about the origin of the world - does a God exist - it is impossible to start a discussion about these things. Their background is too limited and then there you are with 55 years of life-experience against 25-year-old boys..." (male teacher of mechanical engineering)

c. Taking into account girls' different out-of-school experience with technology

In interviews with 83 girls in STT it was found that 72% of them thought there were things they did not know or could not do that most boys did know or were able to do (Udo, 1987). This mostly concerned practical-
technical matters. Some girls mentioned that some teachers did not know how to handle this and that they got impatient with the girl or let her know that she was stupid.

In the interviews with teachers we find that 43% of them mention subjects they think are more difficult for girls than for boys. This concerns mostly the practical-technical subjects, the same as with the girls. The reason that these subjects are found more difficult for girls lies mostly in their less experience with technology and also in their less physical strength, according to the teachers (see also Table 3).

Table 3. Reasons why some teachers find some subjects more difficult for girls than for boys.

<table>
<thead>
<tr>
<th>Reason</th>
<th>No. of times mentioned</th>
<th>% of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socialization (which causes girls to have less experience and background knowledge)</td>
<td>13</td>
<td>37</td>
</tr>
<tr>
<td>Less physical strength</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Experience with girls in STT</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Less ability</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Same ability, but ...</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Girls are less interested</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>The subject is not suited for girls</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Girls are afraid of machines</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total (1.2 answer per teacher)</td>
<td>42</td>
<td>120</td>
</tr>
</tbody>
</table>

For girls it will make a difference whether a teacher considers a lack of technical experience as something that can be overwon after some time, or as a proof that girls are less able than boys in technical matters. Both points of view were found in the interviews with teachers:

"Yes, the contents are of course the same for boys and girls, but girls have more problems with some subjects. If they have to use spatial abilities they get in trouble, for example in the theory of construction. Also in planning, in economics, that is thinking ahead, they have more problems than boys, in my experience...If I point this out to them and explain they say 'oh yes'... and I say 'don't do it wrong the next time'...But the next time they do it wrong again..." (male teacher of construction engineering)

"Yes, I think that theory of construction and practical lessons are more difficult for girls. I think this is because they have less experience with technology, at school or at home...But they have overcome this, after a year at this school I think the effect is
gone. But in the beginning they have a bit less technical insight."
(male teacher of construction engineering)

About 10% of the teachers think that girls have less ability for technical and exact subjects than boys. It is remarkable that in schools with female teachers 35% say there are subjects they find more difficult for girls than for boys, against 56% of the teachers in an all-male team ($X^2=3.992$, df=1, $p=.046$).

On a hypothetical "girls' school" for STT, 42% of the teachers say they would teach in a different way, 49% would not do that and 9% does not know or does not answer. Most of the teachers give reasons how they they would change their teaching or why they would do that (Table 4).

<table>
<thead>
<tr>
<th></th>
<th>Would teach differently (% of N=39)</th>
<th>Would not teach differently (% of N=44)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Another kind of group leads to another kind of teaching, adapt to the group</td>
<td>38</td>
<td>14</td>
</tr>
<tr>
<td>Take into account different experiences, background knowledge or interests of girls</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Use less rough language, behaviour, behave more friendly</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>Would not like to teach at a &quot;girls-STT&quot; at all</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Subject matter, technology or teaching goals at STT are the same for boys and girls</td>
<td>10</td>
<td>43</td>
</tr>
<tr>
<td>Because of experiences with teaching girls until now</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Way of teaching is strictly personal, or &quot;I am I&quot;</td>
<td>-</td>
<td>27</td>
</tr>
<tr>
<td>There are no differences between boys and girls in ability and capacities as regards technology</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Total (1.31/1.18 answer per teacher)</td>
<td>131</td>
<td>118</td>
</tr>
</tbody>
</table>

From Table 4 it becomes clear that a group of teachers that says at first that they would not change their teaching would adapt to a certain extent
to a girls' group. It is rather distressing that a group of 10 teachers would adapt their use of language or their behaviour. Boys are treated more roughly than girls. This can confirm the idea that this is the way people treat each other in technology, which in truth confirms the image of technology as a hard "men's" area, in which women do not belong.

Positive action measures:

Statistical relationships between answers of male teachers on questions about positive action-measures and the presence of female teachers at their school.

We have already seen that male teachers think more positively about girls' abilities for technical subjects when at their school there are female teachers present. But male teachers are also more positive towards positive action measures when there are female teachers at their school. The positive action measures we asked about were: preferential treatment of girls and female teachers in admittance to STT, paying extra attention to recruiting activities and guidance aimed at girls and willingness to visit inservice training about girls and technology. Male teachers at schools with female teachers think significantly more positive about paying extra attention to recruiting and extra guidance for girls and they are significantly more positive about the presence of (more) girls in their classes (Tables 5, 6 and 7).

Table 5. Statistical relationship between the answers on the question "Would you like to have more girls in your classes?" and the presence of female colleagues at school, for male teachers. Absolute numbers and column percentages.

<table>
<thead>
<tr>
<th></th>
<th>female teachers present</th>
<th>no female teachers present</th>
<th>row total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like more girls in my classes</td>
<td>40 (77%)</td>
<td>20 (50%)</td>
<td>60</td>
</tr>
<tr>
<td>Don't care, like less girls in my classes</td>
<td>12 (23%)</td>
<td>20 (50%)</td>
<td>32</td>
</tr>
<tr>
<td>Column total</td>
<td>52 (100%)</td>
<td>40 (100%)</td>
<td>92</td>
</tr>
</tbody>
</table>

\[ X^2 = 7.232; \text{ df } = 1; \text{ p } = 0.007 \]
Table 6. Statistical relationship between the opinion of male teachers on preferential treatment of girls in admittance to STT and the presence of female colleagues at school. Absolute numbers and column percentages.

<table>
<thead>
<tr>
<th></th>
<th>Female teachers present</th>
<th>No female teachers present</th>
<th>Row total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferential treatment of girls</td>
<td>25 (49%)</td>
<td>13 (33%)</td>
<td>44</td>
</tr>
<tr>
<td>Ballot/other procedure</td>
<td>26 (51%)</td>
<td>27 (67%)</td>
<td>53</td>
</tr>
<tr>
<td>Column total</td>
<td>51 (100%)</td>
<td>40 (100%)</td>
<td>91</td>
</tr>
</tbody>
</table>

\[ X^2 = 2.516; df = 1; p = .1 \]

Table 7. Statistical relationship between answers on the question "What is your opinion on extra guidance of girls at your school?" and the presence of female colleagues at school, for male teachers. Absolute numbers and column percentages.

<table>
<thead>
<tr>
<th></th>
<th>Female teachers present</th>
<th>No female teachers present</th>
<th>Row total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>27 (52%)</td>
<td>8 (21%)</td>
<td>35</td>
</tr>
<tr>
<td>Neutral</td>
<td>10 (19%)</td>
<td>13 (33%)</td>
<td>23</td>
</tr>
<tr>
<td>Negative</td>
<td>15 (29%)</td>
<td>18 (46%)</td>
<td>33</td>
</tr>
<tr>
<td>Column total</td>
<td>52 (100%)</td>
<td>38 (100%)</td>
<td>91</td>
</tr>
</tbody>
</table>

\[ X^2 = 12.170; df = 2; p = .002 \]

On the other positive action measures there were no significant differences between both groups of teachers. There is a tendency for male teachers at schools with female teachers to have a more positive attitude towards preferential treatment of girls in admittance to STT.

Conclusions and discussion
We can conclude that there are starting points for 'girl-friendly' technology teaching at STT. Most teachers pay some attention to the societal aspects of technology in their lessons, the positive as well as the negative aspects. But they are no more than starting points: lack of time and good teaching-material, the negative attitude of (some) pupils towards a less superficial treatment can form a problem. There is also a group of teachers that is afraid to sex-stereotype girls in agreeing with the statement that treating
societal aspects of technology might be especially attractive to girls. I think it is best to point out to teachers that both girls and boys profit from paying attention to "Society and Technology": girls because in general this links up with their socialization and boys because they will develop a less narrow view of technology.

In technical training as well as in general education it is found that girls have less background knowledge of and experience with technology (Udo, 1987, de Leeuw, 1987, Alting, 1984). If in STT teachers find that girls have more difficulties with some technical subjects, they mostly attribute that to differences in background knowledge, experiences or interests. It is important to convince teachers and girls that these difficulties can be overcome and that they are not proof of a lesser ability. This is especially important in the first confrontation of girls with the school-subject "technology". Everything possible must be done to prevent this from becoming a "boys' subject" as has already happened to the science subjects. One way of reaching this goal is to promote women teachers in this subject. This offers positive identification for girls. In training teachers for technology attention must be paid to the situation of girls and how to take into account girls' interests and experiences.

The presence of women in an STT-teaching team is related to a more positive attitude of their male colleagues towards, amongst others, girls' abilities in technical subjects and the presence of girls in their own classes. This underlines the importance of having female teachers in technology education.

References


de Leeuw, A. Verschillen tussen jongens en meisjes die het doen en kiezen van natuurkunde beïnvloeden Onderzoekresultaten en aanbevelingen opdat (meer) meisjes (beter) natuurkunde gaan doen. MENT 87-06, Eindhoven University of Technology, Eindhoven 1987. See also:


WHAT CAN MENT DO TO MAKE TECHNOLOGY INTERESTING FOR GIRLS?

Drs. Marja Brand  
Ment-Project  
Eindhoven University of Technology  
Eindhoven, the Netherlands

Summary

16 Schools for Senior Technical Training in the Netherlands have had extra funds from the Ministry of Education to try out a sex-equity programme during the next 4 years.  
The MENT project plays a role in the evaluation of these projects.  
An outline of the evaluation research plan will be given and reports of the first activities schools have planned and started as part of the Topics:  
1. actions to increase the number of girls in schools for Senior Technical Training (STT) (1.5% girls, 98.5% boys),  
2. actions to diminish the problems of girls with deficient exam programmes (non physics programme) in the entire STT, and  
3. actions to better school- and class climates in STT to increase the well-being of lone-girls in an all boys environment.
WHAT CAN MENT DO TO MAKE TECHNOLOGY INTERESTING FOR GIRLS?

Introduction
There are a number of reasons for a government to provide extra funds for emancipation projects at schools for Senior Technical Training (STT). Those reasons can be summarised into two categories:
1. it must be good from an economical point of view, and
2. it can be good for women.

For the schools it begins to be important to diminish the traditional segregation. If they want to keep up with societal and economic changes it will be necessary to change the image of technical work and technical workers. If they want to provide for the coming shortage of technically trained personnel, and the drop of births gives them a smaller crop of students, they have to change their acquisition.

The tasks school fulfil in society are:
1. allocation: assigning pupils to a place in society by developing their knowledge and skills, needed for professional life,
2. self actualisation: developing different human qualities as values in themselves, and
3. socialisation: make pupils behave social and act according to the customs standards and values of society (in the Netherlands the emphasis is on responsible and assertive behaviour).

These tasks make it necessary for schools to be alert on changes in society, for those changes have their impact on the policy of schools.

A. The economical changes in the Netherlands
In a few more years the industries will need more trained technicians and engineers because:
1. the need for highly specialised trained personnel will grow as a result of technological innovations (new technologies);
2. the number of technically trained post secondary young men will diminish because of the decreasing birthrate since the seventies;
3. Dutch industries have had long stops in hiring and engaging personnel and have not started a new pool by inservice training.

The well trained technicians will soon go to retired pay (in the Netherlands
people from 57.5 years are already discharged gradually since 1978).

Upbuilding of ages in industry

B Why women want to enter the technical professions
There are a number of reasons why it would be good to open up traditionally male dominated professions for women:
1. it would increase the range of professions to choose from.

<table>
<thead>
<tr>
<th></th>
<th>1977</th>
<th>1981</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>in % total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nurses</td>
<td>9.1</td>
<td>10.3</td>
<td>11.1</td>
</tr>
<tr>
<td>teachers</td>
<td>7.4</td>
<td>7.5</td>
<td>7.1</td>
</tr>
<tr>
<td>secretaries</td>
<td>9.3</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>bookkeepers/cassiers</td>
<td>6.6</td>
<td>7.2</td>
<td>7.7</td>
</tr>
<tr>
<td>clerical work</td>
<td>11.7</td>
<td>12.3</td>
<td>11.1</td>
</tr>
<tr>
<td>shop assistants</td>
<td>11.2</td>
<td>10.3</td>
<td>10.0</td>
</tr>
<tr>
<td>domestic/caring</td>
<td>11.4</td>
<td>10.3</td>
<td>10.1</td>
</tr>
<tr>
<td>domestic/cleaning</td>
<td>5.1</td>
<td>5.3</td>
<td>5.9</td>
</tr>
<tr>
<td>8 professions together</td>
<td>71.8</td>
<td>71.5</td>
<td>71.3</td>
</tr>
<tr>
<td>total women (x 1,000)</td>
<td>1322.0</td>
<td>1590.4</td>
<td>1730.1</td>
</tr>
</tbody>
</table>

70% Of the Dutch working women work in 8 professions (compared to
men, only 38% work in those 8 professions) while unemployment for women is the highest in clerical, medical and social professions;
2. the chances on a paying job and economic independence would grow if women could enter technical professions;
3. there will be more women available at the labourmarket for a number of reasons (diminishing number of children to take care of; housekeeping costs less time because of machinisation and automation; growing needs for family income; higher level of education and longer period of education make the need for jobs in balance with the growth in educational level; the need for social contact at work; the changing attitude towards working mothers etc.) In the Netherlands 44% of the female professionals want to work (in 1960 this was 22%).

C. The policy of the Dutch Ministry of Education
All the above mentioned reasons made it necessary for the Dutch government to become active and take measurements to get more girls into technical professions.
They use a number of strategies of which we shall mention three:
  - a nationwide campaign started in April 1987 to try to alter public opinion in advising appropriate math and physics pre-requisites for young women;
  - funds for schools for senior technical training (STT) were granted to carry out activities in getting more girls at STT schools and create a girl-friendly environment at their schools, and
  - funds for educational researchers such as the MENT-Project were given in order to evaluate the activities schools execute and to give guidance and support to the experiment schools.

D. What can schools for STT do?
16 Schools for STT received funds for a period of 4 years to experiment with activities to get more girls into STT schools (+ 1.5% girls in 1986) and to create a welcoming environment for girls in school.
They have each 10 teacher-hours a week plus a small amount of money for expences (+ US $ 2,000 each year).

* to enable them to be eligible for those post secondary programs producing skilled personnel needed at the job-market, created as a result of technological innovations and to make young women aware of the possibility and the advantages of choosing a "man's job".
Every school is autonomous in the realisation of their plans. Every year they have to make a progress report and send it to the Ministry.

What kind of activities do schools perform?

They focus on three themes:

1. give girls a realistic image of technology and of technical schools,
2. give them enough role models to see and talk to, and
3. create an environment where girls can learn to practise technical skills and increase their self confidence in order to make it possible for them to think of themselves as technically competent or able persons.

All schools have different ways of working, for example the giving of information. They can give information about technical work, professions, career and information about the senior technical training programme to young girls at secondary general schools, to their parents, their teachers in math and physics, their school career counselors and/or to the (regional) public. The information can be given to pupils/teachers etc. at secondary general schools (as part of a programme on professions) or during days on which girls visit STT schools or go on excursions to technical industries. The information about jobs, career possibilities, technical training programmes etc. can be given personal (through lectures, letters, leaflets, advertisements, activity classes), through media work (essays from women working in the technologies in the schools journal, in newspapers, in (school) radio, computer networks, young girls' magazines etc.) or the information can be given to groups of schoolgirls that visit STT schools or go to information markets about professions. The information can be given by teachers at secondary general school, teachers at STT school, school career counselors of secondary general or STT but also and preferably by female students or female technicians. Every school for STT sets up its own campaign and chooses its own tactics.

* There is no system of school career counseling in the Netherlands. Every school for secondary education can program an amount of lessons for pupils. We call them 'lessons in choosing'. Since all schools have the freedom to prepare their pupils to choose six subjects to be examined in the last year of secondary general, there are schools where pupils have 4 hours of information about all possible professions and training programmes and schools where pupils get three years of career counseling with information about professions, chances on the job market, personal interest development and assessment and a personal counselor who helps to make a choice.
E. Activity days at STT for girls

Eleven schools for STT organised special information days this year. Normally they do so once every year. This year was different, because they organised the information day only for young women and the information day for young men and parents etc. was some other day.

They put special advertisements in the local and regional newspapers for girls to come and see for themselves what STT is all about. They were informed about the theoretical and practical courses, the student colleagues, the teachers, the building etc. They received information about the work they can do after exams and learn about the pros and cons of studying at STT. The invitation did not only come by newspaper advertisements but also through their own schoolcareer counselors, who had been informed about this day and stimulated their girls to go and visit the school. Small groups of 4-6 girls were showed around the house. At several departments they met female students who told them about the things to expect at school and talked about their experiences and the advantages and disadvantages of being a girl at STT. Most schools had specially arranged practical assignments made ready for the girls, so they could learn or train some technical skills needed at school and they made small pieces of technical work, using tools and instruments they were not familiar with at first.

All this had to do with making an unknown type of training known, to take away possible fear of trying, and maybe even arouse a small interest in technology and technical training.

The experience with this type of promoting the school and technical work is very good. Teachers at STT met (sometimes for the first time in their career) technically interested girls; the girls themselves showed motivation, interest and growing skills. They worked with technical tools and instruments and learned to handle them in a free of fear situation. They enjoyed the work and almost all girls changed their ideas about schools for STT. Meeting technically trained young girls helped them realize you don't have to be "different" to choose for a technical training, job or career.

F. How does the MENT-Project help schools for STT?

We have a number of ways to help STT schools to work out plans and perform them well.
1. We give them enough background information:
   a. information about the Dutch situation in comparison to situations abroad (facts and figures),
   b. information about the process of choosing exam subjects and the effect of differences between boys and girls in decision making,
   c. information about the effects of socialisation on behaviour and self esteem of girls.
2. We give them ideas how to make a working plan:
   d. ideas about what you can do, and how to do it,
   e. let them exchange ideas with colleague-experiments schools for STT in their region.
3. We try to give feedback on their plans and work:
   f. we visit every school regularly and make progress reports about some themes.
4. We try to give them moral support:
   g. through regular meetings with non experiment schools, and at workshops we support them in presenting their material.
5. We also give direct support:
   h. we make information materials to inform young girls about STT and the importance of keeping physics as exam subject,
   i. we lead workshops for teachers in physics about how to make physics girl-friendly in curriculum, didactics and make them aware of the problem if they do not change their way of teaching,
   j. we help school career counselors with ideas about how to prepare girls for the choosing problems, and help them formulate ways to help the girls keeping the choice possibility for a technical school/career open as long as possible,
   k. we write reports on girl-friendly physics, girls and STT and teachers and girls and STT,
   l. we make examples of girl-friendly physics lessons and spread criteria for such materials,
   m. we evaluate the experiments at STT.

G. Evaluating the experiments in STT
In order to make it possible for other schools to learn from the experiments an evaluation plan is made. It focuses on three parts:
1. Products evaluation: what did the schools do and what are the results
and products?
2. Process evaluation: how did the school try to make it work and what is the quality of their approach?
3. What marginal conditions make it possible/impossible to succeed?

Evaluation scheme

There are three major goals:
1. getting more girls into STT,
2. create a women-friendly school and class climate at STT, and
3. create a better link between secondary general education and senior technical training schools.

To make an evaluation possible we have to make an overview description of the plans schools make and execute. We use a scheme of questions to make this overview.
1. What are schools going to do in order to reach their goals?
2. What target groups do they work at? (girls, parents, teachers, administrators)
3. Who will do the job? The teachers at secondary general, at STT?
4. What equipment do they need. Can they develop their own material such as pamphlets, advertisements, programs for activity days at school etc.
5. Do they use a time scheme, and to they plan ahead?
6. Under which conditions can a plan work or fail to work e.g. support from teachers at STT, support from parents, problem awareness of administrators and school career counselors etc.
7. What activities can be set up? Activity days, essays from female technicians in schools journal, success stories in leaflets available for all
girls etc. Do you have to perform them all or can you take your pick?

8. What kind of problems do occur and (how) can they be solved? Can you anticipate, prevent or avoid them?

9. Which alterations are necessary according to the first plan?

10. To make sure there are more girls in STT schools that experiment we have to make an overview of the number of girls at STT schools and compare non experiment with experiment schools.

11. If we conclude there is more growth in experiment schools we have to make a list of possible actions that may have caused the growth.

12. To find out if the school climate is friendly we have to make a before and after activities climate "check" and operationalise "friendly climate" e.g. as assessed through interviews with girls at schools with and schools without extra activities for creating a friendly climate.

A list of actions may give insight into possible actions at STT schools to better school climate for girls.
THE CONCEPT OF TECHNOLOGY AND THE INTERESTS OF YOUNG WOMEN

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Summary

In the Netherlands technology carries a strongly masculine image. This can be illustrated by a number of examples taken from education and from the labour market.

In recent years, several researchers have formulated characteristics of technology or conceptual models.

Research data become available about the interests of young women in scientific and technological topics. We will compare those interest topics with the models for technology and will investigate whether those models can take the interests of young women into account.

If these interests can be integrated in technology, this might contribute to a larger participation of young women in technology education.
The concept of technology and the interests of young women

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After some data about the position of women in technical jobs and schools, this paper will focus on the concept of technology as it can be used in education. Dimensions of this concept can be analysed for their potential to include topics which are of interest for women. It will be pointed out in which topics women are interested and how they can be introduced in the curriculum in order to make technology teaching more attractive to women.

Women and technology in the labour market and in schools

In the Netherlands, technology conveys a strongly masculine image. This can be seen in the labour market, where very few women are found in technical professions, and it can be seen in the schools preparing for that labour market.

Table 1 indicates the percentage of women in some technical sectors.

Table 1. Percentage of female workforce in different industrial sectors in 1981

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>textile industry</td>
<td>28.3</td>
</tr>
<tr>
<td>clothing industry</td>
<td>73.1</td>
</tr>
<tr>
<td>paper industry</td>
<td>12.5</td>
</tr>
<tr>
<td>oil industry</td>
<td>7.5</td>
</tr>
<tr>
<td>metal industry</td>
<td>9.4</td>
</tr>
<tr>
<td>machine industry</td>
<td>7.5</td>
</tr>
<tr>
<td>electrotechnical industry</td>
<td>16.5</td>
</tr>
<tr>
<td>construction</td>
<td>4.3</td>
</tr>
<tr>
<td>transport</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Source: Oudijk, 1983

From table 1 it can be seen that few women are found in industrial/technical sectors (1).

Table 2 shows where they are: in the sectors of service and administration.
Table 2. Percentage of female workforce in female sectors in 1979

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>maternity nurse</td>
<td>100.0</td>
</tr>
<tr>
<td>Kindergarten teacher</td>
<td>99.6</td>
</tr>
<tr>
<td>data entry typist</td>
<td>98.2</td>
</tr>
<tr>
<td>medical assisent</td>
<td>97.8</td>
</tr>
<tr>
<td>secretary</td>
<td>96.6</td>
</tr>
<tr>
<td>domestic personnel</td>
<td>90.6</td>
</tr>
</tbody>
</table>

Source: SER, 1987

From an economic point of view this situation is undesirable, because there is only a limited employment possibility in the service sector and there will be (is already in some sectors, such as metal and construction) a shortage of working people for the industrial sectors. For the women themselves, the technical sector may be interesting because the salaries are higher than in the service sector, and employment is more secure.

The strong segregation in the labour market is reflected in the schools. Table 3 shows some statistics of schools for vocational education. It is clear from the statistics that technology is associated with male careers. Taught in a practically all male school, the teaching traditions are male, the curriculum is geared towards the interests of boys, teachers are used to interact with boys, boys are used to interact with fellow male students.

Table 3. Numbers of students in male dominated and in female dominated types of schools for vocational education, 1984

<table>
<thead>
<tr>
<th>Type of School</th>
<th>Men</th>
<th>Women</th>
<th>% of Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>junior technical school</td>
<td>181.8</td>
<td>14.78</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>junior school for home economics</td>
<td>4.833</td>
<td>97.70</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td>senior technical school</td>
<td>68.314</td>
<td>7.101</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>senior school for service and health</td>
<td>5.313</td>
<td>64.26</td>
<td>8</td>
<td>92</td>
</tr>
</tbody>
</table>

Source: Central Bureau for Statistics

Women who enter the field of technology must overcome a lot of barriers. One of these barriers is the masculine image of technology and the male bias in the curriculum. Recent developments in thinking about technology
show that it has not necessarily to bear that masculine imprint.

**The concept of technology in education**

At this moment, Spring 1988, the Dutch government prepares a law for a new system of education for the 12-15 year olds. Technology will be a compulsory subject in the proposed curriculum. A national committee has been set up to describe the objectives and the content of this new subject. This committee can draw on previous developments around technology, which started in 1973 with the introduction of a subject 'General Technology' in schools for vocational education.

The first curriculum proposal came in 1982 from the National Institute for Curriculum Development (SLO), which gave as a working definition of technology:

"Technology is the field of activities of people, based upon collections, knowledge and skills, which provide them with means to adapt the environment to needs, both in the interest of themselves as of the group. The latter equally includes a responsibility for the environment" (SLO, 1982, p. 13).

As 'pillars' of technology are considered: matter, energy and information. Application in education takes place in four human areas: living environment, labour and career, leisure time and natural environment.

The concept of 'technology' was broad enough to encompass diverse human material activities, such as sewing, designing, and could be applied to diverse materials, as plastics and textile.

The two main reasons for this broad definition can be found in 1) the teachers, and 2) the students:

1. the teachers: both teachers with a technical or physical background as those with a background in home economics or health education were qualified to teach general technology;

2. as for the students, technology was taught in schools for vocational education, which were in the seventies frequently separated in technical schools and schools for home economics. The school population was separated accordingly in respectively nearly all boys and nearly all girls.

The broad approach of technology met with resistance from those in favour
of a 'harder' concept of technology. This brought the minister of education in 1985 to the decision to split 'Technology' and 'Care' in two different subjects.

A new committee set up the framework for a subject technology, which is followed by a new curriculum proposal for technology from the National Institute for Curriculum Development (SLO, 1986). This proposal still uses the definition of technology as cited before. The three pillars of technology are still: matter, energy and information. Compared to the 1982 proposal the elements of care are removed: preparation of food, first aid, maintenance of clothes, care of plants and animals. The computer is added as a new element.

These developments have mainly taken place in vocational education. The Eindhoven University of Technology joined the discussion in 1985, with especially the possibilities for technology in general education in mind. De Vries publishes his first version of "What is technology. The concept of technology in secondary education" in 1986 (English version in 1987). He does not give a definition of technology, but cites five general characteristics:

a. the relation between technology and human beings, which includes:
   view of life, gender, and the historical development of technology;
b. the three pillars of technology: matter, energy and information;
c. the relation between technology and natural science;
d. technical skills, among which: design skills, practical technical skills and skills for handling technical products;
e. the relation between technology and society.

The pillars of De Vries are the same as those proposed by the National Institute for Curriculum Development (2).

One may conclude to a rather general consensus on the 'pillars of technology': matter, energy and information. The actual debate in the Netherlands still mainly deals with the proportion between theory and practice and between an approach which starts with general technical principles and skills, or with a thematic, more problem solving approach.

When we look back at the Dutch developments around the concept of technology during the past ten years, one may conclude that it has gone from a broad concept, including diverse activities and materials among which those with a 'female' connotation, to a narrower concept, with the
'traditional' technical activities.
This fits in with the observation of Pacey:

" Technology ' [...] is a term conventionally defined by men to indicate a range of activities in which they happen to be interested. [...] Nearly all women's work [...] falls within the usual definition of technology. What excludes it from recognition is not only the simplicity of the equipment used, but the fact that it implies a different concept of what technology is about. [...] Technique is applied to the management of natural processes of both growth and decay. Child-care, vegetable-growing, bread-making and dairy work all depend on the fostering of growth; other work done by women, ranging from cleaning, hygiene and home maintenance to nursing and the care of the elderly, concerns the management of inevitable processes of decay, and relates to the broader concepts of conservation and prevention [...]. Appreciation of process in this sense partly depends on accepting and working with nature rather than trying to conquer it, and is a neglected concept in conventional technology" (Pacey, 1983, p. 104).

Despite Pacey's remarks, the above mentioned definitions still have a rather broad concept of technology. Diverse materials are dealt with, and attention is paid to social aspects of technology. This makes it possible to include subjects which are relevant to women. This has to be done explicitly. If the new subject technology does not pay explicit attention to the interests of women, there is a danger that women will soon be lagging behind men, especially because of the masculine image of the subject. The same has happened with the introduction of information technology in Dutch schools.

A broad technology teaching will also be relevant to men:

"...If a modified concept of technology were developed in this way [...] it could force us to recognize that engineering may itself be in need of reform: its practice may incorporate values that alienate men as well as women" (Pacey, 1983, p. 105).

Explicit formulation is necessary of topics found in the experience and interest of women and of topics which can have consequences for human life.

To incorporate those topics in the curriculum, the model of Todd (1987) can
be of use. He sees four dimensions in the phenomenon of technology:

1. **elements:** materials, tools, energy, processes, humans, information;
2. **activities:** constructing, transporting, producing, communicating;
3. **growth and change:** exploring, developing, controlling;
4. **impacts:** consequences, decisions, futures

(Todd, 1987; Todd a.o., 1985).

Todd et al. define technology as "the use of our knowledge, tools and skills to solve practical problems and to extend human capabilities" (Todd et al., 1985, p. 3).

These four dimensions can also be used by those who adopt the definitions of the National Institute for Curriculum Development and of De Vries.

Topics that are relevant to women can be included in all dimensions, but especially in the following dimensions as formulated by Todd:

* at the level of the elements: humans, materials, tools;
* at the level of the activities and impact: producing, consequences, decisions;
* at the level of change: developing (also historical).

This paper pays special attention to the humans and their interests, especially the interests of women.

**The interests of women**

In order to know which topics may make technology education more interesting and thus motivating for women, their interests must be known (3).

**Interests in technology**

A number of studies investigated the interests of students in technical topics. Far more studies dealt with science/physics, and others with science and technology. There is overlap between them, since there is a close relationship between topics in science and topics in technology education.

Weltner et al. (1980) asked 1234 11-16 years old students in one of the federal states of Germany, Hessen, about their interest in topics. Students could
choose between a physical or a technical aspect: magnetic field versus compass, induction versus the generator. The interest was greatest for the technical aspects, with all students, more with boys than with girls. Boys and girls were both interested in general technical apparatuses (telephone, clock, camera, calculator). The next interest went for boys to electrical apparatuses (generators, transistors), for girls to natural phenomena (high and low tide, fata morgana, echo). For girls the relation with phenomena from daily life is an important motivating factor. Teachers know less about the interests of girls than about the interests of boys.

The Institut für die Pädagogik der Naturwissenschaften (IPN) in Kiel has started a longitudinal study into the development of interests of students in physics and technology (Hoffmann and Lehrke, 1986; Häussler, 1987). The study will last five years, from 1984, and starts with ± 11 years olds in 54 classes spread over the German Federal Republic. Both boys and girls in this research are interested in radioactivity/nuclear energy, astrophysics, communication technology, atoms, acoustics, optics. Boys are more impressed by technical apparatuses, and are the only group to find electronics interesting. Girls show a great interest in natural phenomena.

All these topics, for which boys and girls show interest, are poorly represented in the teaching, which concentrates on explanations, laws and calculations. Something students dislike most.

The results of research into the interest of students in technical topics show that both girls and boys are interested in 'daily life' technical equipment. When the equipment gets too technical, boys keep a greater interest than girls. Electricity gets more interest from boys, natural phenomena from girls.

These conclusions are in accordance with the results from research into students' interests in physical topics.

*Interests in physics* 
A summary of a number of studies into the interests of 11-14 years old students in science/physics topics (4) shows the following trends:
Both sexes are interested in technical subjects from daily life (telephone, photocamera, record), in spectacular and beautiful natural phenomena,
such as earthquakes and volcanoes, fossils and crystals.
The social effects (especially of the atomic bomb) get high scores, as do 
chemical experiments.
Girls have a particular interest in questions such as: road safety, safe use 
of X-rays, health, food. This means applications which show the use of 
science in relation with society, the human body, safety and medical 
applications.
Girls have no interest for: electricity, energy, electronics, car engines, space 
travel, nuclear weapons.
Boys are interested in: engines and motors, space travel, nuclear energy, 
the atomic bomb, and in electricity.
Boys have no interest in topics concerning the development of and care for 
people, health, and in food.

Including the interests of women in the technology curriculum

This contribution has shown that it is possible to find enough research 
data in order to draw a list of topics that are interesting a) for girls, b) for 
boys, c) for both girls and boys. Curriculum materials must use examples 
from these three categories in equilibrated way, so as to make technology 
motivating for both girls and boys.
This is but one of the measures that can be taken in the curriculum in 
order to make technology more attractive to girls. Other suggestions for 
the curriculum are: more attention for technical careers, for social and 
historical aspects.
Curriculum materials adapted in this way to both girls and boys may 
contribute to diminish the masculine image of technology, to make this 
subject more attractive to girls and to contribute to a successful study of 
technology by girls and boys.

Notes:
(1) Women constitute ±33% of the total workforce in the Netherlands.
(2) And by a national committee not mentioned in this paper.
(3) The research cited below all stems from anglo-saxon developed 
countries. Results in other parts of the world may be different.
(4) Such as Dawson and Bennett, 1981, for Australia; Lie and Sjöberg, 1984,
for Norway; Smail, 1984, for the United Kingdom; Jörg, 1986, and De Leeuw, 1986, for the Netherlands.

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THE FORMATIVE EVALUATION OF MEDICAL TECHNOLOGY, A GIRL-FRIENDLY COURSE

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Summary

For the Project Bovenbouw Natuurkunde (abbreviated PBN, which means Project Physics in the Upper Part of Secondary Education) we developed new courseware for physics lessons. This material, entitled Medical Technology, is a series of about 12 lessons and it is meant for pupils in the upper part of pre-university education (about 17 or 18 years old). The course Medical Technology is meant to be more attractive for girls than other physics courses.

We carried out a formative evaluation to find out whether the text needed revision and also as a try-out of the instruments for the summative evaluation. For this formative evaluation the textbook Medical Technology was used by 4 teachers and their pupils (well over 100). By means of questionnaires, interviews and observations we obtained data to adjust the material. But we also got a fairly good impression of what the teachers' and pupils', and particularly the girls', opinion is of the course on Medical Technology.
MEDICAL TECHNOLOGY: A GIRL-FRIENDLY COURSE?

From research in the project Physics and Technology and the PATT-research it is known that girls have a less favourable attitude towards technology than boys have. Therefore it is very important to pay special attention to the girl-friendliness of technology education.

One of the things that have to be taken into account with respect to this is the choice of issues to be dealt with in technology education. These issues should not only be taken from the experience of boys, but also from girls' interests. A number of researches have shown, that girls are interested in issues that have to do with human beings and the human body, and in issues on the societal aspects of a subject.

To investigate whether or not this interest of girls remains when these issues are taught in education, we developed a course on Medical Technology and evaluated the use of this course in class.

In this paper we present the rationale behind this course and some results of the first, formative evaluation.

Development and content of the course Medical Technology

Medical technology is a subject that combines a number of girl-friendly issues. First of all: medical technology has to do with the functioning of the human body. Secondly, health care is often chosen by girls as a future career. That makes this course more relevant in their opinion.

It is known from research mentioned earlier that pupils have a distorted view of technology: they only think of technology as something with machines. This applies to girls even stronger than to boys. Medical Technology is a subject in which the important place of the human being in technology is very evident. In the development of equipment to be used in medical technology one must take into account the impression these appliances make on a patient. Ergonomics is essential in this development. This is an aspect that girls are interested in.

So in many respects Medical Technology can be expected to be a girl-friendly subject in technology education.

We wanted to investigate whether this is true when the girls have lessons in this subject. Many times it is seen that the interest for a subject decreases very rapidly once the pupils have had lessons about it. Something of the excitement of a new, unknown subject, has then disappeared. Will
this also be the case with a girl-friendly subject like Medical Technology?

In the Netherlands at this moment there is no separate subject Technology yet. But there are proposals for a change in the exam programme for physics education, so that a number of technological and other contexts are introduced in physics education. Biophysics is one of the new parts in the proposed exam programme.

This change in exam programme offered us the possibility to develop course material on medical technology and test it in class.

In 1986 we developed a course called Medical Technology, to be used in physics lessons in the fifth or sixth form of secondary general education (pupils aged 17-18).

Now we shall give a short description of this course.

The first chapter of the course is an introduction to some medical terms like diagnosis, anamnesis, therapy.

It is stated that this course will be mainly about measurement for diagnosis.

Then the main characteristics of technology, as we use them in the project Physics and Technology and also in the PATT-concept research, are listed and illustrated with examples from Medical Technology.

The pupils learn that medical technology has developed in a historical process; that medical technology is not just a large set of already existing appliances, but also the development, designing and making of such appliances.

The 'raw materials' in technology, and also in medical technology, are: matter, energy and information. Examples from medical technology are mentioned.

The great impact of (medical) technology on society is highlighted.

Finally the interrelationship between science and technology, that can also be seen in medical technology, is mentioned.

In chapter 2 the pupils see the first sort of measurements: those measurements that make use of electrical signals in the body.

Here we make a distinction between signals that are generated by the human body itself, which are called 'passive' measurements, and signals produced by the equipment. These are the 'active' measurements: the signal
goes into the body, is reflected, absorbed, or penetrates the tissues. With minimal use of mathematics it is shown what form the potential of a cell wall takes when an electrical signal passes over it. This signal is measured at the skin of the patient. In the course we deal with three examples of electrical measurements:

1. the electrocardiogram (ECG). First the global construction of the heart is explained. Then the pupils see what happens electrically during one beat of the heart. The course contains an experiment in which the pupils measure an ECG and see the (well known) ECG pattern. The measurement technique was developed by Van Einthoven, a Dutch scientist. The Einthoven triangle is a means to get spatial information from three different ECG measurements. Part of this chapter is about heart diseases. The text contains an interview with a woman who has a pace-maker.

2. The electroencephalogram and the electromyogram. The EEG is a measurement of electrical signals from the brain. For this measurement more electrodes are used than for an ECG recording, usually about 20. An EMG is a registration of signals from the muscles.

Chapter 3 is about measurements with waves and radiation. The first part of this chapter deals with X-ray photography. A new, modern form of the use of X-rays for medical diagnosis is 'computerized tomography'. This gives three-dimensional information by rotating the scanner during the measurement. The second part of this chapter is about ultrasound techniques. These techniques are often used when the use of X-rays is dangerous for the patient (e.g. in the case of pregnancy). Another example is ultrasound cardiography. Finally the pupils learn how the Doppler effect is used to measure the bloodstream velocity in blood vessels.

Chapter 4 deals with the positive and negative consequences of the growing influence of technology on health care. In this chapter explicit attention is paid to the human and societal aspects of medical technology. It also contains information on professions in the field of medical technology and professions that make use of medical technology.
This chapter can be expected to be appreciated especially by girls.

**The evaluation of the course Medical Technology**

The evaluation of this course is aimed at the answering of the following questions:

1. what characteristics of the course material can make this course attractive to girls,
2. do the girls still appreciate the subject medical technology after the lessons about this subject,
3. do the girls learn the physical and medical concepts of the course to the same extent as boys,
4. does the concept of and the attitude towards technology in general change by the use of this course,
5. do the teachers' guide and other forms of inservice training that was given to teachers have as a result that the course has been used the way it was intended?

In the formative evaluation we do not seek a definite answer to these questions. We want to see whether or not the course needs adjustment in order to find the answers in a second, summative evaluation.

For the formative evaluation the following instruments have been developed:

1. a Likert-type questionnaire for the pupils, consisting of a number of statements about physics in general, the subject medical technology, and the course Medical Technology,
2. observations and interviews with girls about their opinion on the lessons about medical technology,
3. questionnaires and interviews with teachers about their opinion on the content of the course and the reaction of the girls and boys.

We also used the attitude questionnaire that had been developed in the project Physics and Technology to measure the pupils' attitude towards technology.

Now we shall present some results of this formative evaluation.

**The formative evaluation**

In May and June 1987 a first, experimental version of Medical Technology
has been used in 3 schools. 4 Physics teachers offered the course to a total of 109 fifth form pupils of secondary general education: 33 girls and 76 boys. As a part of the formative evaluation we interviewed the 4 teachers. They also filled out a questionnaire. This way we found out their opinion on the quality of the course and the way they used it. Furthermore we visited one lesson of each teacher. We also interviewed 22 of the 33 girls involved and we presented a questionnaire to all pupils. We asked them to judge the contents of the course and to give their opinion on some statements concerning medical technology. We also asked some experts in the field of medical physics to give their opinion on the course. On the basis of the remarks they all made we made the following alterations:

- the illustrations have been improved. Because of practical difficulties the illustrations of the first version were not always very clear. In the second version this problem has been solved,
- at the end of each chapter a summary of that chapter has been added. Particularly the girls thought the lack of such a summary was a deficiency,
- the part about the originating of an electric signal in the body has been adjusted. Both girls and boys thought this was a difficult part,
- the typing errors have been corrected. As they also occurred in formulas they were sometimes rather annoying. Several subject specific adjustments have been made as well.

First results
Although it is not the aim of a formative evaluation we can find some trends in the answers for this evaluation in which direction the aforementioned research questions will be answered.
The first question is: 'What characteristics of the course material can make this course attractive to girls?'.
To be able to answer this question we first of all have to indicate the criteria that have been taken into account in the development of the course material. In various countries research has been done into what course material would have to look like to make it more attractive to girls. The results from this research can be summarized in 4 criteria that have to be taken into account:
1. the choice of subjects for the course material should link up with the
interests and experience of girls. They are particularly attracted by the social, ethical and aesthetical aspects of physics. The functioning of the human body is one of the girls' favourite subjects.

In the course Medical Technology, as has been described before, a great deal of attention has been paid to the human body and to the social aspects of physics and technology,

2. in text and illustrations one should aim at a more or less equal number of boys and girls in a balanced role-cast. We did this as far as possible,

3. because girls are less self-confident in physics than boys the use of language in the course should not discourage them,

4. because neatness is an important aspect to girls the course material should have a good outward appearance.

The dealing with these criteria also comes up in the teachers' guide. About the first criterion we mentioned we can say on the basis of the answers given by the pupils, that the context we used, medical technology, appeals to girls. They say that the context makes the course material nicer and more interesting. It appears that the other three criteria do not make the course material more or less attractive to girls.

About the contents of the course material we can say that on the whole girls considered almost all the subjects that are discussed more difficult than boys did, but they also thought the subjects were more useful. The subjects that are liked better by girls than by boys are:

- the explanation of the ECG pattern,
- ultrasound measurements,
- subjects on more social aspects such as the interview on the pacemaker,
- the advantages and disadvantages of technology on health care,
- the information on professions in health care.

From the answers to research question 2 'Do girls still appreciate the subject medical technology after the lessons about the subject?' it becomes evident that the girls think Medical Technology is nicer and more interesting than the boys.

Because girls score relatively higher than boys on the test about Medical Technology, it seems that question 3: 'Do the girls learn to the same extent as the boys the physical and medical concepts of the course?' can be answered affirmatively.

With reference to the attitude towards technology (question 4) we can say that pupils who have studied Medical Technology do not have a more
positive attitude towards technology than other pupils from senior secondary or pre-university education who have chosen physics as an exam subject.

Inservice training did not take place during the formative evaluation. The teachers' guide alone did not make teachers treat the girls in a different way (with reference to question 5).

**The summative evaluation**

In 1988 the summative evaluation of the course Medical Technology will take place. The course material will be used on 12 schools by over 400 pupils, from the fifth and sixth form of secondary general education. For the summative evaluation, as for the formative evaluation, we shall use questionnaires, interviews and observations. We think, considering the answers we got from the formative evaluation, that the aim of the summative evaluation, to answer the 5 questions, will be reached.
Summary

Engineer, plumber, carpenter: an 'ordinary' list of technical professions. Female scientist, electrician, engineer fitter: in Dutch this list would strike the attention because in the Dutch language there are special words for women doing this kind of "men's" jobs. However, as little current as these words are, so few women are working in technical professions. How can women and girls be stimulated to choose technology?

In various fields action is taken. Technika 10 opted for a very concrete approach. Since 1986 technical clubs have been set up in the Netherlands for girls of about 10 to 12 years old; so for girls who did not yet have to choose their exam-subjects and/or further education. Under the exclusive guidance of women girls are set to work in their leisure time with, among other things, computers, wood and metal processing, electricity, physical and chemical experiments. The activities are presented in an inviting manner, whereby the accent is not on achievement, because you can learn as much from things that do not succeed as from things that do succeed. First and foremost is the pleasure of working with technology; this way girls can discover that technology does not need to be "scary" or very complicated, but nice and exciting.
AN EXPERIMENT

Girls - afterwards women - lag behind in technical professions, technical skills and in participation in the discussion of technology in society. The purpose of this project is to help them to become familiar with technics and make up for this backward position.

1. Why this project, backgrounds.

1.1 Fewer girls enter in technical jobs than boys. This difference already shows at secondary school, as girls seldom choose the right subjects, essential for admission to higher technical education and in case of lower education, girls prefer a school of domestic science to a technical school.

1.2 This is to be regretted for various reasons:
- as women penetrate less in "men's occupations" (16%) than men do in "women's" (92%), the total employment for women decreases;
- we expect a society more and more controlled by technology. Anyone who feels out of place, will lag behind in general participation in this society;
- many ethical and social questions arise as regards technological developments. The technical possibilities develop more rapidly than the discussion about the effects. In consequence because of their lack of technical knowledge, women are unable to participate in this discussion.

1.3 There is still no reason to suppose that girls have no talent for technology and science subjects, yet, even if it is assumed that they are less talented than boys, special attention is even more desired. Stimulating women to enter the technical sector in itself is not enough. There are more "women's jobs" in the consumers' side of technology: viz. operating computers/text composers/punching machines etc. than there are in more interesting, creative and responsible technical occupations. Therefore the emphasis of a project for girls must be laid on developing creativity and design rather than on
1.4 It can be claimed that the main reason for girls not being involved is due to social conditioning. Girls are not taken to the garage like their brothers, they are given different toys, they are not encouraged in the field of technics. The project Technika 10 wants to change this situation.

2. Social conditioning and a change of mentality.

2.1 There are some remarks to be made about social conditioning in general. Approached positively the following elements can be distinguished:
- a possibility of identification with a person who sets an example and to whom one is attached;
- an active inviting climate, in which learning is appreciated and rewarded;
- growing self-confidence by learning skills.

If social conditioning is to be changed, only reverse conditioning will do. There is no other way. If girls are discouraged to occupy themselves with technics, they must be especially encouraged to do so. That must be exciting, creative, a new field attractive to join in, because you can be active yourself. The person who teaches the girls must be someone they can identify themselves with, so in this case, a woman.

2.2 One can also try to bring about a change of mentality by giving information, but this only works at a more mature age and its effects can only be seen in the long run.

In the European Youth Forum it has recently been stated that change of mentality must be effected by starting at a young age, as all projects for over 16-year-olds have left unused the most important period before this age. At an early age the attitude of the mind follows the development of the experience i.e. doing things. Whilst learning skills, an appeal is made to one's creativity in a new field, which is opened up, and this influences one's outlook.

2.3 Both a different conditioning and a change of mentality are part of
the purpose of the present subject. These however are hard to measure. Some parts of this purpose, data about careers for instance can be gathered after some time, but the ultimate effect aimed at cannot be measured within the three years period of this project. Research and evaluation will be referred to later.

3. Purpose of the project.
The purpose of the project is, to stimulate girls to occupy themselves with technics in their spare time, at an age young enough to influence the choice of subjects at secondary school. The ultimate goal is that thereby women will be able to participate favourable in technical jobs; in the public discussions on technical developments; and also on a basic level in and around the house they will become able to develop more independence. Girls over 10 years old are in a minority in mixed groups for technical subjects, because of the lack of stimulation, therefore a separate project for girls is needed.

Girls will not be pressed towards technical careers, but some obstacles will be removed, so that girls have a fairer chance to find out what they like to do.

The ultimate intention is not to advocate a technical world of their own for women - after all, business life is mixed as well - but to give a better start in an integrated situation.

Technika 10 is regarded as part of a future network of resource facilities for technics as a hobby. Contacts will be made with museums and magazines.

Furthermore an attempt will be made to draw the attention of existing organizations to technics and to encourage them to include these subjects in their programmes; in particular community centres and volunteer youth clubs, special attention for girls will be requested.

By developing attractive, and for children suitable technical activities, also an attempt is made to influence formal educational programmes in schools.

By getting publicity and participating in manifestations Technika 10 hopes to have a wider influence than the creation of hobbyclubs alone can have.
4. **The target group.**

No differentiation will be made within the category "girls". In other words, the interests of girls from deprived situations will not be promoted separately - even at High School girls are socially at a disadvantage to boys.

It is the technical interest which links them, this seems more important in this project than factors that could differentiate between girls. The main point is that as much attention as possible should be paid to creating an atmosphere that appeals to girls from the age of 10. If necessary, even younger.

If initiatives arise to work with special groups within the project, (e.g. ethnic groups, which profit by the non-verbal aspects), this will always be possible, as in the circumstances facilities are available.

5. **The means.**

The means to obtain the goal is to create hobby clubs for girls, where various technical subjects of their choice are available, presented in an attractive and stimulating manner. The development of skills is necessary but it is a means, not an end. The aim is to stimulate creativity and interest in this direction. If this is to be successful much attention must be paid to what happens in the group. The girls should feel at ease. The leadership will be given by women.

The subjects planned are sometimes being decided on coincidence, like the availability of technical women with special skills to lead groups, but careful watch will be kept to see that a wide scope is offered to make sure that exploration and choice are indeed possible.

Examples are:

- computer hobby clubs for programming and design,
- electricity,
- ham radio,
- construction of models from wood or metal,
- photography and printing,
- experimental chemistry,
- funkering,
- etc.
6. **Criteria for choosing subjects.**
   To help to choose the subjects, the following criteria can be applied:
   - the subjects must be interesting for girls, recognisable in their own world;
   - the subjects should have some perspective of development, one should be able to "grow" in it (e.g.: blowing glass is interesting, but does not have this factor);
   - a project should offer a wide range of possibilities to choose from;
   - the subjects should not have the technical aspect completely hidden in more traditional girls subjects;
   - it should be clear what the function or use is of what is being done.

   These criteria apply to the whole (local) project which should offer a variety of subjects, as some aspects exclude each other more or less.

7. **Special programmes for girls.**
   If the offer of clubs is going to work, the activities that can be done should suit the experience of little girls. This can lead to simple solutions, like making the wiring of a dolls house or solder jewelry. Technika 10 goes beyond that. Boys apparently have fun when things explode, make big noises or smoke. Girls find this often just silly, they want things to have a function.

   It is also not a good idea to hide the technical aspects so well in your programme, that they achieve technical skills without being aware of it, like creating fancy dresses from tubes etc., which might need quite adroit handling or learn chemistry by cooking. The girls in Technika 10 should have a chance to really feel a "technika", as only this way they might choose a technical career for themselves.

8. **Instruction.**
   How to make children familiar with technics, so that they are fascinated and feel invited and are not frightened off is the question of the method, which has to be worked out in the course of the project. Being technically occupied has an important educational value for they are at work solving problems, whilst it will immediately be obvious whether or not their "solution" works. It is as concrete as possible and as such an essential addition to the often abstract
subjects in education. The ability to solve (technical) problems and "to learn to think systematically" is of incredible importance both for a career in business and for individual development.

The non-verbal aspect also plays an important part for children who have problems with our language, such as foreign girls. If the question is learning to handle electricity, waterpower, photographic technics or construction of models, other abilities are more important than fluency in the national language. Right solutions are rewarded at once, for "it works!". By stimulating curiosity hidden talents emerge.

As teachers, we want women who have experience of technics or else who attended education in this field, (and also have an affinity for young girls) but what part of their knowledge and skills is transferable has yet to be explored. It depends on the age and level of the child. We hope to gather further knowledge. The most common mistake is to offer too advanced and abstract material/information.

The right method of instruction is the key issue. Should one offer courses, should one offer models to copy, should one offer raw material and only advise on request, or should a project have all elements? The different local projects are going to explore all these possibilities, and bring together the experiences and evaluate, so that the project as a whole - just like the girls - will learn by experience.

For this reason regular national meetings of people who are locally working in Technika 10 are organized. It goes without saying that existing written knowledge gathered by educational institutions, will thankfully be used.


In the development of the project, many decisions have to be made in which different interests play a role. Regular evaluation will be made. Some issues have been fixed that are operative for the whole project, which are:
- it concerns girls, in their own clubs;
- under guidance of expert women;
- the lower age limit as low as possible, dependent on what they can
from about 10 years of age;
- there must be choices, to enable girls to find out what their preferences and talents are;
- it concerns hobby clubs, i.e. leisure activities;
- there must be opportunity for lasting occupation with chosen technics, in order to acquire skills;
- the interest of the girls is the main thing that counts in taking decisions.

10. The "culture" of Technika 10.
In every group, there is a "culture". This is extremely important to realise, as it is the glue which makes the whole project stick together. Therefore, these cultural elements should be made explicit and agreed to by everybody concerned. They are:
- children, and in our case girls, are to be taken seriously, and every question from them shall be seriously answered. Children should not be underestimated;
- one can be stupid and one can be brilliant, but are equally acceptable;
- no certificates or formal achievements are sought. No stress on being "productive". People learn as much from mistakes and failures as from success;
- materials and subjects will be offered in an interesting and playful manner, as a big game all are involved in. When things actually function, the joy is general;
- the emphasis will be on being active yourself, not on taking in information by listening, (although some verbal instruction can be given of course);
- a balance will be looked for, between an open group for every new girl, and a settled group which gives security to the members.
If this "culture" is to be firm and strong, it cannot be applied to the girls alone, but should include everybody who works in the project: the volunteers, the coordinators. Appreciation and valuation of persons concerned, but also the sense that the whole thing is a big game, even a joke, can be a general feeling.
HOW TO INCREASE GIRLS' INTEREST IN TECHNOLOGY?
Propositions based on an analysis of sexual division of labor, manpower management strategies and equal opportunities programs.

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Summary

When considering propositions to make technology attractive to girls (as much as it is considered to be for boys), the accent is generally put on the process of socialization of girls, on the educational system, and on the "resulting" attitude of girls towards technology, that is lack of interest (relative to boys) or no interest at all.

In our text, we would like to put into light another factor which in our view influences girls' perception not only of technology, but more particularly of jobs which are associated with a certain level of control/knowledge of various technologies. This factor is manpower management, strategies which develop "internal labor markets" reserved to men, which tend to restrict women to "entry port jobs", while men climb the occupational ladder having started in the "right" entry port to the employment system.

Our object is not to deny the importance of girls' socialization, nor of the role of the educational system, and even less to deny the importance of the social construction (by men) of technologies, but simply to shed light on a very active and determinant factor, which in our view is too often neglected, that of manpower management by firms. We would like to show that human resources management contributes, through its default to create "female models", to the lack of desire of girls to enter fields of study and jobs associated with a certain degree of knowledge of technology. Being a labor economist and sociologist, and being limited in terms of the length of the paper to be presented, we will concentrate on the analysis of human resources management strategies, equal opportunities programs, and their potential impact on the sexual division of labor, and the creation of female models associated with technology. Our analysis will be based on surveys conducted in the financial sector in Québec and in France.
LABOR MANAGEMENT STRATEGIES, INTERNAL LABOR MARKETS AND SEXUAL DIVISION OF LABOR

When considering propositions to make technology attractive to girls (as much as it is considered to be for boys), the accent is generally put on the process of socialization of girls, on the educational system, and on the "resulting" attitude of girls towards technology, that is lack of interest (relative to boys) or no interest at all.

In our view, another factor influences girls' perception not only of technology, but more particularly of jobs which are associated with a certain level of control/knowledge of various technologies. This factor is manpower management, strategies which develop "international labor markets" reserved to men, which tend to restrict women to "entry port jobs", while men climb the occupational ladder having started in the "right" entry port to the employment system.

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Inspired by a research on the banking sector in France and Canada, this paper will shed light on the evolution of internal labor markets and women's place in the job ladders or hierarchies, in the context of technological change, and of job perspectives for girls in the future.

First, we present the concept of internal labor markets, a concept which seems useful to analyse women's position in job systems, and eventually to construct strategies of access to new jobs arising from the shifts in job content and structure in relation with technological change.

We then analyse employers' strategies regarding employment of women and internal labor markets, which leads us to distinguish two categories of manpower management strategies. The first, observed mainly in Canadian banks, is based on the flexibility of the employment system. The second is one aimed at workers' stabilization in the firm, which usually means development of internal labor markets. This second strategy is visible in Canada as well as in France but mainly as regards male occupations.
Internal Labour Markets

Although the concept goes back to earlier days (Dunlop), Doeringer and Piore (1971) were the ones who popularized the analysis in terms of internal labor markets (ILM). ILM can be defined as "an administrative unit ... within which the pricing and allocation of labor is governed by a set of administrative rules and procedures", to be distinguished from the external labor market of conventional economic theory "where pricing, allocation and training decisions are controlled directly by economic variables."

This coordination through a system of rules is the main difference with the traditional vision of the labor market, governed by prices. In this perspective, an internal labor market can be considered as an "institution" which regulates the system of human resources management through a series of rules (explicit or implicit), often related to collective bargaining issues but also often based on habit and customary procedures.

As for the origins of ILM, various authors have attributed their appearance to different factors. Three main explanations are given: a tendency towards a certain stabilization of the firm's activity, the need for specific qualifications, often related to the specificity of the technology used, and finally the desire to reinforce the social cohesion of the firm's labor force.

The first explanation relates to the variability of economic activity and more specifically to the firm's strategy with regards to this. If a firm dominates a market or can at least reject fluctuations upon other firms, it will tend to create islands of stability within its structure. Also, the increase of certain types of activity such as professional/management activities related to the core of the firm's activity also tends to favour the development of such islands of stability or ILM.

The second factor, that of specificity of qualifications required, is very much related to technological advancement of the firm: if one considers that technology at least partly defines job contents (although not completely), then one must admit that a specific technology would require specific qualifications, and therefore would tend to favour internal training (on the job), an element which largely contributes to the establishment of ILM, as well as the inclusion of certain categories and the exclusion of others.

Finally, the desire to reinforce the social cohesion of the firm is often also related to situations of change, either change in technological systems, or in work organization or manpower management. The existence of ILM is
thus seen as a way for the firm to ensure the profitability of its "investments" in the training of its labour force. A strong integration of workers in the firm can increase productivity, ease reorganizations, by diminishing the threat of job loss or precarious form of employment because of the existence of the ILM. Finally it can help prevent strikes or labour disputes due to technological or organizational changes. In the context of technological or organizational changes, ILM can be seen as a precious tool of human resources management. The main interest of the concept of ILM is precisely the fact that it sheds light on the fact that firms play a very active role in terms of manpower management, more particularly as concerns paths of mobility or career lines within the firm. It is precisely this aspect of management, through rules, through defined paths of mobility or career lines, and therefore through the establishment and modeling of internal labor markets that this theoretical model of ILM appears useful for analysis of women's place in specific jobs, specific sectors, and the possibilities of changing these specific places. From there on, it is possible to conceive an active strategy in order to increase the number of female "models" in scientific and technological occupations and act positively on girls' interest and involvement in these fields of study and of work. In this perspective, the employment and educational systems are seen as closely related, various communication paths organizing the flows between the two systems.

Women's Participation and Female "Models"

In the Canadian economy, as in many other industrialized countries, women's participation rate is getting close to 50%. Soon, one woman out of two will be active in the labor market. However, women are generally concentrated in specific sectors of activity. In Canada, the main sectors of female employment are Community, Business, and Personal services (45% of female employment in the 1981 Census), followed by Trade occupations (19%) and by jobs in Financial institutions (8%).

Although women represent the majority of workers in many service sectors, they are often concentrated in bottom level jobs, what ILM theorists would call "entry port jobs". The problem for girls and women is that these "entry port jobs", often part time jobs (70% of part time workers are women - a majority of which aged 15-24), do not generally lead to higher
level jobs. The majority of women enter the labor market as secretaries, tellers, cashiers, bookkeepers, office clerks, etc., and these jobs often do not open up onto a job ladder.

On the opposite, men either enter through different entry ports which are related to career paths, and climb these occupational ladders, or sometimes enter through the same "entry port jobs", but with a different "pre-management" title, it being understood that they are simply "passing-by", to get to know the basics of the firm's activity. The banking sector is a good illustration of such a situation, situation which puts into light the active role played by firms in labor force management. As we indicated earlier, it is quite clear that labor demand (by firms) is predominant over labor supply (workers characteristics) in the allocation of labor/workers within the employment system. In this perspective, we will now present our view of labor management strategies, based mainly on our research in the banking sector.

Labor Management Strategies and Internal Labor Markets (ILM)

Our research in the banking sector (Tremblay, 1986a, 1987) indicates clearly that there exists a very developed ILM in this sector. Banks have always had very clear lines of promotion in both France and Canada (from entry port jobs to high management was not impossible), strong rules and conventions governing the employment system, very developed systems of job training, and a very systematic organization of the allocation of work. It must however be noted that these ILM or lines of promotion/career are clearly (almost exclusively) more open to men than to women, in both countries.

In the context of technological change and deregulation, the employment system or ILM is however being destructured and remodeled. Criteria, rules and various characteristics of the ILM are touched, some being destroyed and replaced by new rules or criteria, new ones appearing, particularly for the new jobs.

All employment parameters are not destroyed instantly, but many traditional characteristics of the employment system are modified. In the banking sector, reorganization is largely based on more professional (counselling) knowledge, stronger commercial (sales) capacities, and some more technical qualifications related to the use of micro-computers in particular.
From our interviews, it appears that the acquisition of these new qualities for in-house personnel represents a more violent process in North America (Canada) than in Europe (France) because the latter values more "socialized" adjustments to change, whether they be organizational or technological in nature. On the contrary, anglo-saxon systems do not manifest such a tendency or preoccupation for the "social impact" of technological or other changes.

Given these different attitudes toward change, firms still do have some choices to make in terms of manpower management. Various strategies are open to firms, and these strategies will have an impact on female labor, the women present in the firm's personnel as well as the girls who will eventually enter the labor market.

Our analysis of employers' strategies in the banking sector has led us to distinguish two main categories of manpower management. The first can be called a strategy of "flexibilization" (Michon, 1988) of the employment system. It rests mainly on the use of the external labour market for access to jobs, but also on the development of particular or non typical (normal) forms of employment (short duration contracts, occasional work, part time, etc.), as well as on wage adjustments, such as the reduction or elimination of cost-of-living adjustments (COLA clauses). The banking sector usually uses the two first methods of flexibilization, wage adjustments in COLA clauses being more common in manufacturing sectors (automobile, steel, etc.).

The second strategy is one which aims at workers' stabilization in the internal labour market, their motivation and involvement in the "firms project", which usually means more occupational training, development of a strong ILM, sometimes a more "democratic" work organization.

It is not at all impossible for a firm to use both strategies, either in different establishments or in one particular plant. It is even common to use different strategies for different occupational groups, and apparently even more so for different sex categories (Maruani, 1988). In the banking sector, it is particularly evident, since the ILM is very developed, but rather closed to women, who are generally restricted to "entry port jobs" (Tremblay, 1986, 1987).

The research done in France and in Canada shows there are important differences between the two countries' attitude towards the use of these strategies. The second strategy is more often used in French banks than in Canadian banks, but the first strategy (flexibilization) is more common in
both countries for female labour. However, research also indicates that important changes are underway in both countries and the outcome of the changes in job content and ILM due to technological changes and deregulation is quite unclear at the moment. There is still place for the development of a strategy for women to ensure their place in the employment system.

Girls' and Women's Place in the Employment System
In Canada and in France, women form the majority of workers, and particularly of non-management workers, in the banking sector as in others. As concerns forms of employment, occasional work is not uncommon, for example sometimes when it is associated with technological changes; on a short term basis, employees will be hired to do the job "as it used to be done" while the regular employees learn the new ways to do things. Also, part-time work is developing very strongly in the services and financial sector. A survey done at the Canadian level indicates that part-time work represents 16% of total employment, having increased considerably over the last few years. Obviously, women are more concerned by part-time employment, and our interviews reveal that this situation is quite common in the banking sector (10% part-time in Canada) and it often automatically excludes these persons from career paths or ILM.

On the contrary, in France, part-time work is very marginal, but it is developing for female bank employees (3-5% of the personnel), as our interviews indicated (Tremblay, 1986a). In this perspective, it can be said that French banks have preserved the "normal" form of employment (i.e. full time, indeterminate contract). We also observed a certain interest for employees' participation and involvement in the "firm's project", modern management forms and occupational training. This interest is slowly developing in Canadian banks, but American corporations in general (Canada + USA) more often opt for the first strategy identified earlier, and do not seem very intent on modifying their attitude.

How can these factors influence girls' and women's situation in the financial sector, and in the Canadian labour force in general? How does this influence their position regarding the evolution of ILM in this sector, particularly as concerns the new jobs, professional and technical jobs, which are developing the most? In the banking/financial sector, it is evident that the need for office employees, and particularly for the least qualified ones
(tellers, jr clerk) has diminished massively, and will continue to do so, while professional and technical employees (financial counselling and computer specialists...) are in stronger demand.

Obviously, it is almost impossible, even with the best internal training plan, to turn bottom level office workers into high tech specialists. From the point of view of management two options are open for these new professional or semi-technical jobs. The firm can either fire some employees (or let attrition work) and hire young employees at the beginning of their career on the external labor market, or it can give professional or technical training to the women in office jobs, open up mobility paths for them and therefore reconstruct the ILM, transforming "dead end" entry port jobs into the new restructured ILM. This second strategy would permit female employees to enter ascendant career lines through the new ILM. This would also contribute in creating female "models" in new fields of work.

As concerns the pure technical jobs, the strategy is more clearly one of hiring new employees on the external labor market. This of course leaves a possibility for girls' and women's participation to increase, but this aspect depends not only on the firms, but on the educational system which must attract women in these fields. Firms can still remain responsible, ex post, for the design of an "employment equality" strategy aimed at getting some women into the technical internal labour markets. To increase the percentage of girls and women in technical types of jobs, a more active strategy of the "Equal Opportunity" type could surely help. A few Canadian companies, amongst which a cooperative financial institution, are actually engaging in such Equal Opportunity Plans (Tremblay, 1987a). Results remain to be seen in a few years from now, but these EO Plans will surely reduce the "chilling effect", due to the absence of women in many technical jobs, which makes girls not too eager to enter those categories of employment, and therefore the associated fields of study (Tremblay, 1988).

Let us note that besides "pure" high-level technical jobs, some intermediate professional or semi-technical jobs are surely more accessible to girls on a short term basis.

The issue of these undergoing changes is still unclear in Canada, as it is in France, but a few experiences of programs aiming at equality of employment in France and in Québec do confirm that women's place in the labor market, and particularly in banks' internal labor markets, does depend
strongly on the firms' strategies in terms of labor management (Tremblay, 1987a).

References
SUMMARY OF THE THIRD THEME: HOW TO MAKE TECHNOLOGY ATTRACTIVE TO GIRLS

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The discussions that came out in the one session of the discussion groups, can be put into three categories:
1. fundamental remarks about the theme;
2. additions to Rennie's comments on her model;
3. remarks concerning the PATT-instrument.

1. Fundamental remarks
The theme was phrased: how do we make technology education attractive to girls.
In fact, this one phrase implicitly summarizes the following reasoning:
there are not many girls in technology;
there should be more girls in technology;
there are not many girls in technology because technology is not attractive to girls;
if we want to attract girls, we must make the technology more attractive...
how can we do this.

For a number of participants, this went just too fast. They are still discussing the second point, whether there should be more girls/women in technology.
A number of arguments are risen about women in technology:
a. technology needs women in order to change its 'chilly climate';
b. (some) women, like some men, want to do technology for their own pleasure, because they are interested;
c. the state needs manpower in industry. It has tried migrant workers for some time, but why not try to attract womanpower.
According to the argument you stress, your strategies may be different.
Like one participant who said: if the labour market needs more skilled technical workers, the easiest way is to attract more men. From the wo/manpower point of view, this standpoint is indeed the most effective
and the least cost-effective.
Both objectives: personnel supply and equal opportunities for men and women can go together in times where the women are needed. The danger is that they will disappear from the labour market as soon as they are not needed any more: like it happened in some countries after the second world war. This will be done either by official regulations against women or by ideological propaganda. Diane Tremblay has pointed out to us the weak, secondary position of women in the labour market.

Some participants are concerned about women's happiness. They think this can best be achieved by leaving women out of technology, at least of men's technology: women will not be happy doing men's jobs, is their belief.

With respect to this remark we must bear in mind that, whilst the actual position of women in the labour market is weaker than that of men in every country of the world, the history of this state of affairs may be different.

The Netherlands have gone through a process of hundred years during which women were gradually relieved from their hard work in factories. They could stay at home, look after the husband and the children, as we say: be active not in the production, but in the reproduction of labour. At the same time men's salaries, through the fights of the unions, were risen to a standard whereby a whole family could live on it, provided the woman was available and able to keep a household.
We are now in a process where women feel too isolated in their homes and economically dependent on men. They want to be part of the labour market, some of them also in technical jobs.

There are countries where women still are doing hard work in industry or construction, in bad working conditions. They have to, because one salary per family is not enough.

These are quite different situations for women, which we must take into account. So we must look at the situation of the different societies.
THE NATURE OF TECHNOLOGY

ATTRIBUTES OF THE TEACHER
- attitudes, beliefs, perceptions
- experiences
- expectations

ATTRIBUTES OF THE PUPIL
- attitudes, beliefs, perceptions
- skills and abilities
- expectations

CLASSROOM EXPERIENCES
- curriculum materials
- learning activities
- opportunities for participation
- assessment and feedback

OUTCOMES
- attitudes
- perceptions
- achievement
- career options

SOCIETAL AND PARENTAL EXPECTATIONS
If we want to attract more women in technological jobs, we must ask ourselves: in what kinds of jobs are we attracting them? Are those the kinds of jobs that we would like to fulfill?

Let us be realistic: some technical jobs just have very bad working conditions. Is it there that we want to put the women in? It would be better to inspire the unions and/or the governments to improve the working conditions: then these jobs will even attract men. We definitely must not fall into the trap of providing women for unattractive jobs that have been left out by the men. Diane Tremblay pointed this out in her paper too.

A last concern about women in technology that came out from the discussion groups was the concern for the women themselves. Attracting women in technology, is not that making them be like men and is that what we want? And: are not we born with sex differences?
Let me just say to this that women who enter the male world have few female role models, so they will need some time in order to define their own role and not copy on that of men. The more women there are, the more easy it will be.
To the sex differences, I just want to say, as was pointed out in one of the groups too, that there is more overlap between the sexes than there are differences. Not all women will go in technology, neither will all men.

So far for the set of fundamental arguments. Now let us pass to the arguments that could be additional to those put forward by dr. Rennie.

I will refer to the categories of her model.

The nature of technology
Technology is changing in a way that could make it more attractive. In modern technology more accent is laid on the information technology. This requires no physical strength, which used to be one of the arguments to keep women out of the technical jobs.
Another nice example of a development that fits the interests of women is: biotechnology.
**Societal and parental expectations**

Rennie pointed out that curriculum developers and teachers cannot alter the expectations of society and parents in a short space of time. Yet, some examples are known where the schools try to reach the parents (we heard an example at the Pijler school Saturday, were parents were invited to the computer class).

In the discussion groups it was said that it is important to give information to parents, for example on career choice. This can be done by counselors.

**Attributes of the teacher**

Research has shown that often teachers hold lower expectations for girls than for boys and treat them in a different way.

But, as Rennie pointed out, this is often because they do not realise. In our country we say: they have no problem-awareness.

This problem-awareness can be created by giving the teachers information, by having them discuss about good teaching methods. Not by accusing them.

One group suggested the use of videoregistration in the class, provided this would not influence the teachers' behaviour so much that nothing will come out.

Female teachers can act as role models. This again is a problem in a number of countries, which have very few female physics and technology teachers. This appears not to be the case in all countries (Poland). The other way round: in primary education we all have many female teachers, but they did not have any science or technology training.

It is important to train counselors and to make them aware of the fact that they can contribute to widen girls' jobs perspectives.

In-service-training can play a role in changing teachers' attitudes. Some countries seem to have more facilities for in-service-training than others.

The MENTproject pays special attention to the opinions and the role of teachers in technical schools, as appeared especially from Anita Altings' paper, in which she reported research on teachers. Marja Brand also dealt with the teachers' role in her sketch of a plan of action for technical schools.
Attributes of the pupil
Rennie considered the history of the pupils as unchangeable. Though this is correct, we may try to prevent that at an age of sixteen we must regretfully conclude that this female student has a life history that has put her out of science.
There is some evidence both in the research and in the experience of the inspiring primary school team from Devonshire that students who have had the opportunity to acquire practical skills and experienced success in experiments develop a less negative attitude once they reach puberty: the dangerous period for girls in science and technology.
At that age, 12/14, girls start to reflect on their social position as women. Their interests develop in a different direction. If they have a non-traditional interest they may feel uneasy about it. If the technical interest is strong enough, they may go to physics and math courses anyway, but if not they will be lost for technology.

One of the measures with regard to pupils that are taken in some countries are the single sex classes. I am especially speaking, not about all girls schools, but about mixed schools with single sex classes for some subjects. In the United Kingdom this is practised in some schools for math and science. Although quite some people tell me this strategy is succesfull, the written literature that I see about it, tells me the opposite. So if you have any material on the results of single sex classes in the UK, I would gladly hear about it.

An interesting combination takes place in some schools in Poland. Here gymnastics and technology are taught in single sex classes, and timetabled one against the other. The technology curriculum and the final requirements are the same for girls and boys.

Classroom experiences
The classroom experiences deal with curriculum materials and learning activities. Our main question: how do we make technology interesting for girls, really fits into this category.
Two papers especially deal with this question: Wilma Groenendaal described the development of a 'girl-friendly' physics course on medical technology and my own paper listed some of the interests of girls and boys.
Some suggestions came up in the workshops.
- Develop more modular courses with boy-friendly as well as girl-friendly subjects.
Modular courses, with clearly stated objectives and delineated content, are anyhow believed to be beneficial to girls. Up till now, we have no evidence for this assumption in the Netherlands, by lack of sufficiently long experience.

It was pointed out in our group that some countries attract neither boys nor girls in technology; it should be made more attractive to everyone. From the other side: if we make technology more attractive to women, this will also benefit men.

One group discussed whether a different kind of teaching method was needed for girls and boys.
Experience from Germany shows that both boys and girls can be good at doing things with their hands. The top layer of good pupils is always a mixed group.

Few specific suggestions came out of the group in order to improve the curriculum.

2. The model of dr. Rennie
I have used Leonie Rennie’s model for structuring the remarks of the discussion groups. One group commented on the model itself. This group suggested to give the lines between the factors two arrows, in order to make the influence more mutual. Rennie’s model was directed toward pupil outcomes. But indeed, there are mutual influences between these factors.
In fact, these mutual influences can be important change agents: new curriculum material can influence the perceptions of the pupil; or new learning activities may influence teachers’ expectations and so on.

3. The PATT instrument
The third category of remarks concerned the PATT-instrument. As you
may remember, Rennie explored a statement recently made by Jan Harding and Martin Grant from the former GATE-project (Girls and technology education), who in turn borrowed their ideas from Ray Page, as we have heard in this conference.

The concern was about the undecided-category responses of the girls. What does this mean for the PATT-instrument and for the conclusions drawn on the basis of PATT results.

We have to look at the methodology:
- what do we do with the middle group;
- what do we do with the indifferent group;
- what do we do with the undecided group.

Should it not be better to have no zero option and to force girls to make a decision in attitude? The answer in this group is: probably not, because girls are more cautious in answering; they want more information about what is really meant in the question.

May be we must not say that girls have a lack of information, they are just more cautious. Boys more often give intuitive answers without really reflecting on the consequences.

Since the meanings of the don't-know-answers are plural, we have to discuss more about the reliability and the validity of the research, especially when we are going to draw conclusions about differences between boys and girls.

We need more of the 'rational scepticism' demonstrated by Dr. Rennie, in order to give the PATT-research more credibility.

Yet, this group raises the question: since we know that men are more fond of the 'positive' things of technology, and since women tend to be more interested in the 'negative' things, can we then ask the same questions for women and men.

Concluding remarks

When I compare the discussions in the groups with the initial question leading this theme: how can we make technology more attractive to girls, I don't think the answers are clear to everybody. Although Dr. Rennie's paper clearly indicates some roads, not all the participants are already prepared to walk on it, let alone to pave it with new stones.
To some of us the answers seem clear, but we must not forget that we live in a complex society, different from one part in the world to another. The changing role of women is part of that complexity, as is education. Fundamental discussions about the role of men and women in society must take place, and they have taken place in the discussion groups.

Our American friends made a plea to the profession to unify on one concept of technology and to set out a common strategy. One concept will not be possible in matters of sex equity, because the underlying analysis is too complex. But I do believe that it is possible to point at some factors in education which form barriers to a full development of women. After we have defined those barriers, we should try to formulate a common strategy in order to overcome them. This will be the task of the technology teaching profession, both women and men, for the coming years, if we want to provide an education that equally benefits boys and girls.
EDUCATION OF TEACHERS FOR
TECHNOLOGY EDUCATION
TEACHERS FOR TECHNOLOGY

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Summary

The essence of Technology is its complexity. It is not the preserve of any one school subject. It is the responsibility of all subjects. However, it has its own disciplines, concepts and methods. These establish unique academic relationships with individual subjects which, almost invariably, do not fit comfortably with the inherent philosophies of those subjects.

If teachers are to accept responsibilities to contribute to technology education it will be necessary
a. to foster the common acceptance of an overall philosophy of Technology which will,

b. require a common language in which to conduct dialogue between teachers; and

c. to establish working, two-way, connections of mutual support between Technology and each subject.

This lecture will examine a structure on which to base these developments using, as case studies, the subjects of science, craft and the humanities. It will compare the purposes, the processes and the content of these subjects in relation to those of Technology, demonstrating their mutual support and compatibility. It will show how teacher training and in-service training is being based on this structure.
TEACHERS FOR TECHNOLOGY

Introduction
The issue of teacher training for Technology in schools cannot be approached effectively without, first, getting to grips with the complexity of Technology itself and of the educational aims which may be associated with it. It is too easy to make pre-emptive assumptions that school technology is applied physics, handicrafts, electronics, engineering, or whatever, and design courses accordingly but without reference to related areas, or progressive structures of learning.

That this happens is understandable. Technology does not possess a history as a recognised field of school education so there is no received understanding of its nature as an academic discipline.

All the more reason, when planning the education and training of teachers of Technology, to look deeply into its nature, its history and its future. This last point is of particular importance. Students commencing teacher training today, may well, before they retire, be teaching children who, themselves, will still be effective adults one hundred years from today. Looking at the same point in reverse; I was being taught, in the 1930s, by teachers who had been trained in the 19th century. To estimate the technological changes in the last hundred years, concentrates the mind when deciding how to train technology teachers of the future.

Complexity of Technology
With that lesson in mind I will now rapidly survey the nature of Technology in such a way that it can provide a foundation for technological education and for the training of its teachers. I will examine it in the pattern of Figure 1.

This requires a working model of Technology itself which can be used as a framework on which to relate its component parts to each other and to show its overall pattern. One of the, now conventional, models is shown in Figure 2.
The Nature of Technology itself and its Role in the Development of Mankind

- Its component parts
  - Content disciplines
  - Generalisable concepts
  - Process actions

Integration into single holistic entity

Figure 1. Aspects of Technology.

HUMAN PURPOSE
Examples:
- Building sandcastles
- Making artificial limbs
- Making scientific discoveries
- Artistic expression
- Feeding
- Siting an airport

RESTRAINTS ON TECHNOLOGY
- Laws of Science
- Technical
- Financial
- Limits of knowledge
- The specified purpose
- Personal and social

THE PROCESS OF TECHNOLOGY
- Identify problem
- Propose solutions: choose the best
- Implement the practical design
- Test and compare with original purpose

RESOURCES OF TECHNOLOGY
- Concepts and methods of science
- Concepts and methods of technology
- Material
- Sources of information
- Manpower
- Quality and quantity
- Personal creativity

ACHIEVE PURPOSE
Examples:
- Culture
- Exploration
- Comfort
- Artifacts
- Knowledge
- Leisure

Figure 2. A model for Technology (Project Technology, 1970).
I will not discuss this model in detail, it is covered elsewhere, but I will emphasise its three central features as these provide the keys for all further planning. These features are:

1. Technology's central PROCESS of identifying and meeting human needs,
2. The PURPOSES which technology sets out to achieve, and
3. The RESOURCES of knowledge, skills and personal qualities which have to be called upon in pursuit of technology's purposes.

Now this is a very generalised model and its use as an immediate indicator for technology education is questionable. It can happen that simplistic decisions are made. For instance, the central design and problem-solving process sometimes is used as the complete model for a course with children attempting to solve problems, all over the place, without any form of logical progression either in the process itself or in the acquisition of resources of knowledge and skill which will increasingly be needed. Alternatively, it can happen that a course is devised which is centred on one area of resource, such as electronics, which is taught, in effect, as a science without it ever being used to make decisions which effect action. Yet again, courses about Technology, about ways in which mankind has achieved so much in the past, have been created. All three can have their place. On their own they do not represent Technology.

We must stand back from Technology and view it in a more holistic manner.

First, look at the range of contexts in which Technology operates. The list would be virtually infinite but take, for instance, the following:

<table>
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<tr>
<th>Contexts e.g.</th>
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<tbody>
<tr>
<td>Agriculture</td>
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<td>Building</td>
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<td>The Arts</td>
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<td>The Home</td>
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<td>Transport</td>
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These are all contexts in which Technology plays a leading role. As examples, take The Home, and Medicine. A very superficial examination suggests Technology operates in these contexts in a wide variety of ways, namely:

Figure 3. Some contexts in which Technology operates.
So one could, quite arbitrarily, select one or more such contexts and use them as a basis for a course on Technology which could be holistic in terms of Purpose, Process and Resources. It may still not be complete because it only required students to be involved in a single context or major area of human purpose.

One of the main aims of technological education must, surely, be to help students face the unknown of the future. As teachers, we cannot anticipate for them just what problems they will face which will call for technological solutions. This may be one of the failures of classical engineering education which predetermines the problems and their solutions which students are expected to face.

Technology education must base itself in contexts of reality but it will
need to be done in such a way that the competence and capability so developed is transferable to new contexts and students are helped to meet original challenging situations.

An approach to this may be to look at those technological features which are common to the contexts mentioned above. Such features which might come under the headings of "Overview - the grand issues of Technology", "Generalised Concepts and Methods", "Knowledge, techniques and technologies which, although particular to each context, are used in many such contexts", and "Process, actions and skills", for instance:

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<tr>
<td>History and Future</td>
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<td>Purpose, Values and Conflict</td>
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<td>Control - Personal Local National World</td>
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<tr>
<td>Economics - Resources Capital/Labour Politics Employment</td>
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<td>Culture - Human Individuality and Co-operation Dependence and Independence Enterprise Achievement</td>
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<td>Aesthetics - Intrinsic Extrinsic</td>
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<th>Generalised Concepts and Methods</th>
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<td>- language</td>
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<th>Knowledge and Techniques particular to Contexts and Technologies</th>
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<tr>
<td>- structures</td>
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<td>- electricity</td>
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<td>Thermodynamics</td>
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<td>Aeronautics</td>
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<td>Instrumentation</td>
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<td>Physics</td>
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<td>Biology</td>
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<td>Dietetics</td>
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<td>Fertilizers</td>
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<td>Etc.</td>
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<th>Process Actions and Skills</th>
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<tr>
<td>Identification of need</td>
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<tr>
<td>Judgements - values and purpose</td>
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<tr>
<td>creative thinking</td>
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<td>designing</td>
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<td>realisation - of thinking</td>
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<td>Reflection</td>
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<td>evaluation</td>
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Figure 5. Features of Technology common to many contexts.

These must form the raw material of any course in Technology. Although they are context-free they should not be taken out of context as they have to be shown as providing the keys to new and unforeseen contexts.

Courses need to be designed which, operating on this raw material, progressively engage students in the technological processes of a variety of contexts thus developing their Awareness of the potential and implications of Technology, their Resources of knowledge, of intellectual and physical skills, and of personal qualities on which they will need to draw, and their
Capability to tackle the real problems of their lives and their communities which need technological support.

Therein lies the complexity of Technology and technological education — in summary:

- Technology is not an island, it is holistic.
- Technology influences every area of human activity (and hence every school subject).
- Every school subject potentially contributes to the overall concept of Technology.
- The educational aims for Technology are not often owned by other subjects.

This leads us to the conclusion that Technology in the curriculum needs a discrete and clearly articulated progressive discipline which has built-in interfaces with all other areas of the curriculum.

**Teachers for Technology**

The conclusion just arrived at indicates that every teacher has a role to play in technological education but precisely what that role is may be uncertain. I suggest that this problem is considered in two parts.

First there are those teachers who should be responsible for the central, or core, discipline of Technology. They have two kinds of problem. They cannot possibly know all there is to know about Technology in all its concepts and contexts, and they are unlikely to be familiar with the essential disciplines and purposes of other subject teachers who may be able to contribute to technological education. Such teachers must have a sound general basic understanding not only of the overall patterns of Technology but also an intellectual grasp of the fundamental realisable concepts and processes employed throughout Technology (e.g. Control). They must possess expert knowledge, and personal experience of the knowledge, techniques and skills, particular to, at least, some individual technologies and contexts (e.g. micro-electronics, agriculture or medicine). This knowledge must be taken to the level where it can be used to make decisions which effect actions. They must be able to communicate on such matters not only with their students but also with fellow teachers. For this they will need and unambiguous language for dialogue.

They must possess the pedagogical understanding and skills to ensure progressive achievement of accepted aims.
Second, there are the teachers of other, more traditional, school subjects. Very often such teachers regard themselves as isolated from Technology; they do not understand it; they do not wish to understand. The word "Technology" itself is unwelcome and disconcerting.

However, when Technology is approached along the lines indicated above, most subject teachers realize that their subject has its own technologies and accept that practitioners in their subjects can also contribute to technological education as a whole.

If, however, education in Technology is to be a composite of a central discipline and many complementary contributions from other subjects, and if this composite education is to make sense to children, it will be necessary for all teachers concerned to be seen, by the children to be working towards the same ends.

This is why it is necessary to build on a common model of Technology such as that illustrated in Figure 2. The relationship of any subject to this model can be structured in terms of its contributions to, and its contributions from, each of the three central features of Technology, namely, its PROCESSES, its PURPOSES and its RESOURCES.

For instance, the Purposes of Technology may well arise in the contexts of humanities subjects, such as devising hydraulic models for studying aspects of physical geography or in surveying and dating archeological remains. Or they may arise in science when investigations are needed which require accurate instrumentation. Craft subjects consistently raise purposes or needs for Technology, as in glazing of pottery or the structural rigidity of furniture.

Equally, and vice versa, Technology provides purpose for disciplines of other school subjects. Technology of Materials frequently calls for scientific investigation into physical properties such as conductivity, wear, creep or heat treatment; it calls for precision in language for the explanation of its uses; it calls on mathematics for many of its decisions; and it continually calls on art and aesthetics as supporting resources for its design decisions. Perhaps the most significant and fundamental interchange of purpose occurs when judgements have to be made between totally different sets of values, such as safety and cost.

Just as there is a two-way relationship between Technology and each subject, in terms of Purpose, so there is in terms of Process and Resources.
Figure 6 sets up this pattern of relationships.

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<tr>
<th>TECHNOLOGY</th>
<th>CURRICULUM AREA</th>
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<tr>
<td>PURPOSES</td>
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<td>PROCESSES</td>
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<td>RESOURCES</td>
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Figure 6. A pattern of relationships between Technology and other school subjects.

The Process methods of science, the geographer, the historian, the mathematician, etc. are all there to be used by the person who operates technologically. Equally the processes of Technology can be followed by the historian or geographer when they need to create systems to bring about a desired end result.

Finally, the Resources of knowledge and skill of the scientist, the craftsman and the historian are all likely to be called upon by the technologist.

Emphasis on this two-way mutual support relationship enables teachers of other subjects to feel that, in contributing to technological education, they are getting something positive in return.

Another way of looking consistently at the structure of school subjects is that devised by the Science in Technology Education (S.I.T.E.) Project which, although it focussed on the science contribution to Technology education, found that the model held significance for other subjects.

Figure 7 suggests some step changes in the connections between the core knowledge of a subject (the innermost area of the sector representing a subject) to the outermost which are when the subject merges with other disciplines in tackling the problems of the real world.
When this model is applied to the subject field of science it provides several useful structures for developing the necessary science teachers' attitudes towards, and comprehension of, Technology. Figure 8 provides an illustration of these structures.

Stage 1. The symbol \( \triangle \) represents a classical scientific concept used to explain the nature of some phenomenon.

Stage 2. The same symbol, inverted \( \square \), represents the same concept being used to make a decision which will bring about a desired effect.

That transformation, from stage 1 to stage 2, is the first of the significant differences between Science and Technology.

Stage 3. The symbol \( \text{\textbullet} \) represents the use of multiple concepts in the making of a single decision. This second significant difference introduces the fact that, very often, concepts are in conflict with each other; they need to be balanced against each other and subjective value judgements are often inherent in
the final decision despite the scientific certainty of each concept on its own.

Stage 4. Here, the multiple inverted scientific concepts have to become balanced with a series of other issues arising from other curriculum areas - geography, craft, mathematics, etc. It is at this stage that, within the curriculum, Technology is represented as having to cope with the problems of the real world.

Stage 5. But it is at stage 5 that pupils experience the actual problems of the world and can apply their problem solving process skills, calling on the resources which they have acquired from across the whole curriculum in arriving at a satisfactory solution to the problem.

These five stages need to be experienced by science teachers if they are to be able to teach from the heart with experience of Technology. Teacher training and re-training will need to take account of each of these stages in giving teachers the confidence of personal experience they will need.
The Learning Experience of Technology

In the last section I described, in general terms but in specific stages, the kinds of experience any teacher contributing to Technological Education should acquire.

This final section deals with the greater detail of the learning experience each student should undergo in developing capability in Technology. This is the experience of combining the knowledge and concepts with the skills of designing and decision making in arriving at a useful resource with which to face technological tasks. The mere possession of knowledge, however potentially useful it may be, is of little value to Technology without the skills of designing, judgement, making and testing needed if that knowledge is to be put to use.

Learning to acquire resources, therefore, first requires the operation of skills on the concepts. This interaction reinforces the possession both of the skills and the concepts.

This is illustrated in figure 9.

With the acquisition of such useful resources, experience can be given of technological tasks of identifying needs, designing, optimising, generating solutions to the needs and testing the end result. Such experience of real or simulated tasks gives purpose to the acquisition of the resources of knowledge and skills and provides motivation and relevance.

Figure 9.
The complete model is represented in Figure 10 which is taken from, and explained in more detail in, *In place of Confusion* by Black and Harrison, 1985.

**Conclusion**

This paper has taken as its starting point a conventional interpretation of Technology and shown how a satisfactory education in Technology will be dependent both on mainstream Technology teachers and on contributions from other subjects.

Recognising the difficulty of establishing "ownership" of Technology amongst diverse teachers, I have recommended that all contributing teachers need to experience the development of technological capability in themselves. I have, therefore, outlined a way of thinking about Technology for each subject using a language which is not technical or specific to any one subject.

Technology has too great an effect on humanity for it to be left to the Technologists. The aims, aspirations and values of everybody need to be marshalled if it is to be used for the betterment and not the deterioration of mankind.
TEACHER TRAINING AND THE CONCEPT OF TECHNOLOGY

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Summary

In our modern society technology plays an important role. This means that almost everybody has an intuitive notion of 'a' concept of technology. Most people do have a, positive or negative, attitude too towards the use of technology in industry in our modern 'information and automation' society. This very important role of technology in our lives leads in a lot of countries all over the world, to the introduction of a subject called 'Technology' in secondary general education. Almost everybody agrees, that this subject must not include vocational training (as e.g. industrial arts) and that it must be suited and attractive for all pupils, including girls. But, you need capable and qualified teachers!

In the Dutch situation this means, that teachers originally qualified for crafts or science, will be qualified for Technology by means of an inservice training.

One of the main problems we have to deal with is the incomplete and often incorrect concept of Technology our participants start with. Generalizing one can say that this concept depends strongly on the background of the teachers: for 'technicians' technology consists chiefly of 'skills' and 'knowledge' related to future vocations (see industrial arts), and for science teachers technology is essentially 'applied science'. It may be clear, that the obtaining of a balanced concept of Technology is one of the most important objectives of our inservice training, next to the necessary skills, knowledge and attitudes. It may be clear too, that accommodation of existing concepts is very hard to reach, as Piaget stated already two years ago.

Still, we seem to score in the last two years: packed in a lot of practical activities, the participants become more and more conscious of the 'essence' of Technology. Moreover they can translate it to their own situation in education.

In 1990 we will start with pre-service education. The conceptual problems seem simpler there: you start in a 'blank' situation with young students. You can carefully build up a balanced framework of Technology, without the impediments you meet in the inservice training.

Otherwise, it is remarkable that everywhere educators in Technology discuss the concepts of Technology thoroughly. In many other subjects, often with a long history in education, similar discussions would be useful: the problems of pupils in mathematics or physics may be connected with the totally different concepts of educators and pupils!
TEACHER TRAINING AND THE CONCEPT OF TECHNOLOGY

In our modern society technology plays an overwhelming role. Almost everybody has an intuitive notion of technology, but these notions differ a lot, as can be seen in the PATT-results (de Vries, [1]), both for teachers and for pupils. Often the notion of technology includes a, positive or negative, attitude towards the use of technology in our society.

The quite different ideas about technology are inherent to the complex character of technology; it is rather simple to describe how a car can be defined, but for technology it is far more complex. Even specialists enumerated a lot of different distinguishing marks when they were interviewed about the fundamental concepts of technology (Barnes, [2]). History teaches us (Layton, [3]), that the term technology "originally meant systematic knowledge of the industrial arts. This knowledge was implemented by means of techniques. In modern usage, particularly in English, this distinction has become blurred. Technology is often taken to comprise both the knowledge and the means of its utilization".

Looking at technology in secondary education, it is interesting to remark, that recent developments in France closely connect to the "narrow definition" used in the past: after the introduction of the comprehensive school in 1975, nationwide in public schools, for grades 6 to 9, crafts became an obligatory subject in 1984, 2 hours a week in grades 6 and 7 and one and a half hour a week in grades 8 and 9. Soon it became clear that technology would make much more sense in this type of general education. Before 1990 crafts will be replaced by technology in all "colleges" (the French name of this middle schools). The contents of this new subject is closely related to the narrow definition described by Layton, in contrast with the situation in an number of other countries, where Techniques are included in technology.

Which descriptions of technology are used in education?
Keep at the back of your mind, when you read these definitions, that some of them are designed for pupils of 12 to 14 while others are used in curriculum development projects, written down by and for specialists.
First, three descriptions for pupils:
interest of the society. This includes a responsibility for the environment! SLO, National Institute for Curriculum Development, [9]).

A short analysis of the descriptions shows clear differences: in the report of the commission on technology education in New Jersey, the "systems approach" forms the core, while in the workdefinition of Page problem-solving is the most essential part of the curriculum.

The definitions of Van Hecke and the SLO show, that the working-out of a concept in related curriculum-contents of the educational subject may produce a lot of problems: although the descriptions do not contain straight indications for the inclusion of crafts in the curriculum it seems rather important in the developed curricula: in the Dutch case up to 40% of the time has been dedicated to crafts! Of course this ought to be done in a problem-solving approach, but in practice there is a big danger that the factual contents do not relate with the underlying fundamental concepts!

To understand the Dutch situation you have to know that the roots of technology as a school subject are in the vocational technical schools. In these schools, training of skills is still very important, while e.g. "technology as part of our culture" is strictly denied.

One explanation for this may be found in the training of our teachers in vocational subjects and the pupils in their schools.

In general, teachers in vocational education, especially in technical subjects, are specialists of whom the careers started also in the same vocational schools with much emphasis on their technical abilities and less attention for general educational subjects. Their relatively narrow education makes them less aware of the fundamental concepts of technology. Technology and technics are often mixed up (see also DeVore, [10]).

Of course this phrase is a generalization: there are splendid technology teachers among the vocational trainers, fully aware of the fundamental concepts. But they are still a minority. This is not only manifest in technology in general education, but also in the vocational subjects in the upper grade of the technical schools: skill training is emphasized, often of skills which are relevant, in the best case, now, but more or less useless in another 10 years. In a number of industrial sectors this causes dissension: a rapidly changing industrial society requires employees with problem-solving
1. We define technology, at least for now, as the use of our knowledge, tools and skills to solve practical problems and to extend human capabilities. (Todd et al., [4]).

2. Technology is the use of knowledge to turn resources into the goods and services that society needs. (Hacker and Barden, [5]).

3. The goals of technology education are learning to understand how technology may help us to improve things in our surroundings, to formulate opinions about the use of technology and to tackle and solve technological problems. (Van Hecke et al., [6]).

And now some "workdefinitions", used in curriculum development:

4. Technology education is the study of the nature of adaptive systems to include their basic elements (tools, materials, processes, energy, information and humans); the growth of those systems; the use of knowledge and technical means in solving practical problems; and the impacts of these elements, systems and activities on individuals, society and culture. (Todd, in Report of the Commission on Technology Educ. New Jersey, [7]).

5. Technology is a problem-solving process which has as its goals the improvement of the quality of human life, as its starting point human need, and as its continual companions the resources and constraints of human knowledge and natural resources. (Page, [8]).

6. Technology is the field of activities of men, based on collection of knowledge and skills by which men provide themselves of means to adapt their surroundings to their needs, in their own interest and in the
abilities, while system-analysis becomes essential at all levels!

Since about 5 years there is a growing number of science and arts teachers involved in technology in the first two grades of secondary education. Their background is totally different: they are trained as teachers, after a general, often pre-university, education. The general part of their training takes care of a broader view on society and technology and their relationship. As a result of their initial teacher training they are more "pupil-oriented" in contrast with the technical teachers, who are far more "subject-oriented".

Especially the science teachers seem to be conscious of the essential concepts of technology; an extra support is, that they are trained in the scientific backgrounds of technology. From the description of the inservice-training of teachers, below, it will become clear, that these statements are not merely based on "sound reasoning", but on results of "small scale" investigations by means of the PATT-questionnaires.

Comparing the results of these questionnaires with the similar ones for pupils there is a very remarkable result: the differences between teachers with different backgrounds is much larger than the differences between technical teachers and their pupils! This confirms them in their idea, that their own, (mis?)conceptions of technology are the valid ones.

An extra handicap is connected to this: pupils in vocational schools have large difficulties with the more abstract concepts of technology because of their cognitive abilities: in the Dutch system pupils do not choose for vocational education because of the career opportunities, but because of the lack of abilities to succeed in general education!

Teaching-materials, designed for these pupils give a misrepresentation of the desired contents of this subject in future...

Nevertheless it stays hard to "translate" basic concepts in concrete contents of an educational subject: a lot of restricting conditions are responsible for a still existing gap between ideals and reality. The sketched limited vision of the teachers described above is only one of them!
Working on solutions

"In high speed" we try to eliminate the restrictions and to solve the problems in the Netherlands:

- funds are available for equipment and rebuilding of classrooms. This is necessary in relation to the nationwide introduction of technology in general education (the new "basic education", a short type of middle schools) in the 1990s.

- teachers who have to teach this new subject, can prepare themselves by means of an extensive in-service training. Their new task is interesting, but also very demanding, while technology, as said before, is very complex with a lot of different aspects, but also because of the limited equipment, which makes it necessary that pupils are working on different tasks simultaneously.

In the Netherlands teachers cannot be obliged to participate in the in-service training, but the pressure of the authorities is so high, that almost all teachers involved in technology education participate in some in-service courses.

- the school management and the technology department can be supported by teacher training institutes or by special guidance institutes with the introduction of technology. Planning procedures, but also very straightforward help in design of a technology classroom are examples of this help.

The in-service training

The in-service training for technology teachers has been described extensively in earlier publications (Stroeken and Deijsselberg [11], Mirani [12]).

Therefore, I shall give here only a schematic outline and shall go further into the content of various parts of the training in relation to the topic of this contribution.

Thematically the in-service training looks as follows (see diagram next page).

Discussions about the fundamental concepts of technology are the most important part of the starting module, which shall be discussed extensively. To complete the picture of our training, I shall give a short review of the other courses. Participation in these courses is only possible after a,
successful, participation in the basic module!

**The skill training**
Since we do not have an initial training for technology teachers, we have to fill in the gaps in the training of teachers originally trained for other subjects. In short modules they can fill up their own shortages in skills and knowledge. In illustration: we have developed about 20 modules ranging from "working with wood, metals, textile or plastics" via drawing, principles from physics and chemistry and controlling to "safety and first aid" and "designing and problem solving".

**Curriculum development project**
In this module a curriculum for technology for use in their own classroom is developed and implemented.
This course includes attention to a large variety of methodological questions as, how to differentiate between pupils, how to assess the pupils' results, how to deal with different learning and teaching forms. Selection and/or production of suitable learning materials are a central part of the course, which also includes some guiding activities.

And then: **the basic starting module**
The main goals of these courses can easily be described:
the developing of a balanced concept of technology by means of practical examples and hands-on activities.

First of all a review of the content:

1. **What is technology?**
   
   **What do you think of technology?**
   
   By means of open questions and PATT-questionnaires for teachers the ideas of the participating teachers about the fundamental concepts of technology are investigated. The results are used as starting points for several discussions to broaden their view.

2. **What do pupils think of technology?**
   
   Again we use PATT materials. Originally we used the extensive PATT-questionnaires, which were scored by the PATT-working group. In the last four months we used the TAS, to obtain some experiences with this instrument, specially designed for use by teachers in their own classes. Some experience will be reported below.

3. **Consequences of the results of the first two questions for technology education.**
   
   From the discussions about the fundamental concepts of technology conclusions are drawn for education. Goals and objectives are formulated.

4. **The curriculum proposal of the SLO (National Institute for Curriculum Development).**
   
   Next to their own ideas, the proposal of the SLO is discussed. Comparison of this proposal with the developed concepts in the course, in relation to concrete teaching materials, makes it clear that contents are relatively unimportant, compared with the underlying approach.

5. **Strategies for problem-solving.**
   
   In our in-service training, we use two models for problem-solving, PRISME, an extension of a model from STEM [13], and DTMC, the Dutch abbreviation of Thinking-Drawing-Making-Evaluating from SLO. Advantages and disadvantages, differences and agreements come, again by means of hands-on activities, up for discussion.

6. **A short introduction in several learning and teaching activities.**
   
   A short introduction in the school based curriculum development project. Special attention is paid to the pupils' environment as starting-point for education instead of the structure of the subject as the ordening principle.
7. Analysis of teaching materials.
The objective of this unit is to realize, that you have to formulate criteria for written materials you want to use in your lessons. Some of the criteria depend on the concepts of the subject, other criteria depend on the abilities of your pupils, while the background of the teacher may introduce some extra criteria.

8. The first step in curriculum development.
"Translation" of the knowledge acquired in this course in concrete ideas about a technology curriculum.

In this module the participants are informed about legislation and other practical rules, associated with their own qualifications and the funding of equipment and rebuilding classrooms.

All activities in this course are influenced by our attempts to emphasize the importance of the fundamental concepts of technology.

A problem in our approach is, that the SLO curriculum proposal, and obviously also the "final terms" for technology, still contain a lot of crafts as described above.

TAS in the in-service training
Most teachers are hardly aware of the starting situation of their pupils in their subject. Especially in technology the differences are substantial, because of the prominent role of largely varying out-of-school experiences. Under the influence of the training they realize themselves that there are differences between pupils, in cognitive as well as in attitudinal points of view. This makes them aware of the necessity to investigate the starting situation of their pupils. The TAS, the Technology Attitude Scale designed by de Klerk Wolters [14], is a possible instrument for use in the classes.

A preliminary summary of our experiences with TAS shows the following results:
1. The indicated categories are satisfactory.
2. The teachers do not need more standard scores.
3. The scoring was easy to fulfil, although it still took a lot of time.
4. Some teachers indicated that the results were not very "significant" and tended to be "the mean score". The training of teachers in dealing with statistical material is very poor. Most teachers cannot or hardly judge if
a difference is significant or not!

From the evaluation and from discussions about the goals for using the TAS you can deduce some indications for adaptations:

- teachers like to know if their lessons were successful especially in relation to the fundamental concepts of technology. Their own tests are mostly assessing the contents of their lessons. By means of several versions of TAS it is possible to use it in different stadia of education, so offering a means to measure the success of it. The results can be used to change the curricula.

- in our modern, highly automized society, it must be self-evident that the next version of TAS can be processed by a microcomputer: TAS on DISC. It is easier to give feedback to pupils, while it is obvious too that a well designed program meets a lot of the difficulties of the teachers, not used to deal with statistics.

- a version of TAS, used in grade 9, at the end of the basic education should contain some elements of the Fukuyama profile [14], so that pupils can get some ideas about their career opportunities, based on capabilities within and personal tendency to some technical areas.

Summarizing, one may conclude that TAS can become a useful instrument, with some extensions for a more general use and some simplifications of the statistical processing.

In the in-service training, but also in the pre-service education, the use of attitude scales seems to be very important: the differences in knowledge of, interest in and attitude towards technology are localized and become subject for discussion.

References


DIRECTIONS FOR USE OF THE TAS IN CLASS

Technology
Attitude
Scale

The TAS for teachers

Falco de Klerk Wolters
Project MENT-Attitude
Eindhoven University of Technology
October 1987
## CONTENTS

1. Aim of the TAS | 1
2. Description of the TAS | 2
3. Administration of the TAS | 6
4. Determining class-scores of group-scores | 6
5. Interpretation on the basis of standard data | 8

### Appendix 1:
- Standard data 2 AVO - VWO
- Standard data 2 LBO
- Key and score form
- The Technology Attitude Scale
1. AIM OF THE TAS

The Technology Attitude Scale, abbreviated to TAS, is a questionnaire that provides information on what pupils think of technology. Particularly for a teacher of Technology in Junior Vocational Education and later on in secondary General and Pre-University Education it is important to know what the pupils in his or her class think of technology.

The word 'technology' will evoke different meanings for different people. For one person technology is something that has to do with equipment, particularly with computers and other modern electronics. For another technology is being able to repair a car or a washing machine when it is broken down. A third person will think of modern science and clever scientists in relation to technology.

The fact that pupils have different opinions on technology has already become evident from various researches. For a teacher it is useful to know whether the pupils in his/her class have ideas of technology that are different from his/her own. He/she will then be able to take this into account in the lessons. The TAS provides information about a group of pupils; for example about a class or about the boys or girls of a class. We know that, on the whole, boys are more interested in technology than girls. The TAS indicates exactly in what respects girls and boys differ as regards their attitude towards technology, so that the teacher knows which aspects need 'extra' attention.

The TAS can also be used to investigate whether, and if so how, the concept of and the attitude towards technology changes after following a course in 'technology'.

The TAS is not suitable for use at an individual level and certainly not for the assessment of individual pupils.

In these directions we indicate how a teacher can use the TAS in class. What it comes down to is that for a group of pupils mean answer scores are calculated and these are interpreted on the basis of available data. These calculations are fairly simple and can be carried out with a simple pocket calculator.
2. DESCRIPTION OF THE TAS

The TAS consists of two parts.
The first part consists of 26 utterances or items divided over 6 subscales and the second part consists of 28 utterances or items divided over 4 subscales.
The first part of the TAS measures the pupils' attitude towards technology, the second part measures the pupils' concept of technology. We shall subsequently describe both parts of the TAS.

ATTITUDES TOWARDS TECHNOLOGY

The attitude towards technology is measured by means of 6 subscales, each consisting of 3 to 5 items. These subscales refer to important aspects of the attitude towards technology. This was determined on the basis of research.

These attitudinal aspects are distinct from the conceptual aspects in that they refer to the affective part of the attitude towards technology. In other words, the attitudinal aspects refer to feelings and emotions, whereas the conceptual aspects measure the cognitive (knowledge) part of the attitude towards technology.

The subscales of the attitude towards technology can be described as follows:

1. INTEREST (5 utterances)
   This scale indicates the extent to which pupils are interested in technology outside school. For example on the basis of this scale pupils indicate whether they like to read a technical magazine, or to repair something at home.
   e.g. If there was a hobbyclub about technology I would certainly join it.

2. ROLE PATTERN (4 utterances)
   In this scale pupils indicate to what extent they think girls and boys are fit for technology.
   e.g. A girl should not become a car mechanic.
3. **CONSEQUENCES** (5 utterances)
   The scale Importance indicates how important technology is considered to be for the world in general (whether technology means progress).
   e.g. Technology makes everything work better.

4. **DIFFICULTY** (3 utterances)
   The scale Difficulty indicates the difficulty and accessibility of technology at school, the way this is experienced by pupils.
   e.g. Technology is only for bright people.

5. **CURRICULUM** (4 utterances)
   The scale Curriculum indicates whether pupils would like to have (more) technology at school.
   e.g. I should be able to take technology as a school subject.

6. **CAREER** (5 utterances)
   The Career-scale indicates whether pupils like to have a technical job later on.
   e.g. Most jobs in technology are boring.

The pupils fill out the first part of the TAS by indicating to what extent they agree with each utterance. For this they can choose from five alternatives:
1. totally agree,
2. agree,
3. don't agree, but don't disagree either,
4. disagree,
5. totally disagree.

**CONCEPT OF TECHNOLOGY**

The second part of the TAS is based on 5 generally accepted characteristics of the concept technology:
1. the relation technology - human being,
2. the relation technology - society,
3. the relation technology - science,
4. designing, practical skills, handling technical equipment as a skill in technology,
5. matter, energy and information as the pillars of technology.

These aspects of the concept of technology are measured by means of utterances in 4 subscales (the aspects 1. and 2. in one subscale):

1. TECHNOLOGY AND SOCIETY (10 utterances)
   This scale measures to what extent pupils think that technology is determined and controlled by man and influences all aspects of society. At one extreme (a high score) they agree with this thesis, at the other extreme (a low score) they think that technology is only related to (modern) equipment, and that technology cannot be influenced (technology is elusive and develops independently).

2. TECHNOLOGY AND SCIENCE (6 utterances)
   Between technology and science, and the natural sciences in particular, there is a mutual relationship. Natural sciences influence technology, but on the other hand, technology also influences natural sciences. The scale Technology and Society measures to what extent pupils see this mutual relationship.

3. TECHNOLOGY AND SKILLS (7 utterances)
   There is a process-side to technology, it is not only the products that matter, but also the process to manufacture these products and the way to handle them. Designing, practical skills (to carpenter) and knowing how to handle equipment (e.g. a videorecorder) are all technical skills. The scale measures whether pupils see the relationship between Technology and Skills. A high score means that they indeed see this relationship.

4. TECHNOLOGY AND PILLARS (5 utterances)
   The era of information, that is the name of the period in which we live now. Indeed information is an important pillar of technology. But the other pillars, matter and energy, are at the least equally important for the present technology. If pupils think that matter, energy and information are the pillars of technology, they will score high on this scale.
The questions of the second part of the TAS measure the knowledge and concept of technology at a certain abstract level. We deliberately opted for an approach in which we do not ask for facts, because in that case we would construct a cognitive test. We, however, have a situation that we give a right or wrong score to the answers to the concept questions, whereas with reference to the attitude questions we speak of a positive or a negative attitude.

The pupils fill out the second part of the TAS by choosing from three alternatives:
1. agree,
2. disagree,
3. don't know.
Here pupils' answers cannot be as detailed as with the attitude questions. This because the concept questions are more focused on knowledge.

RESULTS

The result of the TAS consists of 10 class scores or group scores, each referring to one of the subscales. On the basis of standard data it can be determined how common the attained class scores are for the situation in Dutch education.

The scores are taken down on a score form. To limit the teachers' calculating we made answer-models for each subscale.

TAS-MATERIAL

The material of the TAS includes:
- these directions,
- the TAS-questions (background questions + attitude questions),
- sheets with answer-models,
- the score forms on which the results of a class or a group are taken down (printed on both sides),
- the 'key' to the recoding and calculating of the group scores.
3. ADMINISTRATION OF THE TAS

Target population:
The TAS is suited for classical administration in second form of Junior Vocational Education, Junior Secondary Education, Senior Secondary and Pre-University Education. The standard data from the Netherlands are based on these target populations.

Time:
One should take about half an hour for the administration of the TAS: ten minutes for distributing and giving instruction, and it takes about twenty minutes to fill out the questionnaire.

Instruction
The administration starts with the distribution of the questionnaire.

Then there is a short introduction for the pupils in which the teacher says, for example, that he would like to know what the class thinks of technology and therefore a part of the lesson is used to enable pupils to express their opinion about this.

The teacher explains that it is not a test or exam and that there are no right or wrong answers and that the questionnaire is filled out anonymously.

Finally the teacher explains that what pupils think of technology is what matters here. Therefore he/she will not tell what technology is in his/her opinion, and questions about the interpretation of the utterances will not be answered either.

4. DETERMINING CLASS SCORES OR GROUP SCORES

The scores for the first part of the TAS (attitude towards technology) are calculated in a way different from that for the scores for the second part (concept of technology). In both cases it concerns mean scores on a subscale. We shall discuss the calculation of the scores for both parts.
CALCULATION OF SCORES PART 1 TAS

For the attitude items there are five answer-alternatives, and also five possible answer-scores, viz. 1, 2, 3, 4 and 5. The score that is taken in the calculation depends on whether the item is formulated in a positive or in a negative way. The attitude part consists of 13 utterances that are formulated positively and 13 utterances that are formulated negatively. We assume that a score of 1 is the most positive attitude and a score of 5 is the most negative attitude. This means that for the negative formulated utterance the pupils' scores should be recoded: 5=1, 4=2, 2=4 and 1=5. By putting the answer-models on top of the pupils' answers the correct scores for one subscale can be seen immediately.

Thus, the teacher can read the scores that have to be used in the calculation straight from the answer-models. Subsequently these scores of the items from a subscale are added up and divided by the number of items in this scale.

The mean individual score is obtained each time by multiplying the last figure by ten. The score vary between a minimum of 10 and a maximum of 50. A score of 10 is the most positive attitude and a score of 50 is the most negative attitude.

The mean class scores or group scores arise by calculating the mean of the pupils' scores.

Both the pupils' scores and the group scores can be filled out on the score form. It is the intention to compare the group scores and the standard data to come to an interpretation.

Again we shall give the calculation in steps:

1. Calculating the individual score:
   - add up the scores of the items of one scale, by means of the answer model,
   - divide by the number of items of a scale,
   - multiply by ten.

   e.g. for Interest (Int.):

\[
\frac{(\text{Score}(1) + \text{Score}(7) + \text{Score}(13) + \text{Score}(19) + \text{Score}(24)) \times 10}{5}
\]
2. Calculating the group scores:
   - add up individual scores,
   - divide by the number of pupils.

CALCULATION OF SCORES PART 2 TAS

For the concept items there are three answer-alternatives, but there are 2
answer scores, viz. 0 or 1. The "wrong" and "don't know" answers get a
score of 0 and the "right" answers get the score 1. These scores can be
obtained by using the answer-models.

Further calculation is the same as for the attitude items:
1. Calculating the individual score:
   - the scores of one scale are added up by means of the answer-model,
   - subsequently they are divided by the number of items and then again
     multiplied by ten.
   e.g. for T&Sc (Technology and Science):

   \[(\text{Score}(2) + \text{Score}(6) + \text{Score}(11) + \text{Score}(14) + \text{Score}(19) + \text{Score}(26)) \times 10 \div 6\]

2. Calculating the group scores:
   - add up individual scores,
   - divide by the number of pupils.

Both individual scores and group scores can be filled in on the score form.

5. INTERPRETATION ON THE BASIS OF STANDARD DATA

A group score in itself does not give that much information. Scores can
only be interpreted if we know the meaning of the scores and can
compared them with scores of other groups. These "other" groups will then
be the standard. Naturally the standard is more reliable as it is more
representative. Therefore the number of pupils involved and the type of
education is mentioned with all standard data. All standard data refer to
13-14-year-old pupils. For the interpretation of the subscales of the TAS 2
types of standard data are available. In appendix 1 and 2 the standard data are presented. We describe how these standard data can be interpreted on the basis of the standard for the subscales Interest and Technology + Society.

The first type (type a) is fairly rough and assumes that a score is a 'mean' score if it falls within one standard deviation from the mean. Because this is a fairly rough standard many group scores fall within the 'mean' standard and the information remains limited. The second type (type b) gives more information because a deviation from the standard is considered meaningful if it falls more than a particular number of units from the median (The median is the score at the 50% point).

Rule of thumb: for the attitude scale 5 units, and for the concepts scales 1 unit.

EXAMPLE 1: THE INTEREST SCALE

Standard data (a) for the Interest scale.

<table>
<thead>
<tr>
<th>score</th>
<th>standard score</th>
<th>% standard group</th>
<th>meaning standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14,5</td>
<td>1</td>
<td>10 %</td>
<td>far below mean</td>
</tr>
<tr>
<td>14,6 - 18,3</td>
<td>2</td>
<td>9 %</td>
<td>below mean</td>
</tr>
<tr>
<td>18,4 - 37,8</td>
<td>3</td>
<td>64 %</td>
<td>mean</td>
</tr>
<tr>
<td>37,9 - 43,0</td>
<td>4</td>
<td>9 %</td>
<td>above mean</td>
</tr>
<tr>
<td>43,1 - 50</td>
<td>5</td>
<td>8 %</td>
<td>far above mean</td>
</tr>
</tbody>
</table>

Remarks:
1. the attitude is more positive as the score gets lower,
2. standard data from 2.667 pupils of 2nd form secondary general/pre-university schools in the Netherlands.
Suppose a group of pupils has a mean score of 22.0 on the Interest scale, what does this mean?

From standard (a) it appears that the standard score 3 belongs to 22.0. The result is comparable to that of 64% of all pupils in secondary general/pre-university education. The group's score is 'mean'. For the research group, as for the standard group, it appears that there is a positive interest in technology.

If one wants to go into the meaning of a group score in greater detail, standard (b) can be used. In standard (b) it can be seen that 70% of the pupils of 2nd form secondary general/pre-university schools scores higher, so they are less interested in technology. Now, to determine to what extent the score of 22.0 is deviant and therefore meaningful, we use the rule of thumb that the group score should fall 5 units or more from the 50% score of the standard group (here 27). In descriptive statistics this score is called 'median'.

We may conclude that a score of 22.0 is not abnormal because it falls within the mean group (see standard (a)), but compared with the standard group there clearly is a strong interest in (and thus a positive attitude towards) technology (standard (b)).
EXAMPLE 2: TECHNOLOGY + SOCIETY SCALE (T&So)

Also for the subscale Technology + Society (T+S) 2 standards are available. Here the standard group is 2nd form Junior Vocational Education.

Standard data (a) for T&So.

<table>
<thead>
<tr>
<th>score</th>
<th>standard score</th>
<th>% standard group</th>
<th>meaning standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 1,0</td>
<td>1</td>
<td>5 %</td>
<td>far below mean</td>
</tr>
<tr>
<td>1,1 - 2,3</td>
<td>2</td>
<td>11 %</td>
<td>below mean</td>
</tr>
<tr>
<td>2,4 - 6,3</td>
<td>3</td>
<td>64 %</td>
<td>mean</td>
</tr>
<tr>
<td>6,4 - 7,8</td>
<td>4</td>
<td>15 %</td>
<td>above mean</td>
</tr>
<tr>
<td>7,9 - 10</td>
<td>5</td>
<td>5 %</td>
<td>far above mean</td>
</tr>
</tbody>
</table>

Remarks:
1. a high score means a 'good' concept,
2. standard data from 2,349 pupils of 2nd form Junior Vocational School in the Netherlands.

Standard data (b) for T&So.

<table>
<thead>
<tr>
<th>% of pupils</th>
<th>pupils' scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>scoring lower than</td>
<td>the given</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>40</td>
<td>3,8</td>
</tr>
<tr>
<td>50</td>
<td>4,3</td>
</tr>
<tr>
<td>60</td>
<td>4,8</td>
</tr>
<tr>
<td>70</td>
<td>5,0</td>
</tr>
<tr>
<td>80</td>
<td>6,3</td>
</tr>
<tr>
<td>90</td>
<td>7,2</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

We assume that the group score for the T&So. scale is 6.2. This means that 62% of the questions is answered 'correctly', so that a small majority of the group thinks there is a relationship between technology and society and that technology is more than just equipment.

A score of 6.2 is a normal score, which means that this score falls in the large mean group (64%) of the pupils of 2nd Junior Vocational Education.
However, the 50% point (the median) for the standard indicates a score of 4.3, which is notably lower than 6.2.

As a rule of thumb we use a difference of one unit with the 50% point as being meaningful. Because $6.2 > 4.3 + 1$ we conclude that the group score is clearly higher than the standard in 2nd form Junior Vocational Education.

Concluding we can say that in the interpretation of a group score we can pay attention to 2 aspects. First of all: What does the score mean in general; is there a positive attitude, is there a good concept. Or more specifically for a scale: are pupils interested in technology outside school hours and/or do pupils associate technology more with equipment than with human beings?

Secondly we have to relate the score to standard groups, whereby the central question is how far the group score deviates from a standard and whether this deviation is meaningful.
APPENDIX 1: STANDARD DATA 2 AVO - VWO (= 2ND FORM SEC. GEN. SCHOOL)

1. Interest (2667 pupils)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14,5</td>
<td>10 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>14,6 - 18,3</td>
<td>9 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>18,4 - 37,8</td>
<td>64 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>37,9 - 43,0</td>
<td>9 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>43,1 - 50</td>
<td>8 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores

2. Role pattern (2667 leerlingen)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 15,7</td>
<td>14 %</td>
<td>1 below mean</td>
</tr>
<tr>
<td>15,8 - 26,8</td>
<td>70 %</td>
<td>2 mean</td>
</tr>
<tr>
<td>26,9 - 50</td>
<td>16 %</td>
<td>3 above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores
3. Consequences (2667 pupils)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14,9</td>
<td>18 %</td>
<td>1 below mean</td>
</tr>
<tr>
<td>15,0 - 27,0</td>
<td>67 %</td>
<td>2 mean</td>
</tr>
<tr>
<td>27,1 - 50</td>
<td>15 %</td>
<td>3 above mean</td>
</tr>
</tbody>
</table>

% (Cumulative)

<table>
<thead>
<tr>
<th>Pupils' Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

4. Difficulty (2667 pupils)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 17,0</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>17,1 - 23,0</td>
<td>15 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>23,1 - 39,0</td>
<td>68 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>39,1 - 43,0</td>
<td>7 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>43,1 - 50</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (Cumulative)

<table>
<thead>
<tr>
<th>Pupils' Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>
5. Curriculum (183 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 13,9</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>14,0 - 19,3</td>
<td>11 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>19,4 - 38,0</td>
<td>72 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>38,1 - 44,9</td>
<td>7 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>45,0 - 50</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores

6. Career (183 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 11,0</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>11,1 - 18,3</td>
<td>11 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>18,4 - 35,6</td>
<td>70 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>35,7 - 42,0</td>
<td>9 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>42,1 - 50,0</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores
APPENDIX 2: STANDARD DATA 2 LBO (= 2ND JUNIOR VOCATIONAL SCHOOL)

1. Interest (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 13,0</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>13,1 - 19,6</td>
<td>14,5 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>19,7 - 35,6</td>
<td>66,5 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>35,7 - 39,9</td>
<td>9 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>40,0 - 50</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) 0 10 16 pupils' scores

2. Role pattern (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 12,0</td>
<td>21 %</td>
<td>1 below mean</td>
</tr>
<tr>
<td>12,1 - 28,0</td>
<td>65 %</td>
<td>2 mean</td>
</tr>
<tr>
<td>28,1 - 50</td>
<td>14 %</td>
<td>3 above mean</td>
</tr>
</tbody>
</table>

% (cumulative) 0 10 10 pupils' scores
3. Consequences (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 13,0</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>13,1 - 18,0</td>
<td>13 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>18,1 - 30,5</td>
<td>70 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>30,6 - 33,9</td>
<td>7 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>34,0 - 50</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative)

| 0  | 10 | 15 | 20 | 18 | 30 | 21 | 40 | 22 | 50 | 24 | 60 | 25 | 70 | 26 | 80 | 29 | 90 | 31 | 100| 44 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|    | 10 | 15 | 20 | 18 | 30 | 21 | 40 | 22 | 50 | 24 | 60 | 25 | 70 | 26 | 80 | 29 | 90 | 31 | 100| 44 |

4. Difficulty (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14,6</td>
<td>21 %</td>
<td>1 below mean</td>
</tr>
<tr>
<td>14,7 - 29,8</td>
<td>66 %</td>
<td>2 mean</td>
</tr>
<tr>
<td>29,9 - 50</td>
<td>13 %</td>
<td>3 above mean</td>
</tr>
</tbody>
</table>

% (cumulative)

| 0  | 10 | 11 | 20 | 14 | 30 | 16 | 40 | 18 | 50 | 20 | 60 | 22 | 70 | 25 | 80 | 28 | 90 | 31 | 100| 45 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
5. Technology and Society (2349 pupils)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1,0</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>1,1 - 2,3</td>
<td>11 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>2,4 - 6,3</td>
<td>64 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>6,4 - 7,8</td>
<td>15 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>7,9 - 10</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (Cumulative) pupils' scores

<table>
<thead>
<tr>
<th>% (cumulative)</th>
<th>Pupils' scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,8</td>
</tr>
<tr>
<td>20</td>
<td>2,7</td>
</tr>
<tr>
<td>30</td>
<td>3,3</td>
</tr>
<tr>
<td>40</td>
<td>3,8</td>
</tr>
<tr>
<td>50</td>
<td>4,3</td>
</tr>
<tr>
<td>60</td>
<td>4,8</td>
</tr>
<tr>
<td>70</td>
<td>5,0</td>
</tr>
<tr>
<td>80</td>
<td>6,3</td>
</tr>
<tr>
<td>90</td>
<td>7,2</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

6. Technology and Science (2349 pupils)

<table>
<thead>
<tr>
<th>Score</th>
<th>% Standard Group</th>
<th>Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0,5</td>
<td>10 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>0,6 - 1,3</td>
<td>11 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>1,4 - 6,6</td>
<td>63 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>6,7 - 7,8</td>
<td>10 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>7,9 - 10</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (Cumulative) pupils' scores

<table>
<thead>
<tr>
<th>% (cumulative)</th>
<th>Pupils' scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0,5</td>
</tr>
<tr>
<td>20</td>
<td>1,1</td>
</tr>
<tr>
<td>30</td>
<td>2,0</td>
</tr>
<tr>
<td>40</td>
<td>2,6</td>
</tr>
<tr>
<td>50</td>
<td>3,1</td>
</tr>
<tr>
<td>60</td>
<td>4,0</td>
</tr>
<tr>
<td>70</td>
<td>5,0</td>
</tr>
<tr>
<td>80</td>
<td>6,0</td>
</tr>
<tr>
<td>90</td>
<td>7,1</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>
7. Technology and Skills (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1,8</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>1,9 - 4,9</td>
<td>22 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>5,0 - 9,0</td>
<td>61 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>9,1 - 9,3</td>
<td>7 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>9,4 - 10</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores

8. Technology and Pillars (2349 pupils)

<table>
<thead>
<tr>
<th>score</th>
<th>% standard group</th>
<th>standard score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0,5</td>
<td>5 %</td>
<td>1 far below mean</td>
</tr>
<tr>
<td>0,6 - 1,9</td>
<td>14 %</td>
<td>2 below mean</td>
</tr>
<tr>
<td>2,0 - 7,0</td>
<td>67 %</td>
<td>3 mean</td>
</tr>
<tr>
<td>7,1 - 8,0</td>
<td>9 %</td>
<td>4 above mean</td>
</tr>
<tr>
<td>8,1 - 10</td>
<td>5 %</td>
<td>5 far above mean</td>
</tr>
</tbody>
</table>

% (cumulative) pupils' scores
APPENDIX 3: KEY AND SCOREFORM

<table>
<thead>
<tr>
<th>KEY TAS part 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The following items have been formulated negatively:</td>
<td></td>
</tr>
<tr>
<td>2, 3, 4, 11, 12, 13, 14, 16, 17, 21, 23, 24, 26</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KEY TAS part 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. not agree: 1, 3, 4, 5, 6, 7, 9, 11, 12, 17, 18, 19, 24, 25, 27</td>
<td></td>
</tr>
<tr>
<td>2. agree: 2, 8, 10, 13, 14, 15, 16, 20, 21, 22, 23, 26, 28</td>
<td></td>
</tr>
</tbody>
</table>

How to compute scalescores

| Interest: | \((1 + 7 + 13 + 19 + 24) \cdot 10/5\) |
| Role pattern: | \((2 + 8 + 14 + 20) \cdot 10/4\) |
| Consequences: | \((3 + 9 + 15 + 21 + 25) \cdot 10/5\) |
| Difficulty: | \((4 + 10 + 16) \cdot 10/3\) |
| Curriculum: | \((5 + 11 + 17 + 22) \cdot 10/4\) |
| Career: | \((6 + 12 + 18 + 23 + 26) \cdot 10/5\) |

| T&Sk.: | \(1 + 5 + 7 + 10 + 13 + 16 + 18 + 20 + 23 + 25\) |
| T&So.: | \((2 + 6 + 11 + 14 + 19 + 26) \cdot 10/6\) |
| T&Sc.: | \((3 + 8 + 12 + 15 + 17 + 22 + 27) \cdot 10/7\) |
| T&Pi.: | \((4 + 9 + 21 + 24 + 28) \cdot 10/5\) |
| PUPILS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | groupscore |
|--------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Int.   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Roll.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Con.   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Diff.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Cur.   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| Car.   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| T&Sk.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| T&So.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| T&Sc.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
| T&Pi.  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
APPENDIX 4: THE TECHNOLOGY ATTITUDE SCALE

Questionnaire for pupils about technology
Part 1 (questions 1-26)

1. If there was a hobby club about technology I would certainly join it. 1 2 3 4 5
2. Boys are able to do practical things better than girls. 1 2 3 4 5
3. The world would be a worse place without technology. 1 2 3 4 5
4. You have to be very clever to study technology. 1 2 3 4 5
5. I would like to learn more about technology at school. 1 2 3 4 5
6. I will probably choose a job in technology. 1 2 3 4 5
7. I like to read technological magazines. 1 2 3 4 5
8. A girl can very well become a car mechanic. 1 2 3 4 5
9. Technology makes everything work better than before. 1 2 3 4 5
10. Technology is not only for bright people. 1 2 3 4 5
11. I would rather not have technology lessons at school. 1 2 3 4 5
12. I do not understand why anyone would want a job in technology. 1 2 3 4 5
13. There should be less TV- and radio-programs about technology. 1 2 3 4 5
14. Boys know more about technology than girls. 1 2 3 4 5
15. Everyone needs technology. 1 2 3 4 5
16. To understand something of technology you have to do a difficult training course. 1 2 3 4 5
17. There should not be more education about technology. 1 2 3 4 5
18. I would enjoy a job in technology. 1 2 3 4 5
19. I enjoy repairing things at home myself. 1 2 3 4 5
20. A girl can very well have a technical job. 1 2 3 4 5
21. Technology has brought more bad things than good. 1 2 3 4 5
22. I should be able to take technology as a school subject.  
23. Working in technology would be boring and dull.  
24. I am not interested in technology.  
25. Technology is very important in life.  
26. Most jobs in technology are dull.
One can choose from 3 answers: 'agree', 'not agree', don't know'.

1. With reference to technology I mostly think of machines.  
2. I think physics and technology are related.  
3. In technology you can seldom use your imagination.  
4. I think technology has little to do with our energy problem.  
5. With respect to technology I mostly think of dealing with equipment.  
6. To me technology and science are the same.  
7. In my opinion technology is not very old.  
8. In technology you can think up new things.  
9. I think technology is more part of computers than of computer programs.  
10. Technology is as old as mankind.  
11. Elements of physics are rarely used in technology.  
12. You need not be technical to invent a new piece of equipment.  
13. Technology has a large influence on people.  
14. I think technology is often used in physics.  
15. Manual dexterity is part of technology.  
16. In everyday life I have a lot to do with technology.  
17. In technology there is little opportunity to think up things yourself.  
18. Technology is far away from my daily life.  
19. Biology and technology have nothing in common.  
20. The government can have influence on technology.  
21. I thing the transformation of energy is also part of technology.  
22. In technology you handle tools.  
23. Technology is meant to make our life more comfortable.  
24. When I think about technology I mainly think of computer programs.  
25. Only technicians are in charge of technology.  
26. There is a relation between chemistry and technology.  
27. In technology there are less opportunities to do things with your hands.  
28. Processing materials is an important part of technology.
ON THE TRAINING OF TECHNOLOGY TEACHERS USING THE CONCEPT OF A GENERAL TECHNOLOGY

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Summary

Teacher training in modern industrialized societies should enable the teachers to offer science-oriented education. It is being disputed which scientific disciplines can supply the foundations of a technical education which would improve the technical orientation of those citizens who do not later on proceed with related vocational training. The engineering sciences are highly specialized and traditionally separated from each other. Also, historical changes in the use of materials and methods and in the judgement of efficiency or environmental consequences are often kept out of consideration. Obviously an integrative science is required which would combine the transfer of technical knowledge and the critical reflection of the objectives. It can be shown that the concept of a general technology is adequate to plan lessons in accordance with this criterion.

This paper is devoted to the historical background, the present state of the art, and the application of the general technology to teacher training. The modern instrument of relating the knowledge and combining the methods of individual disciplines is the systems theory. Basically the general technology relates this theory with the product design sciences in order to determine which statements of an individual science are useful for a given task. It can be shown that by systematically analyzing the flow of material, energy and information the instructor will derive adequate results.

To apply the concept of the general technology to the training of technology teachers only a limited number of key questions need to be answered to structure lessons on arbitrary technical subjects without contradictions to engineering knowledge. The teacher will also be provided with the criteria to check the validity of simplified statements thus enabling him to correctly reduce the complexity of technical facts. The concept is well suited to build up individual judgement, too. It gradually replaces the former multiperspective approach which lacks the foundations of a formal science and therefore tends to follow up a catalog of well-established examples and to give way to students' identification with the instructor rather than to criteria-related judgement.
This paper outlines the concept of a general technology and its application to the education of technology teachers. The concept meets the demand for an integrative science which would relate the transfer of technical knowledge to the critical reflection of the objectives. The name of the concept was chosen with respect to Johann Beckmann's "Draft of a General Technology" from 1806. Meanwhile the concept reflects a formal combination of systems theory and product design sciences. The general approach is to analyze systematically the flow of material, energy, and information in a technical system. Usually this requires the definition of suitable system boundaries and the design of corresponding models; hence the implementation of the formal science by statements of individual disciplines becomes feasible. For teaching purposes the historical changes and the actuality of a subject and furthermore, the dynamic properties of the system need to be considered as well. But this means that only six key questions will guide to the structure of lessons on arbitrary technical subjects without generating contradictions to engineering knowledge. Also, the instructor will be provided with criteria to check the validity of simplified statements. This will enable him to build up individual judgment, thus acting against the disposition to follow up a catalog of well-established but sometimes outmoded examples. The concept gradually replaces the former multiperspective approach which lacks the foundation of a formal science.
The education of technology teachers should be based on a scientific concept. But which technical discipline would be adequate? Which one would supply the foundations for the treatment of arbitrary technical subjects? In 1806 Johann Beckmann published a book entitled "Draft of the General Technology", /1/. His idea was to compare the products and methods of arts and crafts by investigating the procedures to shape materials or change their properties through applying energy or work according to a given plan. He did not use the notion "energy" as it is used today but he classified technical activities with respect to the materials, working principles, and procedures, /1,2/. This appears to be very close to the investigation of the flow of materials, energy, and information in a technical system. He might have referred to James Watt who knew the materials from which steam engines were made, added the condenser which saves energy, and invented the ball-governor which uses speed information to control the flow of steam.

Nowadays the cybernetics or systems approach is used where complex technical matter is to be analyzed. It is a formal but generally successful way if adequate system boundaries can be defined and corresponding models can be designed. Usually the formal description obtained has to be implemented by statements and methods of individual sciences according to the specifications of a given task. This approach proved to be almost unlimited in its application to technical and other problems. In a modified way it can be employed for technology teaching as well. According to Jozsef Déri the fundamentals of technical education are five basic categories: material (M), energy (E); information (I), system, and model, /3/. Correspondingly, general technology can now be defined as a science relating the statements and laws of interaction between these basic categories. This means that systems theory and product design sciences have to be combined to structure the concept of general technology.
The application of the concept will require a good understanding of technics. Otherwise transitions to biology or chemistry may not be noticed because these sciences as well have to deal with the flow of material, energy, and information within model systems. Following the definition given by Horst Wolffgramm, /4/, "technics will comprise the totality of ways and means which man conceives and uses to satisfy his material and cultural needs. It is the combined effect of natural processes which is enforced according to pre-established targets by the use of artificial material means, and which serves to transform the objects of human activity in a way appropriate to the intentions of a society". Hence technics cannot be separated from human labour since the enforcement of natural processes requires the expense of work. Furthermore, technics will unseparably be related to space and time because any installation required to apply a natural law occupies space, material products extend in three dimensions, and the operations to convert energy or to process information are generally time-dependent. Also, man's activity is obviously time-dependent. While he works he can use his expert knowledge which he acquired during earlier periods of his life, including those insights which are not even verbalized.

Based on Horst Wolffgramm's definition of technics general technology becomes the science dealing with the causal relations between technical statements. This result can be visualized. Coarsely, human activity needs to be plotted versus the basic categories of material, energy, and information as well as versus time, /5,6/. Human activity, as far as technological activity is considered, can obviously be subdivided into a set of generally applicable technological main functions. Time may be subdivided into the periods of past, presence, and future. Then a very descriptive three-dimensional representation of the concept of general technology can be drafted. Suitable definitions of technological
main functions covering the fields of product design and the conversion of material, energy, and information were given by the "Technics Advisory Group" of the Comprehensive Universities of Duisburg and Essen, /7/, and later on by Wilfried Härtel, /8/. Generally applicable appear to be to:

<table>
<thead>
<tr>
<th>Product Design</th>
<th>Conversion of M, E, I</th>
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<tr>
<td>Objective Specification</td>
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<td>Functional concretion</td>
<td>Source development</td>
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<td>Product conceptioning</td>
<td>M, E, I extraction</td>
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<td>Component drafting</td>
<td>Primary materials conversion</td>
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<td>Systems optimization</td>
<td>Commodity distribution</td>
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<td>Details elaboration</td>
<td>Product utilization</td>
</tr>
<tr>
<td>Preproduction inspection</td>
<td>Scrap or waste removal</td>
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</tbody>
</table>

Quality rating

This results in a situation where only a limited number of questions need to be considered formally in order to assign a given technical subject to a specific main function, basic category, and period of time. Following these decisions individual disciplines can be identified which are appropriate for the further investigation of arbitrary technical facts. Thus the scientific approach to draft the concept of general technology is comparable to the draft of any scientific concept: The invariants of a given field of knowledge are listed and causal relationships are established. The basic categories of M, E, and I constitute invariants of technology teaching. In the concept of general technology they usually represent flow variables which characterize the operation of a technical system. Research has to be continued. Actual contributors are Walter Theuerkauf who presented his idea of the invariants of technical qualifications in view of rapid technological change, /9/, and Jozsef Déri who derived and specified sub-categories of the combined flow of material, energy, and information through technical installations, /10/. The application of these ideas will enable the in-
structor to organize his teaching matter. As he identifies the relative location of a technical subject in the three-dimensional representation of the concept, he can overlook the influence of the adjoining categories, main functions, and periods of time. Simultaneously he is guided to a specific discipline which would implement the formal concept and can supply the statements and methods which are needed to give reasons for learning sequences.

The advantage of this procedure is that the instructor can always prove that he is about to treat a technical subject with respect to commonly accepted technical rules: Once he has been led to a suitable technical discipline he will be able to use it to select exemplary statements and to derive criteria to simplify his matter for teaching. For instance, if he was led to the field of production engineering he may be directed to certain properties of materials, exemplary assembly operations, mathematical methods to predict the time behaviour of technical installations, etc. Simultaneously, he has to deal with definitions of technical terms and to think of means to clarify the appropriateness of working principles, /11/. In this way technology teaching becomes very similar to the methodology of product concepting as presented by the VDI-guideline 2222, /12/, and besides that, it corresponds to the idea of formalizing an arbitrary technical production process, /13/. Moreover, the approach will be repeatable independent of a teacher's personal attitude towards a technical problem. This means that the application of general technology is suited to build up individual judgment based on self-assessment of individual performance. In Northrhine-Westfalia the latest examination standards for technology teacher training were derived from the concept of general technology, /14/.

Prior to general technology another approach called the multiperspective model of technical didactics was conceived. An
extensive description was published by F. Wilkening and W. Schmayl, /15/. Again "technics" was to be defined more precisely to characterize the model's range of application. The authors suggest that "real technics" will be adequate if it is assigned to artefacts, their production, and their utilization by man. Correspondingly, the description of coherent knowledge about these artefacts is called the scientific perspective. An anthropological and a sociological perspective serve to treat the consequences of technics with respect to human relations, a historical perspective is necessary to avoid insufficient consideration of technical change, and finally, a perspective of value-oriented philosophical analysis is introduced to reconsider the idea of moral neutrality of technics which is often claimed by technicians. The use of the model requires multiperspective teaching as well. Therefore the authors distinguish between four lines of teaching objectives which they call knowledge-related, process-related, value-related, and behaviour-related, respectively. The guiding principle is "acquiring the competence to decide and act humanity-oriented and based on critical reflection in technically determined situations of life". Examples of such situations are to be selected from household activities, factory or office work, public life, and leisure time. To open the scientific perspective the user is referred to a limited number of classical sciences: civil, mechanical, and production engineering, besides these, energetics and informatics, and finally, textile, engineering.

From a general technologist's point of view a limited number of specific sciences may become insufficient as technical innovation proceeds. Why is textile engineering accepted while electrical engineering is not? Furthermore, Burkhard Sachs, another author of the multiperspektive model, enumerates only four perspectives: technical activity, knowledge and structural insights, meaning and evaluation of technical facts, and pre-vocational orientation, /11/. He does not refer to a historical perspective as Wilkening and Schmayl
do while the latter do not list the pre-vocational orientation. This leaves the potential user of the model with some uncertainty about the number and the kind of the perspectives which are to be considered. Another uncertainty remains about the meaning of "humanity-oriented". Also, real technics will very likely be inadequate to cover the problems of modern information technology. In the concept of general technology, objective specification and evaluation as a way of quality rating are main functions and no direct reference is made to any specific engineering science. It would appear that the uncertainties of the multiperspective model could be avoided by defining basic categories of technics and using a formal science to proceed from there.

General technology may even be employed in a more colloquial way by simply considering a technical subject's historical change, actual meaning, and time dependency besides the flow of material, energy, and information (keeping in mind that this flow usually represents the operation of a technical system). It will still give reasons to structure lessons without generating contradictions the scientific knowledge. The flow of material, energy, and information will be treated in accordance with the engineering sciences. There may have been functionally more conspicuous devices and machines in the past. The learners may be affected directly by the actuality of the subject to be taught. And moreover, taking into account dynamic properties will ensure that the traditionally static understanding of technics can be avoided. Thus individual judgment can be achieved. There is no need anymore to follow up a catalog of well-established teaching examples which might be outmoded.

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Teacher training in Polytechnical Education

By giving a short historical review of teacher training in the field of polytechnical education we would like to offer some advice to those countries which are planning a similar development in education. But we should emphasize, that one can neither repeat the actual development nor simply copy the present stage of development. A correct representation of teacher training, particularly that of teachers of polytechnics at diploma level, has its roots in the development of the society as a whole.

In 1960 (but strictly speaking, already in 1958) when the polytechnical instruction as "Day of instruction in production" was introduced, at first, experienced instructors from vocational training, especially from the metal working industry and agriculture were chosen to do practical instruction as well as theoretical training. But also those teachers of natural science subjects, who had practical experience of production because of their personal development and technical interests, were involved into organizing polytechnical education. By means of qualification measures planned and executed by the local educational authorities, by an intensive exchange of scientific and pedagogical ideas in the teachers' special groups and by
providing written instruction materials under the responsibility of the central administration, these teachers could be qualified in such a way, that they were able to meet all demands on a teacher concerning the content, the methodology and the school policy. At that stage they could solve the special problems of the subject "Introduction to Socialist Production" as a subject within the limits of general education.

The majority of these teachers finally acquired the diploma level by taking additional qualifications - partly guided centrally and partly at the private initiative of the teachers concerned. Furthermore, in 1961 the training of special teachers for the "Basic industrial production" and "Basic agricultural production" started - whereas these disciplines only existed as a subsidiary subject in combination with a natural science subject.

In the second half of the sixties the teacher training for polytechnical instruction was also reorganized. Up to that time the existing special combination of "Natural science subject and basic production" could not guarantee that every graduate who had taken "basic ... production" as his subsidiary subject, was really employed at school for teaching polytechnical instruction, particularly at schools where there was a great lack of teachers of physics, chemistry, biology etc. Then polytechnical instruction could also be given by teachers without any special training. This meant, that on the one hand the existing urgent demand for trained teachers for polytechnical instruction could not be satisfied quickly enough, and on the other, the existing cadres were inadequately or insufficiently employed.
Meanwhile a higher level of qualification at teacher training colleges was reached and there were many graduate teachers as well as some professors and lecturers for both polytechnic subjects and methodology of teaching polytechnics - and after the material-technical equipment of the teacher training colleges had been completed in that period, the teacher training of polytechnics could be taken over by the former "Faculties of teaching polytechnics" as a single-subject study. During a 4-year-course students acquired the qualification to teach the following subjects at a general polytechnical secondary school:

- Manual Instruction (forms 4 to 6),
- Introduction to Socialist Production (forms 7 to 10)
- Technical Drawing (forms 7 and 8)

A qualification to teach "Productive work" did not belong to the professional tasks of these teachers, but they were expected to have a fair knowledge of the curriculum of the subject "Productive Work". Furthermore the polytechnics teacher was expected to acquire a sound knowledge of the internal problems of the firms, where the pupils did their productive work, and to attend classes regularly during the period of productive work and to cultivate contacts with the pupils' instructors concerning the specific subject-matter.

The hitherto existing differentiation of teacher training in two variants (basic of agricultural or industrial production) was cancelled in favour of a uniform training, since during their first 3 years the students could not know if they they to work as teachers at schools located in industrial or agricultural areas. In order to prepare all students fairly equally for the
potentially different practical demands of their future jobs, a special component of training was introduced. This subject "Differentiated compulsory training" dealt with special problems of technology, economy and industrial management of some main production branches.

In teacher training as well as in all fields of training at university level of the GDR, the unity of theory and research (research-oriented theory) is a fundamental didactic principle of higher education.

Based on this principle, most members of the academic staff at teacher training colleges were engaged in research. From this followed once again, a great advance in qualification that resulted, in a fast-growing number of staff members having achieved their doctor's degrees and the qualification required for a lectureship.

During that period the situation at teacher training colleges was characterized by the "3rd university reform" begun in 1968/69. From that time student teachers were also awarded a diploma after completing their courses, like other university students. The diploma is the "First academic degree" - the official title of a graduate is: "Certificated teacher of polytechnics". The student acquires the qualification for writing the diploma thesis by organizing his training as a "scientific-productive study" and by making himself familiar with the scientific strategy for solving his research problems from a choice of obligatory training lasting 4 hours per week.

Simultaneously with the accomplishment of the 3rd university reform, a research study was introduced as a 3 year postgraduate
course. The best students - about 1 to 2 per cent of every full course - got the chance to stay at the university as research students after finishing their normal studies and to prepare for their "2nd academic degree" (e.g. D. phil., D. ped., D. rer. nat.).

For the time of this research study a grant is paid. Altogether an essentially higher level of scientific qualifications could be witnessed in that period. A new teacher generation grew up. The intellectual and material-technical resources of the educational system in general and of the polytechnical education in particular were increasing rapidly. Polytechnical education had become a firm part of general education and had established itself already among other excellent traditions. The whole society, especially school management and administration, plants and schools, teachers, parents and the democratic public authorities were prepared for, ready and able to take the next steps, which would not have been conceivable without the previous successful development.

Our preceding explanations illustrate, that polytechnical education at general schools is not only the problem of the polytechnical teachers and instructors at the factories but is the problem of all those concerned with education of the young generation and particularly of all teachers. The task of linking lessons with life makes it necessary that, without exception, all teachers, regardless of the subject they are teaching, do not only have a better insight into production practice, but that they also master the specific educational and didactic principles of polytechnical education.
From this the following essential tasks for a modern teachers' training can be derived:

1. In connection with their pedagogic training the student-teachers of all subjects are made familiar with the theoretical basis of the unity of productive work and study and the connection of factory to school.

2. During their practical training at school all student-teachers, irrespective of the subjects they study, visit the pupils at their productive work in factories.

3. Those student-teachers who study subjects of natural science and polytechnics are made familiar, theoretically and practically, with the discovery-stimulating role of experiments and with the didactic principles of carrying out experiments during lessons.

4. In the course of their training, future teachers are enabled to organize study-groups or optional groups of interest in the fields of natural science, technology, art, etc. Special emphasis is laid on natural sciences and technology.

5. A growing number of student-teachers, sometimes whole seminar groups, take over the development of specially talented pupils - teaching them extra material, beyond the usual curriculum, carrying through with them technical experiments and solving construction tasks.

Alongside the variety of basic aims, the teachers' training always has to take into consideration the actual tasks of the school derived from the country's technological, economic and social development and the appropriate consequences for the further development of general education. That means, that the long-term educational-political tasks of a general school (e.g.
for 2 decades) cannot be solved by training teachers of poly-
technical education without regard to its gradual modification.
The further development of the curriculum for polytechnical
instruction at school that will be necessary after some years,
(based on experience about every 10 years or even less!) must
conform to an appropriate modification of the teachers' training.

In the mid 1960's, that is to say, in the training of the first
teachers of polytechnics, the subject electrical engineering
consisted, above all, of classical electrical power engineering
(the larger part of which being wiring technology) and classical
weak current engineering, but only a small part concerned
electronics, whereas in the 80's the student-teachers for
polytechnical subjects deal increasingly with microelectronics,
computer science and information technology. In the subject
"Automation of Production Processes" a similar development took
place. Actually electrical engineering and automation technology
have come closer to each other in production and consequently in
university and college training, too. In the course of this
development not only were new scientific facts integrated into
the teachers' training but also new thinking and representation
strategies. Attention is no longer paid to the single concrete
element (resistor, capacitor, transistor, etc.) but to the
functional unity of a large circuit combining thousands of
single construction elements. A typical example, that teachers'
training can be subjected to dramatic changes in accordance with
general social development, is the cancellation of the former
qualification variants "Teacher of basic industrial production"
and "Teacher of basic agricultural production". In the early
sixties, when those two training variants had been introduced, neither the dimension nor the speed of the technical development in agriculture could be estimated exactly. Furthermore, there had not yet been a uniform and overall view of polytechnics, that would have been able to include agricultural technology as well. The problem pointed out could only be finally solved by theoretical work concerning the scientific foundation of polytechnical subjects.

Now the student no longer considers agricultural and industrial technology as two separate branches, but agricultural production as well as horticulture, forestry, the fishing and brewery industries are considered as one large branch of biological production - alongside mechanical and chemical production. And agricultural technology stands side by side with the technology of the building, metalwork and textile industries etc., all with their own specific features, but as general production strategies they can also be considered in an integrated scientific view.

According to this theoretical position a new curriculum was developed and introduced in 1983/84 into all schools and the training of polytechnics teachers was reorganized. Now this training covers aims, content and methods enabling the future teacher to acquaint himself with the specifications of a particular production branch or an actual firm, where his pupils do their productive work.

Altogether the teachers' training for polytechnics is shaped in such a way, that the graduate will get the necessary insight into general and special fundamentals of technology and production and that he will acquire the ability to teach the
compulsory and optional lessons in a didactically effective way.

The training comprises of the following special elements:
1. fundamentals of mathematics and natural science in technology /technical drawing
2. special technical fields
3. pedagogics.

In addition to these, there are some elements with a more general character:
- improvement of knowledge in foreign languages
- fundamentals of philosophy and epistemology
- cultural-aesthetic education
- sport.

For those students who are especially interested in cultural and aesthetic education or sport, additional optional educational opportunities are available, for example, playing in orchestras, singing groups, artistic gymnastics groups, different sport groups, amateur radio clubs etc.

Every year about 460 students are enrolled, who have passed their final examination of grade 12 or completed vocational training with abitur. They begin their studies with a basic training which is oriented to applied mathematics, science and technical subjects. (1st and 2nd academic year)

In the third and fourth academic year the training is continued in the fields of manufacturing engineering, theory of machines, electrical engineering/electronics.

In these fields the scientific-technical fundamentals are taught, important abilities and skills in material processing are obtained. In those teaching areas as automation technology,
general production engineering, socialist economy and selected production processes, concrete phenomena and laws of this matters are treated and their interactions are considered. The subject field "Selected Production Processes" has the aim to integrate the detailed knowledge which the students have obtained in the separate technical discipline, which reflect the actual production process. In this subject the students of polytechnics also take their main examination. The education in methodics of polytechnical instruction consists of theoretical classes, methodical exercises and teaching practice. During the teaching practice in the fifth academic year the student develops and stabilizes his pedagogic-theoretical abilities of teaching. According to the aims and contents of the syllabi the students learn, how to select and how to use subject-specific methods, forms of organization, working- and teaching aids for an effective organization of the educational process in the different grades. The student teacher gets experiences in encouraging the individual and collective creative learning and working of the pupils.

Periods of practical work in factories, visits to enterprises, practical training in workshops, visiting classes and polytechnical centres with the students giving lessons of their own combined with optional lectures are an integrated part of the 5 year course in polytechnics.

Lehrgebiete
- Mathematik
- Physik
- Werkstofftechnik
- Technisches Zeichnen
All elements of the training are didactically organized in such a way, that the student will have many different opportunities to do creative, active and personality-forming work during his studies. Beside lectures, seminars and private study, practical exercises (in the form of laboratory, production and pedagogic practices) play an important role. During the course of studies special intermediate examinations have to be passed at fixed dates. Besides his final examinations, the student has to take a degree (diploma) examination. It includes the defence of the diploma paper in front of an examining board.
Subject matters and principles of the syllabus
Introduction into Socialist Production of forms 7 - 10

Product - result of applied technics in the production process

1. Basic principles

<table>
<thead>
<tr>
<th>process of manufacture</th>
<th>mechanical engineering</th>
<th>information processing</th>
<th>efficiency</th>
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<tr>
<td>• product → process → active principle</td>
<td>• product → function → construction → active principle</td>
<td>• product → process → active principle</td>
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<td>• function → construction</td>
<td>• function → construction</td>
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technics of automation

• product → process → active principle
electrotechnics / electronics

• product → service properties → process → construction
efficiency

• efficiency → development
<table>
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<tr>
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<tr>
<td><strong>FE</strong> : Funktionselement</td>
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<td>Bauteil</td>
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<td>Arbeitsgang</td>
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<td><strong>FO</strong> : Funktionsorgan</td>
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<td>Baugruppe</td>
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<td>Verfahren</td>
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<td><strong>FS</strong> : Funktionssystem</td>
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<td>Maschine</td>
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<td>Fertigungs- oder</td>
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<tr>
<td>Montagetechnologie</td>
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<td><strong>FOS</strong> : Funktionsoberreltem</td>
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<td>Anlage</td>
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<th>Erkenntnisprozess</th>
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<td>technologisches Bedürfnis</td>
<td>konstr. Entwicklungsprozess</td>
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<tr>
<td>Prinzipstruktur für Gesamtfunktion</td>
<td>Wirkstruktur für Teilfunktionen (Gebilde)</td>
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<td>2. Phase</td>
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Übersicht Suchraummodell für schöpferische Aufgabenstellungen
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<th>Periods Per Week</th>
<th>Specialized Field Studies</th>
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<th>Pedagogics</th>
<th>Psychology</th>
<th>Methodology</th>
<th>Preparation for Research Work</th>
<th>Physical Education</th>
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<td>V</td>
<td>9</td>
<td></td>
<td>Teaching practice, preparation and defence of the thesis, preparing and taking of final examinations, special lectures and seminars on education, psychology and methodics</td>
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Übersicht 2: Strukturglieder im technischen Problemlösungs-Prozeß
<table>
<thead>
<tr>
<th>cycle of a product</th>
<th>necessity</th>
<th>preparation</th>
<th>production</th>
<th>utilization</th>
<th>outlet</th>
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<td>single part</td>
<td>initiation</td>
<td>maintenance</td>
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<td>production</td>
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<td></td>
<td>engineering</td>
<td>assembling</td>
<td>delivery</td>
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</table>

| intermediate state $z_i$ | $z_{0.1} \ldots z_{0.3}$ | $z_{1.1} \ldots z_{1.5}$ | $z_{4.1} \ldots z_{4.3}$ | $z_{5.1} \ldots z_{5.3}$ | $z_{6.1} \ldots z_{6.4}$ |

| contents of $z_i$ | | | | | |

| the $z_i$ marking contradictions and relations | | | | | |

| kinds of representation of $z_i$ | | | | | |

| working steps $AS_i$ to the transition $z_n \Rightarrow z_{n+1}$ | | | | | |

| efficient methods | | | | | |

| examples | | | | | |
Legend

P  product (material, energetic, informational)

S, E, I  material, energetic and informational couplings

cycle of the product

chronological co-operation of components

part of the teaching profession which enters integrating into other teaching professions and being there the basis for the further development

part of the teaching profession which enters into the final result

integration into the teaching process; a new quality will be established

FV  process of manufacture

Ph  training in physics

IV  informatics

WT  materials engineering

TS  technical systems including mechanical engineering, technics of automation, electrotechnics/electronics

Allg. T  general technology

APP  selected production processes
Object: Production of products and its cycle

Total function:

\[ g = \int_{P_0}^{P} \int_{t_m}^{t_0} t \{ f, e, y \} \, dt \, dp \]

\[ f = \begin{pmatrix} S(V,M) \\ S(V,P) \\ S(V,Pz) \\ S(P,M) \\ S(P,Pz) \\ S(M,Pz) \end{pmatrix} \quad e = \begin{pmatrix} E(V,M) \\ E(V,P) \\ E(V,Pz) \\ E(P,M) \\ E(P,Pz) \\ E(M,Pz) \end{pmatrix} \quad y = \begin{pmatrix} I(V,M) \\ I(V,P) \\ I(V,Pz) \\ I(P,M) \\ I(P,Pz) \\ I(M,Pz) \end{pmatrix} \]
Process of integration in the professional training Polytechnics

main contents and main requests

procedures for change of state
technical means for realizing procedures
processes for connecting changes of state

of products

$g = \int_{t_0}^{t_1} t(\tau, \xi, \omega) d\tau d\xi$

(certificated teacher of Polytechnics)
Summary

From 1979 in Hungary there is a new general subject for the primary and secondary Schools: so-called "TECHNIKA" (= technics or general technology). The task of our Department is preparing the teachers for teaching this subject in the secondary schools. 
In past years we have worked out the general conception for subject of "technics". My paper deals with the following questions:
1. Basic conception of school technology education. Our method essentially is an application of system approach for school technology education.
2. Fundamental categories of general technology ("technics"). In our aspect these are: system, model, matter, energy and information. We have built the curriculum of teachers training on the skeleton of these categories. This conception was very interesting for some colleagues from West-European countries, too.
3. The experiences of our university work. At present we have more than 100 students, and more than 300 qualified teachers. We have prepared books for students, too.
In Hungary the road leading to the present educational system has been long and rather difficult; however technics was first taught in the frame of "distant education" from 1979 onwards, and at present technics in being taught as regular subject at our University. All that happened in rather a short time: the New Law on Education was passed in 1972 and the "White Book" that laid down principles and guidelines of it was published by the Academy of Sciences in 1976. The white book stated that by the time students leave school they should be able to grasp ideas on a large scale, to collect and process information to analyse and solve problems. Furthermore they should acquire certain technical skills as well as a basic technical attitude to the world they live in.

According to these guidelines Teachers' Training in Technics can be summarized with the following conceptions:
Introducing instruction of fundamental categories of technics into school curriculum as part of general education does not necessarily mean obligatory "technical education" as such, But it means the following:
Similarly to other parts of educational material technics can also be divided into two main categories:
 - one that is subject to quick changes and
 - one that contains relatively permanent, constant elements.
The elements of technics, the so called "latest elements" of "latest technology", however important they might be cannot and also ought not to be taught by means of books and should not be introduced into general education.
Constant, permanent elements on the other hand can be and should be introduced to new generations of students because without these they cannot understand new developments let alone being able to develop new things.
In accordance with the aims and demands of society the aims of Technics Teachers' Training are: when they graduate our teachers should be committed to Marxism-Leninism they should have a solid knowledge in the field of technics and they should be able to teach in secondary education should be able to convey a creative attitude to the technical world that surrounds us at present, and last but not least they should be able to solve problems in education, in public education as well as in the life of a wider community. Accordingly, during training period the University should have a curriculum that contains material which can be put to general use and also can serve as a basis for further development and for postgraduate learning, should the necessity arise.

These are the requirements and the aims that can be best served by teaching permanent, constant elements in technics. University curriculum should not contain yesterday's and today's wonders but should concentrate on knowledge that will, by taking the two above mentioned aspects also into consideration, be valid tomorrow as well.

Elements that are really and truly constant, knowledge that is generally valid, principles and methods that are generally applicable these should be the main structural point of our task.

When deciding about University curriculum, curricula of secondary education had to be taken into consideration, with a view that teachers should not only have a solid knowledge of their subject, but at the same time they should know much more and also should have a much wider, coherent view of their subject so that they can be able to show how things are related to each other and can also point out tendencies of future development.

Constant elements of technics:

Man-made technical environment
- meets needs for a better and more humane way of life and also generates such needs,
- the history of its past development runs parallel with the history of mankind,
- possibilities of its development are determined by laws of nature,
- the aim of its development is characterised by social laws which in turn reveal needs, requirements and also tendencies of change in those,
- the possibilities of technical surrounding constitute the conditions of changes in the system;

**technical systems**
- mutually tible and interdependent processes and structures,
- mate -energy and information-transformations;

**technics**
Synthetizes and makes use of present knowledge and in turn stimulates special branches of science
- it has its own basic principles and methods out of which the most important are that it should be practical, systematic organised, optimal and economical.

The main tasks of technology is to create new systems, for which technical sciences are needed, i.e.:
- to examine existing systems and to describe them
- iterative /repetitive development/, planning and systems approach.

The first 112 teachers who graduated from technics /"distant education"/ were created by the Educational Undersecretary who stated: "In recent years there has been a considerable change in our educational system following our society's demand that was expressed by the conception of the Academy of Sciences... Working out a curriculun for Technics Teachers' Training has been a brand new task: there have not been any former experiments either at home or abroad and subjects /with their corresponding contact hours/ and requirements had to be outlined without the assistance of knowledbeable teachers. We think, however, that this first stage of training has met the aims laid down at the beginning."

***
In 1980 a working committee was set up inside the Ministry of Education /"MM Technika Szakbizottság"/. The committee worked out a curriculum drawing on the experience of distant education furthermore on the ongoing research on technical erudition and formed a new curriculum for regular students. The conception was further refined by establishing the fundamental categories of technics [2].

Out the fundamental categories of technics
Grasping the general will be a constant endeavour for man. We also want to find a system that gives an overall explanation to seemingly unrelated phenomena, processes, etc. There have been many valid theories in the field of technics but they - with some exceptions - refer to separate sections and cannot be applied to the field of technics as such. I am convinced that there is at least 5-15 years' work ahead of us in the field of technics before we arrive at an integrated theory of our subject matter.

Let us consider technics as a term, in a somewhat different light. The word "technics" or "general technology" has such a wide variety of interpretation and usage that it is almost impossible to give its unified valid definition /just consider technics of a sportsman or an artist on one hand and the technics of any equipment/.

In our view the Greek tekhné /which means art, craft, skill, tricks of a trade/ is a word that means no other thing than interaction between man and his environment e.g. nature that surrounds man. So we can say that technics equals interaction between man and his environment.

The difference is being in the extent of refinement and subtlety. The interaction was first and immediate effect and went from handicraft to simple machines, logical machines and ended with complex technological systems. The latter is no longer an immediate interaction it is rather an indirect interaction between man and his environment which at the same time became man's new artificial environment. This technology has become an integral part of man's environment.
and has considerably changed the original picture of a natural environment. It has not only changed our environment but also has established itself that's why tomorrow's environments are natural-social and technical environments. This means that man would not survive without technics or technology any longer. That's what we have to take into consideration and act accordingly.

The world of technics is an extraordinarily complex exteriorized reality. It is not easy to find our way around its past present and future and to actively adapt ourselves to it. There's one thing that is even harder- to teach other people to do the same, keeping the particular age-group they are in, in mind.

What should the theoretical bases contain? I am convinced that there is no "formula of technics" as there is no world-formula, either/ and there will not be any. There is no such thing as one single formula, one closed idea that would contain everything necessary. Not even "permanent" elements of technics can be put into one. But there is something like a "system of theories" which has a few sections which in turn have unified bases. What do I mean by these basis? All theories have categories and create their system of categories/Philosophy has the most of them/.

We are not able to create a system of categories for technics as yet. There are however five fundamental categories that are basic. What are these?

Without giving a final definition, I would say that basic theories without which no restricted categories can be formed and which serve as a basis for technics - can be called fundamental categories these are the following five [2,3,4]:

- system
- model
- matter
- energy
- information.
It is important to state that
- matter here is not a philosophical category, but a notion that is commonly used in technics and can be characterized by mass, solidity, conduction power, etc.
- energy and information are separate categories here to underline their basic roles in technics.

These three categories /matter, energy and information/ are not going to be dealt with any further here. We would like to call the attention to the fact that these three categories are not important in themselves but only important in the ways they are put to use that is from the point of view of their transformations which is our special point of view.

Let us have a closer look at system as a fundamental category. We use this category here to denote system as seen in technics that is system that can be separated from its environment and which is at the same time in interaction with its environment. System and environment are each other's complementary categories. As it is well-known technical systems are functionally matter-energy-information-transformations and are such systems and processes that can transform matter, energy, information in a purposeful planned and organised way. It follows logically from the above definition with the first three categories by transforming these categories. This transformation is suitable to the purpose which means that it is not spontaneous but a controlled process. /Ervin Szücs states: in natural systems there is a spontaneous change or state whereas in technical systems there is a deliberate change of state./ This fundamental category contains the category of controlling and regulation.

In technical systems beside function processes and structures have an important role. /When we speak about processes we also bear objects that give a frame to processes in mind./ Processes and systems structure are mutually interdependent since there is no such thing as structure without process and vica versa. On the other hand however structures and processes can be separated from each other on the level of
planning and examination. This separation has to be done during planning and manufacturing. Technical systems exist as separate entities in space and time, but
- in structures spatiality is the main characteristic,
- in processes time is the main characteristic.
We can also say, that structures are basically three dimensional, processes are one dimensional. It does not mean however, that one particular structure or element will not change because of time or one particular process will not change because of space. It does mean on the other hand that one particular process - on a given point in space, in space-time continuum is a meaningful series of events and this is a basic characteristic of process whereas in the case of structures it is the special dimension that is the main characteristic.
This quick survey shows that one can build a large system of categories around the fundamental categories. These can be placed along the following lines:
0 level: natural-social-technical environment
1 level: technical system and environment
2 level: function, process, structure
3 level: matter, energy, information transformations, controlled process, spontaneous process, parts, structural connections.
If we go along these lines this analysis or a similar analysis can be done.
The abovesaid has hopefully shown, if not proved even if it could not proved, that structure belongs to the fundamental categories of technics without which it is hardly possible to operate in technics.
Finally let me say a few words about model as a fundamental category. It is well-known that when we speak about something - we use models. Models have a decisive role in planning, supervising of a technical system. It's central role is pointed out in technical literature [6].

***
The above 5 categories will probably raise the question: are they really fundamental categories of technics only or are they characteristic categories of other fields as well? We cannot say, that matter or energy, or information etc. are not important notions in other fields of science. The important difference is that these five notions and a combination of those are fundamental to technics and to technics only.

Another question would be if these five notions are the most important in technics or there are some more. According to research done so far we would state that without these five notions no restrictive notions can be formed and these five notions can cover the whole field of technics which means that they are sufficient. A detailed proof or this statement would of course need further research in the field.

The fundamental categories of technics serve as a basis for the curriculum of regular students. The "permanent", "constant" elements of technics served as a basis to structure the knowledge our students are requested to learn in our regular training for mathematics-technics teachers. Fig 1. shows how the fundamental categories reappear in the curriculum.

matter - "Technology"
energy - "Energy"
information - "Information technics" and "Drawing"
system, model - "System and Model", and "System Theory of Machines"

Naturally the fundamental categories are not separated because of the "subjects", technics being a complex, synthetic discipline each category appears in every subject.
<table>
<thead>
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<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Natural sciences</td>
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<tr>
<td>Man and technology</td>
<td>3+1</td>
</tr>
<tr>
<td>Descriptive drawing</td>
<td>2+2</td>
</tr>
<tr>
<td>Information technics</td>
<td>2+2</td>
</tr>
<tr>
<td>Energy</td>
<td>2+1</td>
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<tr>
<td>Technology</td>
<td>2+2</td>
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<tr>
<td>System Theory of Machines</td>
<td>2+0</td>
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<tr>
<td>System and model</td>
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</tr>
<tr>
<td>Laboratory practices</td>
<td>0+2</td>
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<tr>
<td>Extracurriculum Subjects</td>
<td>2+0</td>
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<td>Methodology of teaching technics</td>
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</tbody>
</table>

Fig. 1
References


TECHNOLOGY EDUCATION IN HUNGARIAN SCHOOLS

Prof. Ervin Szucs
Department of General Technics
Eotvos Lorand University
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Summary

The most important characteristic of man's culture is the relationship to the Environment as a complexity of Nature, Society and Artificial (so-called: technical) Environment (Environment of Technology). Therefore was created in 1979 a new general subject for the primary and the secondary schools in Hungary: so-called "TECHNIKA" (= technics or general technology), in order to give children the basic knowledge of technical culture too (and not only "how to operate technical tools"!). Our University Department prepares teachers for teaching this secondary schools subject.

In past years we have worked out a conception and a complex programme of instruction from the primary schools to the teachers training. In the paper is written about the following questions:
- What is the relationship between classical subjects in the schools and the subject "TECHNICS"?
- What is the basic conception of technology education?
- What are the variable and the stable parts of technology education?

Finally my paper gives details about the role of informatics in the school technology education. (Informatics and computers or computer sciences are not "synonyms", but a very important part of technology education.)
TECHNOLOGY EDUCATION IN HUNGARIAN SCHOOLS

The most important characteristic of man's culture is the relationship to the environment. The environment is a common complex of nature, society and artificial (so-called: technical) environment (environment of technology). Therefore a new general subject was created in 1979 in Hungarian education: so-called "TECHNIKA" (= technics or school technology), in order to give children the basic knowledge of technical culture too (and not only: "how to operate technical tools")!

While creating and developing this new education curriculum we have to discuss the following questions:
- What is the relationship between classical subjects in the schools, and the subject "TECHNICS"?
- What is the basic (theoretical) concept of technology education?
- What are the variable and the constant parts of technology education?
- What is the role of "informatics" (or: information technology) in the school technology education?

1. Classical subjects and "technics"

The basic aim of primary and secondary schools is to establish the ground of culture. I think a man of culture has a general approach to his environment, he can't only search and store information with, but acts in and on the environment. As it is possible to classify the environment into 3 parts (Nature, Society and Technology), we have to classify educational subjects for these three parts too. All the educational subjects have the same target: man and/or environment. The difference between the educational subjects is (first of all) not the target, but the approach (e.g. the classical physics is analyzing the statement and movement, chemistry the composit and reactions, and so on). The goal of technology is (first of all) not to analyze, but to synthetize; not studying the natural objects, but creating new artificial objects (systems). Therefore the process of creativity stands in the centre of school technology education. The most important parts of creativity are:
- identification of a problem,
- planning of the problem solving,
- organizing of conditions of the realization,
The basic principles in the processes are:
- goal-orientation,
- organization,
- design,
- choice of extreme solutions, and
- the system approach.

The technology education must apply - and not only demonstrate - all the nature laws (and other information) from the other educational subjects.

2. The Skeleton of Technology Education

Technical (artificial) environment is the most rapidly developing part in the environment. Therefore it is impossible to write a detailed curriculum for technology education. We must create a "christmas tree" (the tree of basic and constant concepts of technology) and yearly "hang up" the new (and modern) examples to demonstrate and project these concepts in reality. In our point of view the examples are not the goals, but only the tools in the education and require continual updating. Our basic idea was in this respect to distinguish the constant and the variable parts of technology.

Every technical process takes place in a technical system. Every single technical system is a transfer of matter, energy and information. We have to use only models of a technical system from description to prescription. On that account Deri [1] has defined the
- matter
- energy
- information
- system and
- model

as basic categories of technology. And all our curricula from primary schools to teachers training are based upon these categories.

In our University, for example (it is not by accident, that our Department is called Department of General Technics!) we teach the following subject tail:
- History of Technology (1. term)
- Basic knowledge of sciences (1., 2., 3. & 4. terms)
- Technical visual communication (1. term)
- Energetics (2. & 3. terms)
- Information Technology (2., 3. & 4. terms)
- Matter-technology (3., 4. & 5. terms)
- System and Model (6., 7. & 8. terms)
- Machine-systemology (7. & 8. terms)
- School technology education (8. term)
- Laboratory practice (4., 5., 6., 7. & 8. terms)
- The so-called free facultative subjects form is a very important part of our teachers training (in the 6., 7., 8., 9. & 10. terms).

Another example:
The curriculum for the I. & II. class in the secondary schools consists of the following parts:
I. class: 1. The transformation of information, matter and energy
   2. The measurement technology
   3. Amplifiers in the technology
   4. Control
   5. Regulation
II. class: 1. System analysis (elements of technical systems)
   2. Subsytems
   3. Systems and Models in Technology
      Information Systems
      Traffic Systems
      Microcomputers
      Integrated Systems

It is very important in the teaching practice to distinguish clearly the difference between tasks and problems. Briefly: both are processes of "solution". But on one hand a task is from the very beginning to the end an algorithmical process. On the other hand a problem-solving process has at least one subprocess that cannot be algorithmical.

3. Computers and School Technology
If we use the computer as a tool of general culture, we must draw into consideration the majority of people. They need not draw up any program at all. They only should make good use of a computer. Fortunately
operating a machine turns to be more and more simple (user-friendly operation systems).

Informatics and computers (or computer sciences) are not synonyms! There is a lot of informatics that is not part of computer sciences. For example: video, newspapers, scientific documents and papers, books, broadcasting, information transfer, measurement, interpersonal communication, etc. And inversely: there is a great field of computer sciences that is not part of informatics.

For example: theory of program languages, number theory, numerical analysis, operating systems, the majority of hardware, etc.

My point of view: informatics is a system for - collecting
- transfer
- store and
- processing information.

No less - no more! Information was important in the beginning of life, and it is more and more important in society development.

Our task is: preparing children for the unknown future. That is the aim of (so-called:) "educology". This is a big cultural task. I emphasize: a cultural task! Nowadays the microelectronics dominate, but "yesterday" were mechanics; and "tomorrow"? Who knows it exactly? (Very likely it will be bionics, biological chips.) The tools change, but the function lasts for ever! Without information life does not exist. Without information, energy- and mass-transformation technology does not exist either. And without technology - society and human life does not exist at all.

So I keep saying: the computer is only a tool (a very important tool, but only a tool) in the school technology education. Preparing children for the information age means far more than to teach them computing, programming.

Literature


TECHNOLOGICAL EDUCATION IN SCOTLAND

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Summary

In Scotland, the government has taken the lead in establishing courses in technology in schools. Through the Scottish Education Department, it has initiated two new degree courses which will offer degrees of B.Ed. (Technology) at honours and ordinary level to provide the teachers for secondary schools.

This paper describes one of these courses, the one offered by Jordanhill College of Education in partnership with The University of Glasgow, which started this session.

The concept of technology adopted for the degree, the manner of conveying this to the students, the methods of developing students' expertise and competence in technology and the integrated professional training as a teacher, will be explained.

Reference will be made to the courses in technology being developed in and for schools, again on a national basis.
1987 saw the start of a new degree course designed to produce teachers of Technological Education for secondary schools in Scotland. It is the result of an initiative by the Scottish Education Department to meet the needs of young people living in increasingly technological times and also to interest them in the prospect of pursuing a career in some branch of technology. It is hoped that the change from the traditional technical subjects with their heavy male dominance, to the lighter, cleaner, less physical environment associated with technology, will also serve to attract more girls into the technological industries.

Teachers of Technical Education have, in the past, been trained only in Colleges of Education in courses lasting from 2 to 4 years depending on entry qualifications and industrial experience. The majority of entrants came from industry, mainly mechanical engineering, with the balance entering directly from schools. Of the nineteen hundred teachers of Technical Education in Scotland, only four are women. The traditional school subjects of woodwork, metalwork, technical drawing and engineering science have now been resolved to Craft and Design and Technological Studies. Craft and Design is proving to be extremely popular, with an increasing number of girls participating, while Technological Studies will only start in the schools in 1988/89 session but, if the response shown by the pupils to the pilot run is any indication, it will prove extremely popular, much more so than Engineering Science which never realised the numbers hoped for it in schools.

In its description of the type of degree which was to be constructed, the SED stipulated that emphasis should be placed on the philosophy of "design, make, evaluate" with studies in computing, electronics, systems, control, mechanisms and pneumatics specifically mentioned.

To ensure that the input in technology could be adequately done without incurring huge expense on resources which would not be fully utilised, it was further stipulated that the colleges must prepare and teach the new degree in partnership with a Central Institution or a University. The availability of staff from a wide range of engineering (technological) courses thus made available was an added factor to the case for such a liaison.

Jordanhill elected to approach the Faculty of Engineering of the University of Glasgow and received a warm response. The outcome was a degree
called Bachelor of Technological Education awarded at Honours or Ordinary levels, both studied over four years. In preparing the syllabus, care was taken to meet the needs of the schools today, prepare for the increase in technological subjects that would be in the schools when the students graduated and also attempt to predict the direction in which technology would go over the next ten years and how this might be reflected in the school curriculum.

The Course Structure

[Diagram showing progression and inter-relationship of studies]
Description of Units

Professional Studies. This provides the education and training to be a teacher. It includes studies in psychology, education, school curricula, communications, educational technology and techniques of teaching.

School Experience. Is an integral part of the professional studies programme. Extensive periods spent in schools allows the theory and preparation done in College to be applied and evaluated at first hand. As experience is gained and confidence developed, the role of the student progresses to that of the teacher. A selection of schools is used to make this experience as varied as possible.

Engineering Craft Workshops. In order to carry out practical problem solving, an extensive range of skills is required in manipulating material, using appropriate tools, machines and equipment and planning. These life skills are developed in the ECW.

Technology Design Workshops. These form the core of the course. The first year provides the students with the tools required by a designer, namely, skills in computing, graphic communication and the process of designing. Projects in the following years are drawn from a wide range of technological situations and offer the opportunity to apply the knowledge, skills and understanding gained in all other areas of the course. They can come from the College, University, schools, industry, home, hobbies, hospitals, etc. and culminate in a 200 hours project in the final honours year. Students are required to analyse the problem, formulate a strategy, design a solution and evaluate its effectiveness.

Industrial Experience. It is essential that students are given first hand experience of technology in industry and an opportunity to see how industry operates. It is hoped that many 'real-life' projects can come from these contacts which will be of benefit both to the student and the industry.

Basic Technology Laboratories. These establish familiarity with and the basic skills in using technological equipment in laboratory situations. These will be applied throughout the course and particularly in Technology Design
Workshops.

Technology. Includes studies in robotics, control systems, electronics, structures, CAD/CAM, engineering design, materials, energy, mechanics and pneumatics. It establishes a broad base of knowledge which provides an insight into the different branches of electrical, electronic, mechanical and civil engineering. The application of this knowledge occurs in the Technology Design Workshops.

Mathematics. The studies in mathematics are seen as fundamental to the understanding of modern technological theory and design. The course has been devised to integrate closely with the lectures in technology.

To meet the changes which will inevitably come, the degree sets out to provide a broad base of technological knowledge covering areas of electrical, electronic, mechanical and civil engineering but inter-relating these in as natural a way as possible. None of these disciplines is emphasised and demonstrated throughout the course. The assignments and projects which are undertaken in every year, and not only in the Technology Design Workshops, are structured to reinforce both the understanding of the theory through practical application, but also the integration of the study topics. The problems are chosen from real life situations where possible and the solution left to the student, in consultation with the client, to develop to a satisfactory outcome. As much of the construction will be undertaken by the student as possible.

Within the Professional Studies, due attention is given to consideration of the technological approach 'design, make, evaluate' as it might be applied to lesson planning and teaching.

This approach is compared to other strategies and students are encouraged to experiment and evaluate the different approaches in different teaching situations.

School Curriculum

During the first four years of secondary schooling (S1-S4), the curriculum is offered under eight groups of subject studies called Modes, and students must have at least one topic from each mode. One of the modes is
'Technological Activities and Application' which has its brief description the 'Development of technological and practical skills; designing, making and using artefacts; practical problem-solving'.

Craft and Design and Technological Studies are included in this mode along with such as Home Economics, Computer Studies and Office and Information Studies. Up to 30% of the pupils' annual study in S3 and S4 can be taken from this mode. Craft and Design has course work in S3 taught on the basis of design briefs where skills in designing are fostered along with those of making and learning about materials. The course culminates in a 'design and make' project of fifty hours' duration which is internally assessed and externally moderated. By this use of internal assessment, the pupil's abilities in pursuing the design process can be continuously and validly monitored.

Technological Studies consists of three main areas - an introductory unit, a main unit and a major project. The introductory and main unit introduce the student, mainly through practical application using custom built equipment and kits such as Fischer Technik, to the topics of electronics, mechanisms, pneumatics, technology in manufacture and permeating aspects. Emphasis is placed on the inter-relationship of these topics and assignments designed to demonstrate this in practice. The major project of 30 hours is, again, internally assessed and externally moderated.

The Degree in Practice

The Bachelor of Technological Education is unique in offering the expertise and experience of a College of Education and a University in the education and training of teachers. It has been designed round the concept of technology involving problem solving, applications and communication. The practical applications breeds familiarity with materials, components, processes and diagnostic testing which encourages students to pursue their own solutions rather than follow a stereotyped route. It is also proving to be much more interesting than just handling the theoretical equations and diagrams, but not necessarily easier. An understanding of basic engineering principles is firmly established on which students can build and develop with increasing confidence even after (or especially after) they have commenced to teach. The connection with industry will consolidate the College/University learning by first hand real-life experience of technology.
in action.

Conclusion

As with all new degrees, only time and careful monitoring and evaluation over a number of years will decide the success or otherwise of the content and strategies. We are confident that these teachers will know about technology, including its effects on society, and will be able to convey this to their pupils. They will have the training to deal with all ability ranges and the technological knowledge and understanding to promote the study to the highest level in schools and also across the curriculum from primary school to further education. With the government initiative to promote design and technology backed up by adequate resourcing, the topic has enough appeal for young people of both sexes that, with enthusiastic and knowledgeable teachers, the requirements of future industries might well be met.

The young people leaving school should have a positive attitude towards technology, understand what is happening, be able to readjust and to participate. The aim of the new degree is to produce teachers who can make this possible.
TRAINING TEACHERS FOR TECHNOLOGY EDUCATION: A NEW GOAL IN A NUMBER OF TURKISH PROJECTS OF VOCATIONAL AND TECHNICAL EDUCATION

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Summary

A number of government establishments in Turkey have launched in the past few years improvement projects in their vocational and technical education institutions in order to increase the number and to raise the quality of technical manpower needed in export related technological areas. A significant fragment which may simply be stated as 'instructor training' was incorporated in all of these projects and serious attempts were spent to enlist and train such technical staff in adequate numbers.

The paper starts with summary statements on the needs for technical teachers in the country, then proceeds with general and specific objectives of instructor training of the various developmental activities undertaken by the Council of Higher Education, the Ministry of Education, Youth and Sports, the Ministry of State and Industrial Training and Development Center (SEGEM), and continues with detailed accounts of planned training programs. It stresses some of the new approaches adopted in Turkey toward training teachers for technology education.

Finally, it supplies ample information on a combined recent effort, to procure further training for as many as 18,000 instructors for short-term vocational courses, secondary and post-secondary levels, which is to be administered by the Council of Higher Education of Turkey, within the coming seven and a half years (1988-1995).
TRAINING TEACHERS FOR TECHNOLOGY EDUCATION: A NEW GOAL IN A NUMBER OF TURKISH PROJECTS OF VOCATIONAL AND TECHNICAL EDUCATION

0 Background

"Training Teachers for Technology Education", has a long and well established tradition in Turkey. As a system and process it has gained identity and momentum with the advent of the Republic and, with anticipation, preceded the movement of industrialization. Historically one may identify, among many others, certain milestones in the development of the system of vocational/technical teacher training in Turkey.

The earliest one of these can be traced to the inception of the Republic when the renowned and pace-making educator Professor John Dewey was called upon for consultation and produced a report (1924) which contributed to the remodelling of the educational system of the modern Republic along the lines of the contemporary trends and practices, particularly in the field of teacher training.

Another milestone is a Report and a "Draft Five-Year Plan for the Vocational and Technical Education in Turkey", prepared and implemented by a joint ILO-UNESCO Mission (1956) which helped update and upgrade the curricula, methods and practices throughout the system of vocational/technical education with emphasis on training teachers for Technology.

The Reports of both "Turkish National Commission on Education" and the "Commission in Charge of Preparing National Education Plan" can be cited as another attempt at reforming the overall system again with emphasis on teacher training in general and vocational and technical teacher training in particular (1960).

The "National Education Reform Strategy" and the "Basic Law of National Education" both have a unique place in the reformative and developmental stages of the system of National Education as they are designed to restructure the overall system to meet the socio-economic requirements of the country and to redefine and confirm the professional and institutional nature of teaching and teacher training process.

As stipulated in these documents:
"Teaching is a profession which requires specialization at every level and in every field. Preparation for this profession will be secured through the acquisition of general culture, education in fields of specialization and pedagogic training."

"To acquire the above qualifications, it is essential that teacher candidates have higher education, no matter at what level they may teach."

To these milestones, a new one is about to be added through the Second Industrial Training Project which is particularly designed to completely rehaul the vocational and technical education system. It is this issue that we shall take up and discuss in this paper.

I. An industry-based economic development strategy.

To appreciate fully the importance and meaning of the recent project-based governmental undertakings in the field of vocational and technical education and their implications for vocational/technical teacher training one must be cognizant of the nature of the long-term developmental strategy of the country which extend to the year 1995.

This strategy has not only identified major developmental problems, but also the failure on the part of the educational system in meeting the manpower demands of the economy. Turkey's eventual integration with the European Economic Community has also played an important role in the design and formulation of the developmental objectives.

Among many structural changes envisaged in the long-term strategy was the restructuring of the educational system in general and the vocational and technical education in particular, so as to be able to strike a happy balance between the EDUCATION-PRODUCTION and EMPLOYMENT processes.

Practically all the recent vocationally- and technically-oriented projects undertaken by the Government should, therefore, be seen as conscious attempts on the part of governmental agencies to achieve these projected structural changes in the educational system with a view to meeting the manpower requirements of an economy irreversibly based on industrialization.

The program of structural adjustment initiated in 1980, has had considerable success in stabilizing the economy, accelerating structural changes in
technical education and rationalizing the fiscal and monetary system. A major component of this program has been the encouragement of exports in preference to production for domestic market. Thus Industrial production and in particular manufactured exports have been the mainstay of the sustained economic growth. Exports are expected to grow annually at about 11% in the next five years, concurrently with improved levels of industrial productivity. The manufacturing sector accounts for about 22% of GDP, 11% of total employment, and 60% of total merchandise exports. In order to sustain the growth of the manufacturing sector and to retain its competitiveness in international markets, improved levels of productivity are essential. Studies as regards the cause of low industrial productivity have helped identify several issues including inadequate industrial training capacity. The four main issues identified in the industrial training sector are:

1. the absence of pre-service industrial technician training;
2. the lack of in-service industrial training programs at all skill levels below the professional level;
3. the lack of an integrated national industrial training system; and
4. inadequate industrial and vocational training facilities at the pre-service secondary school and non-formal education levels.

All these issues identified over time are currently being addressed through several World Bank-supported Industrial Training Projects. The appraisal reports that provide rationale and approach to these projects, have also helped identify a long forgotten issue which relates to the critical shortage of teaching staff in all the problem areas of education. Unless qualitatively and quantitatively resolved, this shortage would stand to frustrate the achievement of the objectives of all the projects designed to address the issues mentioned above.

The realization of this problem has led the Governmental authorities to undertake a feasibility study with a view to finding a solution to the overarching issue of Vocational and Technical Teacher Training - which will be dealt with in this short presentation.
A brief consideration of the current World Bank Projects in Vocational and Technical Education and their implications for teacher training

1. Republic of Turkey (Ministry of Education)

Industrial School Project

US $ 57.7 million

The Project was prepared by the Government following a World Bank Project identification mission in July 1984.

Objectives and Scope

The Project is designed to assist the Government implement priority industrial training programs to improve productivity and assist the maintenance of high rates of economic growth, particularly in the manufacturing/exporting sectors. The project objectives are defined as follows:

a. to improve the quality and increase the quantity of trained industrial manpower by equipping and re-equipping seven existing trade specializations and equipping four new trade specializations in 39 existing industrial schools;

b. to improve the quality of existing curricula and training materials, and to assist the development of programs for new trade specializations; and

c. to improve the planning and management capacity of the Department of Technical and Vocational Education by providing technical assistance.

The project includes technical assistance for curriculum and program development, overseas fellowship training and special studies.

It is intended to meet the demand for skilled workers and junior technicians by producing some 2,500 additional graduates annually from 1991. It will increase access to training for low income-level groups in outlying provinces and is expected to result in an increase in the enrollment of women in the industrial schools system.

To meet the project requirements alone; a total of 218 technical instructors are needed to staff the additional training programs. Of these 143 are in specializations covered by programs in the existing Faculties of Technical Education and for which the current enrollment is adequate. A total of 31 instructors are required for specializations for which instructor training is not presently provided.

The project therefore includes fellowship training for 31 instructors for 310 man-months of training in these subjects. An estimated 44 instructors are
required for specializations for which training is currently provided though not at a sufficiently advanced level (i.e. electronics, electrical, machine tools and CNC Manufacturing, and computer science). Accordingly, the project includes fellowship training of 44 instructors for 370 man-months.

2. Republic of Turkey
Nonformal Vocational Training Project (NFVT) (Ministry of Education)
US $ 58.5 million
As the Government's economic strategy has major implications for human resource development, the NFVT Project supports the Government's efforts to increase and improve the supply of well-trained labor for manufacturing industries and to improve employment (including self-employment) for young people and adults with little education and training.
The project will focus on improving the quality of NFVT Programs and enhancing their relevance to the labor market needs.
It will assist the Ministry of Education in developing a number of critical areas, such as:
  - instructor training, training needs assessment, curriculum design,
  - instructional materials development, skill testing and certification,
  - and entrepreneurship courses.
The project will include the establishment of Production Revolving Funds (PRF) to enable training institutions to generate additional revenues through the production of items for sale. It will also expand the number of training places in various institutions such as the Apprenticeship Training Centers (ATCs) and the Public Training Centers (PTCs).
The main benefits expected to be derived from the NFVT project is a valuable contribution towards meeting critical manpower shortages which constrain growth in manufacturing industries. It will also significantly increase basic skill training to improve employment opportunities for disadvantaged groups including out-of-school youth and unemployed adults.
The major quantifiable benefit of this project when fully operational is expected to be an annual output of 60,000 additional workers with industrial and service skills.
The project will, in addition, strengthen areas critical to the quality of training, notably, curriculum development and instructor training and reduce the cost of financing the NFVT for the Government through Production Revolving Funds.
As is the case with other vocational and technical education projects, the main issue in NFVT project is the provision of instructors, as its success is dependent to a large extent upon the skills of the teaching staff. Presently Ministry of Education relies heavily on part-time instructors who need intensive induction training as well as up-grading. The source of supply for instructors vary from one type of program to another. Therefore, a critical factor in the development of NFVT programs is the Ministry's capacity to provide regular and systematic in-service training to instructors - all having implications for the general problem of vocational and technical teacher training.

The unemployment problem and measures directly taken by the Government to fight the issue
In addition to the non-formal vocational training project of the Ministry of Education, it would be appropriate to refer briefly to the long, medium and short-term measures taken by the government through the Ministry of State to fight against the problem of unemployment. Of these measures, the medium and short-term ones are generally of non-formal education nature and include:
- projects for mobilizing the idle capacities,
- projects orientating the unemployed to acquire skills for setting up their business or finding jobs,
- projects encouraging household production.

3. Republic of Turkey
Industrial Training Project
The project I. US $ 36.8 million
The project II. US $ 115.8 million
With its two phases the project addresses the first three of the four issues identified in the industrial training sector, namely: (1) the absence of pre-service industrial technician training; (2) the lack of in-service industrial training program at all skill levels; (3) the lack of an integrated national industrial training system.

The First Industrial Training Project
Consistent with the Government's development strategy to improve productivity and maintain high rates of growth of manufactured exports, and
as an approach to the solutions of these issues, the First (Pilot) Industrial Training Project was designed with a view to:

a. strengthen the institutional capacity of the Council for Higher Education (YOK), a Constitutional governing the higher education sector of the system and the Industrial Education and Development Center (ITDC-SEGEM);

b. alleviating scarcities of technicians in industry by assisting the development of pre-service technician training programs; and

c. improving industrial productivity by developing SEGEM's in-service, on-the-job, industrial training programs for middle level manpower and professional staff (*), and to establish a basis for a national industrial training system.

In order to assist the Government achieve these objectives, the project included the provision of:

a. equipment, furniture, and minor refurbishing for eight pilot Technician Training Centers (TTCs) under YOK;

b. technical assistance to YOK for curriculum and staff development for TTCs and to assist with strengthening of the TTC management system and future project development;

c. equipment and technical assistance to SEGEM to assist with the development of a framework for a national industrial training system, program expansion, diversification and improvement, and future project development.

The First Industrial Training Project, still in process, has now reached the stage of evaluation of the practices of pilot nature to pave the way to the Second Industrial Training Project - much broader in nature and scope.

(*) ITDC-SEGEM, a semi-autonomous public organization founded in 1978 in order to contribute to the development of industry with knowledge and skills to accelerate economic development. Its activities cover training (to meet the needs of industrial organizations parallel to the technological innovations); and consultancy (to find out solutions to the technical, managerial and training problems of the organizations). ITDC's training program for 1988 includes such areas as management; computer science; production management; inspection and control; manufacturing techniques; hydraulics/pneumatics; machine design; process design; heating-ventilating and A/C refrigeration.
The Second Industrial Training Project
The ongoing Industrial Training Pilot Project referred above (2399-TU) included a pre-investment and feasibility study which indicated that further expansion of the system of pre-service industrial technician training would be required to meet industry's needs for higher-level technicians. Also the World Bank's 1986 survey of the education and training sector recommended selective expansion and improvement of the vocational/technical education system, particularly; (a) development of a country-wide system of higher-level technician training for industry; and (b) upgrading the quality of instructor training for technical and vocational education.

Based on the findings of these studies the Government has proposed a second phase of assistance to develop and expand training programs in areas where technician have been identified by employers to be in shortage.

The Project objectives are as follows:

a. to strengthen the institutional capacity of YOK to plan the development and coordinate the implementation of technician and technical/vocational teacher training programs;

b. to alleviate scarcities of technicians in industry by assisting YOK in the development of additional pre-service technician training programs targeted to produce about 3,100 graduates per year by 1986;

c. to meet a projected shortfall of over 13,700 technical and vocational teachers in secondary, post-secondary and non-formal skill training institutions;

d. to strengthen the institutional capacity of the Ministry of Culture and Tourism to plan the development and coordinate the implementation of basic level hotel and tourism training programs at 10 Tourism Training Centers (TUREMs).

Having briefly considered the Government's recent projects in the field of vocational and technical education, we now turn to the overarching problem of teacher training - the solution of which is essential for the success of all the projects designed to bring about the structural changes in the vocational/technical sector of the education system.

III Vocational/technical teacher training in prospect

The Technical/Vocational Teacher training component of the Second Industrial Training Project (US $ 33.1 million), is intended to assist the
Council of Higher Education (YOK) in developing a system of high quality technical and vocational teacher education in four Faculties of Technical and Vocational Education (FTVEs).

As there is a projected shortfall of about 13,740 well-trained technical and vocational teachers by 1991, the teacher training component of the project is designed to address this issue by improving the quality and increasing the quantity of technical and vocational teachers through support to three Faculties of Technical Education in Western, Central and Eastern Turkey and one Faculty of Vocational Education in Central Anatolia.

To improve teacher quality, the project will assist the FTVEs in improving their existing teacher training programs by:

- updating and up-grading the technological content of programs, and reducing emphasis on engineering practice and production work;
- establishing appropriate training standards.

To achieve this, a technology department, a technical/vocational education department and a development and instructional support unit will be established at each FTVE.

Curriculum Development for technical/vocational teacher training programs will be undertaken at the Technical/Vocational Education Departments and will involve relevant experts from the technology departments.

In the longer term, these departments will have the capability to advise MOE on curriculum development for its secondary industrial and technical high schools.

The project will also upgrade training facilities in these new department units, and improve faculty management.

To increase output of technical/vocational teachers, the project will assist in the development and implementation of new improved and shorter courses at these faculties. The new courses will include:

- one-year post-graduate courses for graduates in relevant specializations;
- two-year courses for graduates of post-secondary institutions such as TTCs; and
- modular in-service training programs for suitably qualified persons in industry, and for currently employed teachers who wish to upgrade their skills for career advancement.

These courses will be developed in consultation with MOE and other client ministries, as well as industry. Training flexibility will also be enhanced.

To address the issue of recruitment and retention of technical and
vocational teachers in the Ministry of Education's secondary skill training institutions, terms of service for these teachers will have to be improved. Loss of potential teachers will be reduced by about 30 percent through:
(a) improving teacher quality and involving MOE in curriculum development, thereby eliminating the need for an external examination in which currently 50 percent of the candidates fail; and (b) simplifying MOE, recruitment procedures to shorten the waiting period for candidates.

**Technological Content.** Expertise will be developed in the Technology Departments to revise the curricula of existing technology courses and the teaching methodology for instructor training programs, which are too heavily oriented towards engineering.

**Pedagogical Focus.** The role of the Technical/Vocational Education Departments will be to provide the pedagogical focus to training programs that is currently missing, and to develop curricula for instructor training programs in conjunction with the Technology Departments.

**Research and Development.** The Development and Instructional Support Units will be responsible for:
- developing new training materials;
- establishing training standards for pre-service and in-service programs in the faculties; and
- providing leadership for research and development in technical and vocational education.

**Teacher Training Facilities.** Facilities in the FTVEs will have to be upgraded for the new and improved training programs. To upgrade training facilities, the project will provide equipment, furniture and renovations of and extensions to existing buildings. Equipment will primarily be used to support pedagogical and methodological improvements in the training programs.

In Sum, a Key element of the teacher training component of the project is the staff and curriculum materials development provisions aimed at improving the quality and relevance of vocational and technical teacher training preparations - ultimately to meet a projected demand for 17,400 teachers by 1991 - as these teachers will enable the upcoming generations to live in and contribute to a technological society; and as "...practical education is progressively making exacting intellectual demands" on teachers and teacher training institutions.
TECHNOLOGY AT PRIMARY SCHOOLS

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Summary

There is a growing interest in technology at primary schools (age 4-12). It is clear that the attitude towards and the concept of technology of secondary school pupils, that we have studied so far in PATT, is for a great part shaped by their primary school experiences. Differences between boys and girls seem to originate at primary school. Therefore there is a growing need to pay some (and non-formal) attention to technology at primary schools. It is essential that teachers during their training at primary school teachers' training institutes get technology education. It is important to know what starting-points/frameworks should be used in this respect.

The student/future teacher will:
1. have to acquire a feeling for technology (research living environment),
2. have to be able to talk about it, be superior to it (meta-technology).

In a system of inservice training
- 'BASTEC' workshops will have to be provided,
- relational networks will have to be made with industry,
- 'do-days' for pupils from primary schools will have to be organized at schools for junior technical training.

*BASTEC is an abbreviation of BASic school TEChnology (basic school = primary school).
TECHNOLOGY AT PRIMARY SCHOOLS

1. Developments of technology at primary schools

1.1 At many primary schools experiments are done from time to time with electricity, with light and liquids. There are also computers at many schools. Some children fit up a 'discovery-corner' with constructions in which children, often with printed instructions, do experiments, build technical installations or work with the computer. At primary schools too there is a growing interest in technology.

1.2 However, the teachers are not very familiar with technology. During their general education (senior secondary general education) they are hardly or not at all acquainted with technology. This is also the case at the teacher training institutes. The teachers at those institutes are themselves not so technically orientated either. They are focused on social subjects, on language, on arithmetics, on orientation on the world.

Young people who choose a career as teacher at primary school choose for children, for pedagogy and didactics, for conversations with parents, if necessary; but not for technology. In general there is not such a flashing career at senior secondary education behind them. In their training they often choose for an alpha- or gamma-set of exam-subjects. At the teacher training institute they meet with teachers who are just like them: alpha-orientated, social, focused on human beings. This way we get a vicious circle resulting in a population of teachers at primary schools who, in general, have little knowledge of, experience with and insight into technology.

1.3 So we see on the one hand that there is a growing interest in technology at primary schools, whereas on the other hand many teachers at those schools have little knowledge of and experience with technology. The result of this could be that many teachers have a distorted
concept of technology and also because of this, a negative attitude towards technology.

We presume that this does not only apply to the Netherlands, but also to other countries.

So there is a certain need to pay more attention to technology at primary schools. But if we want to do this it is essential that we first of all pay more attention to technology during the training of teachers for primary schools. And also to arouse attention for an interest in technology with the teachers at those teacher training institutes.

1.4 There is one more special reason for which it is important to pay attention to technology at primary schools.

It is a well-known fact that at the age of 12 girls have a vaguer concept of technology than boys and also a less positive attitude towards technology.

This has a negative influence on the choices of studies and profession of girls. It is important to give girls a thorough knowledge of technology already at primary school to affect this way that they have a correct concept of what technology is, and that they have a positive attitude towards technology.

1.5 We have a Working Group BASTEC (= BASic school TEChnology; basic school = primary school), consisting of representatives of 6 teacher training institutes. This group was started on the initiative of Jan H. Raat, Henk Siegers and Keimpe Kuipers.

In cooperation with the Ministry of Education and Sciences the Working Group BASTEC develops a basic set of four video films with booklets to make students at teacher training institutes and their teachers interested in technology.

The four films and booklets are about the following:

1. an orientation, comprising: technology is not frightening, not incomprehensible and for women too,
2. what is technology: technology and the human being; matter, energy and information; the relation between technology and science; the relation between technology and society; technology as a trade,
3. the third film gives a number of examples of lessons for teachers in the lower part of primary school (4-8 years old), and
4. the fourth set does the same for the upper part of primary school (age 8-12).

2. Thoughts on technology at training institutes for teachers at primary schools

2.1 Technology is valuable.

a. Technology is hidden in the things around us. To draw the attention of pupils in basic education to this, teacher training institutions for this type of education have to provide a 'technical sensitivity training': investigation of immediate living environment, excursions and practical work in factories, workshops etc. This has to take place in a systematic and ordered way. Apart from influencing the attitude the aim is also to get hold of the (technical) reality by means of the possibility to classify.

b. Minor and major technology. The student has to learn to link up his own work (also for craft and physics) with the 'main work'. thereby new questions will come up, for example about the control of costs and raw materials and the effects in the long run. The student learns to weigh aspects, and thereby he/she sets standards. These standards and values have to be made explicit and then a strong link will be made with other fields of study (anthropology, philosophy, religion).

2.2 Technology and therapy. In some therapeutic literature system-theoretical concepts are used to gain insight into what happens in groups: the class, the group, the family. Certain phenomena (redundancy, homeostasis) are explained -already now- on the basis of technical examples: thermostats, Ashby's homeostat etc. Insight into systems theory can better be obtained after the student has developed a 'technical feeling'. So a link originates between technology and 'theory of influence'.

2.3 In the theory of communication a distinction is made between communication and 'meta-communication'. We explain it this way:

you can talk to children and you can talk about children. This makes all the difference. Talking about music is talking, not music. Wouldn't it be possible that there is also technology and 'meta-technology'? Talking about technology is talking, not technology?

One piece of information seems to be that as the children you are concerned with are younger, the language should be more direct, less meta.

With children and mentally defective people you should not talk 'about' music, but make music. Translated to technology: at primary school and in special education one should pay attention to technology by discovering, playing, constructing, getting it at their finger tips. But to be able to realize this the teacher (at the teacher training institute for these types of education) should master meta-technology. He should be able to think and talk about it, be a master of the situation.

2.4 Digital and analogous language.

When a pupil reaches the age of six he/she is introduced to the secrets of reading, writing and arithmetics. The digital language. Language in signs. After some time these signs will start living for him/her and they will form a new reality.

The appreciation of digital magic is overwhelming. There is a high status-line from these subjects via mathematics to engineer in information technology.

Several years later we have to explain to students at teacher training institutes once more how important the analogous means of communication are: play, music, drama, craft. It seems as if a human being has to have a lot of (enforced) leisure time to discover this once again.

The more digital, the more status. This also applies to the previous subject: the more meta-, the more status.

Technology at the teacher training institutes should comprise
analogous and digital aspects. Technology at primary school should mainly be analogous: experiencing, feeling, discovering, making.

2.5 Theory of communication.
With the introduction of technology we shall probably have to take into account resistance based on supposed loss of status, comparable with the learning/teaching of play and drama. This can be compensated for by introducing (at the same time) a new basic subject at teacher training institutes: theory of communication. This field of study is a meta-meta-subject: it looks at phenomena like play, language, mathematics and technology in the perspective of human behaviour, as communication. An example from theory of games: games are 'stripped' to their basic form, the concept of games. This basic form is confronted with new circumstances and a new game originates (converting ball games that require a large field and many players into a game for a child with a broken leg in the hospital.....). Would it be possible to take a similar approach to technology? To strip technical expressions to their basic form and to convert this to new technology in other circumstances?

2.6 Technical schools.
Children from primary school can discover a lot about technology in the school's own building, certainly when 'discovery-classrooms' are fitted up. The (possible) technical, crafty aspiration of a junior technical school may be used to improve the attitude of pupils from primary school towards technology. If one has ever had the chance to observe a ten-year-old child working on a lathe, tongue sticking out, extremely concentrated, he/she will have discovered the hidden opportunities of junior technical school. It requires a change in attitude to be able to realize such a partnership between schools for primary (and secondary!) education and junior technical schools. Not only of the teacher at primary school, but also, and particularly of the teacher of the subject at junior technical school. Because he/she is the one who abhors this example of the ten-year-old pupil.....
The junior technical school will have to be adjusted to the regular stream of children from groups six to eight from primary school.
However, opposed to this there is the fact that less energy can be spent on open days: the children will be coming anyhow....?

2.7 Concrete:
Several activities are required to arouse interest in technology at primary school:

a. The teacher training institutes -in cooperation with school counselling services?- are going to set up educational workshops in the field of technology (BASTEC-workshops). Here teachers at primary schools and students at teacher training institutes can be acquainted with discovery-boxes and -corners, they can pick up new ideas for the fitting-up of their school and their education. There may be a relation with the craft workshop, and perhaps also with the regional support institute for education and information theory.

b. The teacher training institutes are going to set up a network of relations: with companies, factories, laboratories etc. They organize excursions for teachers at primary schools, sometimes within the framework of inservice training. Naturally for their own students as well. They will take up these institutions in the programme for practical training.

c. The junior technical schools organize do-days for pupils from primary and secondary education. If necessary they will reorganize their buildings and their educational organization. Perhaps the network of relations of the junior technical schools can also be at the service of the teacher training institutes. Is it possible for older students at junior technical schools to give guidance to the children at primary school? Can students from teacher training institutes teach this to those older students? This way the social knife cuts both ways.

d. All this is surrounded by a system of inservice training. This requires material and teachers that have to be trained. Technology at primary schools means also technology at teacher training institutes. And also attention for technology in the
training of the teachers for the teacher training institutes. If they did not get this training at the university we shall have to do it ourselves, in inservice training.
A 2-year programme of developing teacher expertise in Science and Technology is now half completed in primary schools in Devon. The term "technology" is taken to include the Home Economics aspects of Food and Textile Technology as well as the structural and mechanical aspects of technology. The programme is operated by a team of four advisory teachers, three women and one man, selected for their teacher credibility rather than qualifications, and this team works throughout the 450 primary schools in Britain.

The course pattern includes preliminary school visits, a period of full-time tuition, and follow-up visits, and a large pack of equipment and materials, including booklets prepared by the teachers under tuition, is given to each participant at the end of the full-time course to enable them to start work immediately in their own classes. The headteacher of the school is also involved and is required to make a commitment of support.

The major problem encountered in developing Science and Technology in primary schools is without doubt the lack of confidence of the teachers, particularly women teachers. By providing a complete and individual long-term supporting framework for the introduction of the work, this problem has been overcome. The programme is an outstanding success, and the demand for places now far exceeds the places available.

The Devon LEA will fund the attendance of two of the teachers, one man and one woman, and a complete pack of resources with a video of the scheme in action, would be brought for display.
The test of technology is not "How does it work?", but simply "Does it work?". This principle was applied in planning the in-service training programme for science and technology for primary (ages 5-11) teachers in Devon. By placing the programme in the hands of four good practising teachers, giving them the responsibility for organising and operating the three year programme, and relying on faith rather than figures, we believe the programme will be a success. Two years on, the technological approach is working.

Devon is a large education authority, by British standards, covering an area equivalent to the Eindhoven-Köln-Liege Triangle. It is mainly rural, with most of its 70,000 primary children in schools of less than 200 pupils, and with 75% of the teachers female. Neither the teachers nor the social environment appear to encourage technological interest. For educational administrative purposes it is divided into four Areas.

The structure of the programme has been to develop a science and technology centre in Exeter, the administrative centre of the County, but to appoint the four advisory teachers to operate in each of the four Areas, and with the support of an adviser in that Area. The advisers cover the specialisms of science, home economics, and design and technology, as well as general primary expertise, and all the subject specialists were involved in the selection of the advisory teachers, coordinated by the adviser for design and technology at the County administrative centre. The main principle in selecting the advisory teachers was performance, not qualifications.

The operational principles of the programme were four fold:

(i) the aim was to benefit actual pupils through their actual teachers, dealing with broad pedagogical principles only as and when appropriate;
(ii) quality of the training was considered more important than the quantity, so that while fewer teachers would receive in-service training, the success of those trained could be virtually guaranteed;

(iii) the approach was project, not subject, based although it included the subject areas of science, home economics, and design and technology;

(iv) the target of the operations would be the school, not the technology centre, and the training undertaken centrally would only be a means to better operation in the teachers' own schools.

The operational practice may be compared with the birth of any new baby:

(i) fertilisation of ideas was not difficult, as the government has given wide publicity to the emphasis on technology, and developments in technology at secondary school level have been widely publicised for a number of years in Devon;

(ii) pre-natal care took the form of visits by the advisory teachers to the school selected to send a teacher for in-service training, to reassure the teachers, and assess their precise requirements, operational difficulties, etc.;

(iii) the birth of the technological baby took place in an eight day concentrated course, initially with a staffing ratio of four tutors to twelve teachers. While apparently extravagant, this ensured that the teachers made good use of every moment during this formative period;

(iv) nourishment for the baby was given to the teachers in the form of packs of materials to enable them to start work with their own pupils in their own schools immediately following the concentrated course, without having to order and await delivery of materials;
(v) post-natal care comes in the form of visits by the advisory teachers once the courses are under way, to give support when the inevitable minor difficulties occur in practice.

The problems arising so far fall into three categories;

(i) initially, there is the problem of teacher confidence, and this can be overcome by individual attention, and setting the starting point to suit the teachers' expertise;

(ii) currently, the major problem is the demand of teachers to join the courses, and while it is now possible to expand the numbers on the courses considerably, it is nonetheless quite impossible to meet the demand from other schools which have seen the good results coming from these courses;

(iii) the potential problems, which are already appearing, lie mainly in the transfer to secondary schools, many of which, despite in-service training, have not yet realised the degree of change taking place in the primary schools, and how the secondary courses can and must adapt.

The video recordings of the work in progress, and the explanations of the work by the advisory teachers themselves, demonstrate the scheme in operation.
PROBLEMS AND PERSPECTIVES OF TEACHING TECHNOLOGY

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Summary

The technology of teaching is a relatively independent area of the pedagogical technology. It is an up-to-date integral theoretic-practical science which for improving the process of teaching is making use of the knowledges not only from the didactic and the psychology, but successfully collaborates with other sciences. Between its principal characteristics are to be mentioned:
1. contemporaneousness,
2. optimality,
3. integrality,
4. wide use of varied technical means and didactic materials,
5. programming the activity of the teachers and the students.

In the technology of teaching could be distinguished the following more important areas:
1. classical (traditional) teaching technology,
2. technology of preparing and using the traditional didactic materials,
3. technology of developing the didactically oriented languages and programs of teaching,
4. technology of the complex use of contemporary and classical technical means of teaching,
5. technology of the didactic communication,
6. ontodidactic technology,
7. technology of the pedagogical diagnostic and dodactometry.
The technology of teaching is relatively independent area of the pedagogical technology. It is an up-to-date integral theoretic-practical science which for improving the process of teaching is making use of the knowledges not only from the didactic and the psychology, but successfully collaborates with other sciences. Between its principal characteristics are to be mentioned 1/ contemporaneousness, 2/ optimality, 3/ integrality, 4/ wide use of varied technical means and didactic materials, 5/ programming the activity of the teachers and the students.

In the technology of teaching could be distinguished the following more important areas: 1/ classical /traditional/ teaching technology, 2/ technology of preparing and using the traditional didactic materials, 3/ technology of developing the didactically oriented languages and programs of teaching, 4/ technology of the complex use of contemporary and classical technical means of teaching, 5/ technology of the didactic communication, 6/ ontodidactic technology, 7/ technology of the pedagogical diagnostic and dodactometry.
The scientific-technological revolution carried out worldwide causes considerable changes in the field of material production, as well as in the sphere of social activity. Nowadays the science-technological revolution is being defined as a technological microprocessoring, informative or intellectual revolution. The incessant process of development and application of new technologies in the different fields of economy and in the intellectual sphere is being accomplished. The widening use of computers in the communications leads to the continuous rapprochement, the fusion and the integration of the technologies for the use of the phone, the computer, the cablevision or the video discs. This causes a considerable improvement of the circulation (exchange) of information among people, not only in a national but also in an international aspect.

Even though the idea for a technological approach towards the problems of teaching and education, about the need and possibility for an operationalizing of knowledge and actions is not new, the foundations of the teaching technology are being laid only now in the last decades. Due to this many questions of theoretical and practical character are not yet fully clarified or are still being discussed. What is also missing is a conceptive-terminological clarity: quite different terms are being used in our pedagogical literature: technology of education, technology of teaching, technology of the educative process, technology of the technical devices for education, etc. There are also pedagogues who believe that the term technology cannot be applied in the educational sphere since it is used mostly to describe the processes taking place in material production.

Some authors regard teaching technology as a supplementary sphere of didactics, able to realize the ideal process of teaching in the given conditions of the pedago-
gical practice. According to them the main purpose of the teaching technology is to create all conditions needed for the transformation of the laws and principles worked out by didactics (as an ideal technology) into operational solutions. We believe that such an approach in the examination of educational technology is one-sided because it does not give account of its integrative character. In order to achieve the most optimal and intense form of education teaching technology uses knowledge not only from didactics, but also from psychology or pedagogy as well as from many other sciences: biocybernetics, euristics, synthetics and so on. Therefore it may not be regarded as a part of didactics for it has a clearly defined integrative character. Of course the informative-cybernetical and technological approach towards education does not ignore its social nature. Teaching technology does not deny the significance of the classic pedagogical and psychological theories about teaching and learning. It helps them raise on a quite higher scientific and theoretical level.

According to us teaching technology should be regarded as a relatively independent and significant sphere of pedagogical technology, as a theoretical supplementary science, which can be characterized by the following main features: 1/ up-to-dateness in the orientation for application of didactical innovations, 2/ optimality - a striving towards the achievement of significant aims with the least possible expenses of time and devices, 3/ integrality - a summarizing of the achievement of different sciences for the sole purpose of their further practical realization, 4/ wide use of various technical devices and didactical materials, 5/ programming of the activity of teachers and pupils based upon the recurrence of the educational processes and others.

Teaching technology gives solution to the follow-
ing more important problems:

1. It assures a taxonomical approach when the aims of education are being defined and works them out in a strictly defined hierarchical manner in the form of controllable characteristics (standards).

2. It works out the full strategy and tactics of teaching.

3. It guarantees the wide use of a system of modern technical devices and mechanisms such as the automatized systems for education microprocessor technique and optoelectronics.

4. It assures the possibility for a widening use of the operational-functional technological approach in the process of teaching.

At the same time it gives an answer to a great number of more particular questions such as:

1. It studies the effect of different model solutions in the sphere of the technology of teaching upon the results from learning.

2. It defines the most effective ways for choosing and structuring of the educational content with the sole purpose of improving the process of its mastering.

3. It makes the choice of materials, devices and organizational forms which are adequate to the aim, type and conditions of teaching.

4. It carries out an incessant or staged check (measurement) of the results obtained in the course of teaching throughout a systematic analysis of the effectiveness of the separate variants and combinations of methods and forms.

5. It works out a system for planning and regulation of the teaching process so as to help in the reaching of an optimal responsible employment of teachers and pupils and so on.

In the conditions of a proceeding modernization
what can be felt more tangibly is the inadequate constructiv-
tivity of traditional didactics, the impossibility for assimilation of the achievements of the different sciences in the frames of her apparatus which can be used for rationalizing of teaching and learning. That is one of the main reasons which caused that intensified interest towards modern teaching technology. There is even more to it. Lately, even in the frames of didactics many of her general conclusions are starting to play the important part of technological functions.

The further development of teaching technology is closely connected with the thoroughness of the processes of its internal and external differentiation and integration. All this will lead to the relative detachment of narrower-ly specialized spheres in the frames of teaching technology and to its integration with the other branches of pedagogical technology.

At the present stage can be singled out the following more important spheres in teaching technology:

1. First of all comes the classic (traditional) teaching technology which has often been absolutized by some pedagogues. It reveals and uses different mechanisms, operations, procedures, algorithms, etc. in the process of teaching with the only aim to achieve its higher resultat-tnity. No up-to-date technique and new didactical materials are used here.

2. Another sphere of teaching technology is technology for the preparation and use of traditional didactical materials. Cinema films, slides, videofilms and others are made thanks to this technology.

3. The third sphere of teaching technology is connected with the development of didactically orientated languages and programmes for education. This form is very perspective and requires an incessant improvement of teaching programmes.
4. The fourth sphere of teaching technology includes the combined use of up-to-date and classic technical devices for education - mostly computers and video systems. The wide use of calculating machines and especially that of microprocessor technique in the educational institutions has an enormous importance for the development of technical devices and systems for education. The invention of personal computers is a big success for technical thought and marks a qualitatively new stage in the use of electronic devices in all spheres of human activity. With the creation of comparatively inexpensive specialized microcomputers for the aims of education a lot wider possibilities for its individualization and differentiation, as well as new forms for its technologization will be discovered.

5. The wide use of the mass media devices for the needs of teaching during the last decades led to the detachment of a relatively independent sphere in teaching technology - technology of didactical communications. The process of teaching is regarded as one of the private cases of social communication. Lots of efforts are being made in order to identify didactical communication on the basis of the accumulated experience by communicative didactics, social psychology and others.

6. Another sphere of teaching technology is the so-called ontodidactical technology, which includes all procedures and mechanisms for the transformation and reduction of the newest knowledge in the spheres of different sciences, which are used for didactical aims. The ontodidactical approach permits the transformation of modern scientific knowledge into an accessible for the pupils form, as well as into a device for the maximum development of their cognitive abilities and personal qualities. This approach is extremely perspective for the solving of the deepening contradiction between the evergrowing volume of scientific and technical information and the narrow possi-
bilities of the pupils for its mastering.

7. An important sphere of teaching technology is technology of pedagogical diagnostics and didactometrics. It is connected with the mass use for the aims of teaching of a system of modern methods and procedures for the exploration of the intellectual abilities, properties, personal qualities of the pupil, of his temperament, emotional mobility, deepness of experiences and a lot of other parameters of its psychological and psycho-physiological sphere. At the same time pedagogical diagnostics and didactometric is directed towards the establishing of the condition the clarification of the causes, conditions and the revelation of the tendencies and perspectives in the development of the student's personality as a result of pedagogical interactions. Towards this sphere can be referred: a/ technology of the preparation of different kinds of tests intended for educative and instructive aims; b/ technology for the organizing and carrying out of pedagogical diagnositical research; c/ technology of didactometrical procedures for the measuring of the preparation and development of students.

It is possible that in the future there may stand apart other spheres of teaching technology which stands as the main direction of pedagogical technology. At the same time the integrative links among teaching technology and technology of education, technology of the control of education and the other main trends of pedagogical technology will be strengthened. The coordination of teaching technology with that of other technologies in the sphere of social and productive activity will be deepened.

What is needed now is that the study of the actual problems of teaching technology must come to being not according to the private preferences of the different specialists but that it should be done planned collectively and complexly. Along with that the different forms of edu-
cation of teachers from all kinds and degrees of schools in the main aspects of teaching technology must be used; Its growing use should make a study of the experience of different countries in the sphere of industrial production of didactical materials and technical devices.
INTERNATIONAL PERSPECTIVES ON TECHNOLOGY TEACHER EDUCATION: AN ANALYSIS OF THE IMPLICATIONS OF PATT-III

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Introduction

Purpose
As with all human endeavors, technology education and technology teacher education are not insulated from issues and problems that face all emerging disciplines. These challenges need to be resolved if this type of education, which provides both the theoretical and practical knowledge, attitudes and skills that are necessary for the control and adaptation of the environment, is to succeed. Some of these problems and/or issues (such as equipment, funding and partnership with industry) are as mundane as those plaguing vocational-technical education, while others are unique to technology education. Included among them are: the question of the desirability of developing technological generalist teachers as opposed to technological specialist teachers; or the relative emphasis on the constant and permanent elements of technology content versus the fluid and contemporary aspects of technology. It is the purpose of this section to critically analyze the issues raised by the experts attending the PATT-III 88 Conference. The primary intent will be to highlight the implications, for technology teacher education, contained in the presentations and discussions of this conference. In doing so, it is important to distinguish between the teaching of technology education in the elementary and secondary schools of various nations and the preparation of teachers for this task. The reader must recognize that our focus is the latter, i.e., the preparation of technology teachers at the university level.

Methodology
The author's methodology in addressing the purpose involved primarily the
review and analysis of notes made during the presentations and discussions of the PATT-III Conference. In addition, the co-authors analyzed the papers provided by the conference's presenters.

**Necessary Conditions**

Soon after accepting Dr. Raat's assigned challenge to attempt quality international communication in our profession, it became clear that several important conditions must be satisfied in order to succeed. Foremost among these are:

a. shared meaning of key concepts,
b. careful documentation of existing knowledge,
c. replicability of practice, and
d. the establishment of a clearinghouse to facilitate international contact.

Shared meaning simply means that in order for effective communication to proceed, all parties involved need to possess at least a modicum of understanding about what the profession's key terms are. Additionally there needs to be a significant amount of agreement about the meaning of these terms. Our review of the PATT-III papers suggests that, at least presently, this important condition is not satisfied very well. In the co-authors' analysis as well as in Vohra's report, there is ample evidence of contrary definitions, and more importantly, undisciplined usage that undermines the effectiveness of our communication.

Among the concepts that seem indispensable to our communication are curriculum, science, technology and technology education. In addition it will also be important, not merely to define each individual concept, but also to differentiate between related ones, e.g., science and technology. We will need to be able to clearly state what both are and what they are not! As we address this preliminary challenge, we must remember the caution raised by Harrison - namely to avoid the preemptive assumption. Given this it would seem wise to systematically examine all our basic tenets for the existence of such assumptions. Often interaction with interested parties from outside or normal sphere of activity will serve as an effective litmus test for such easily inserted assumptions by us "believers".

Careful documentation of our rationales, practices and experiments is another essential condition for future success. The degree of rigor we employ in this task will certainly affect the extent and quality of our communication and through this, the quality of technology education's
implementation. It is this condition that leads to replicability, i.e., the verification of our results, and through this enables true progress. To achieve this end, we must be careful to document all information necessary to replicate our experiments - not just enough to describe them. Finally it seems obvious that our profession, i.e. those who are interested in developing the next generation's understanding of and capability with technology, has evolved sufficiently to require a central clearing house for key information. Despite their quality, a once-a-year PATT Conference is simply not sufficient. We need an international clearing house to collect, catalog and disseminate information about technology education and technology teacher education. This clearing house needs to provide an effective international access mechanism as well as an international periodical to reach out to those who cannot visit the site directly.

Organization and Nature of Teacher Education

Types of Technology Teachers
The participants of PATT-III addressed the organization and nature of technology teacher education in many ways. One of the most prevalent was the discussion of what types of technology teacher education there were and/or should be. Harrison, for example, suggested that two types of teachers were needed to properly provide technology education in the elementary and secondary schools. One type was the freestanding technology teacher and the other was the teachers who infused technology in their other subjects. The first would teach a separate technology course while the latter would teach an existing school subject, e.g., science or social studies and infuse key technological concepts and activities into it. Typically the latter would be general education subject teachers and primary teachers. Deijsselberg, Türker and Dyrenfurth, also noted that a third group of teachers was involved with technology education, namely the vocational-technical teachers. Generally the PATT participants exhibited strong advocacy for the freestanding technology teacher although there was a minority opinion that this was an impossible job assignment.
There are problems associated with both of these approaches to the preparation of teachers for technology. The sheer breadth and complexity of technology makes it difficult for "stand-alone" technology educators to cover the subject adequately in the limited amount of time they are typically
afforded. This same complexity makes it difficult for non-technology prepared teachers to understand the subject sufficiently to infuse it properly into their traditional courses. Often overgeneralizations, misconceptions and limited concepts are taught when such teachers attempt the challenge.

Outcomes of Technology Teacher Education

Despite the difference of opinion about what types of technology educators should be prepared by universities and other institutions, the conference attendees evidenced considerable agreement about the need to prepare technology teachers who can integrate technology with science, economics and other general education subjects. Vohra's call to develop "know-how" and "do-how" received considerable support. The ability to integrate theory with practice was clearly deemed an important outcome for technology teacher education programs.

Other discussion about the outcomes of technology teacher education included Türker, Dyrenfurth and other's pointing out the need for the preparation of technology teachers who could effectively provide for the unique needs of adults and out-of-school youth. Similarly, Blondel highlighted the relationships between the nature of needed teacher qualifications and the pedagogical and content (technology as subject) components of technology teacher education programs.

Types of Technology Teacher Education Programs

Both inservice and preservice (initial) teacher education programs were extensively discussed during the PATT-III Conference. Neither was deemed to be sufficient by itself and Claeys' call for an emphasis on both approaches was representatively of most participants' opinions.

Particularly effective examples of inservice technology teacher education were presented by speakers from England (Devon), Scotland and the Netherlands. Their consensus was that this type of technology teacher education was of paramount importance because that is where the teachers are presently. If we want to effect change, then we will have to go to the teachers. To facilitate this, the Devonshire participants highlighted key principles which, according to their extensive experience, increased the effectiveness of inservice technology teacher education. Contrary to the Devonshire experience, Moore opined that voluntary inservice participation was ineffective. It was also noted that inservice education was typically
considered sufficient for technology teachers operating at the elementary grade/age levels but specialized preservice preparation was deemed important for secondary teachers. It should also be noted that several participants called for the infusion of technology into the preparatory programs of other (non-technological) teachers.

Preservice technology teacher education seemed to receive little attention at this conference. Certainly the German (Blonde) and American (Dugger) participants highlighted some programs in their countries, but these appeared to be variations of existing programs rather than newly emerging models, specifically addressing the imperatives of technology teacher education.

The introduction of this analysis pointed out that one of the major issues that needs to be resolved is the definition of technology. This surfaces the issue of what type of technology teacher education program to develop. Should the technology teacher education program be for specific technology or should it produce a "generalist"?

Harrison believes that there should be two types of technology teachers. One type is the teacher responsible for the central or core discipline of technology and the second type consists of those teachers prepared as technology teachers, infuse technology and technological activity into their subjects. His proposal generated considerable discussion since not all participants agreed that it was either desirable or possible to prepare either type of teacher.

One of the questions that Harrison's typology raises is whether a central core of technological understandings exists that is common to both types of teachers. Furthermore, if so, how is it to be transmitted?

Regardless of their position on the need for either type of technology teacher or teacher education program, all participants seemed to be in agreement about the need for many working examples of effective technology teacher education programs. Similarly there was considerable agreement on the need to bring practicing teachers together to identify problems and share solutions as indicated in Morisson's paper.

Elementary and Secondary Education

Characteristics Affect Technology Teacher Education

Not unexpectedly, given the positions of the conference's participants, a large amount of time was spent sharing perspectives about what was and was not happening in the elementary and secondary schools of the
participants' countries. Most of this discussion was apparently based on individual and rather non-systematic observations. Other than Dudziak's interviews, there was little evidence of systematic observations of what was happening in the schools. The consequence is that reviewers with an empirical bent are left with an uncomfortable feeling about the generalizability of the observations that were shared. Despite this apparent limitation, which in itself is perhaps an indicator of the evolutionary stage we find ourselves in, mention must be made of the observations made by several participants. First and foremost was the general lack of technology teachers as highlighted by Dugger, Kapiyo, Depajlier, Türker and Claeys among others. Serious questioning of the competence, i.e., the knowledge of technology, was also prevalent (Siegers, Kapiyo, Claeys). Similarly Depajlier raised a question about the teachers' ability to teach i.e., their command of appropriate methodology, about technology. Also highlighted by participants, was the absence of a great supply of instructional materials appropriate to the teacher of technology. Perhaps this is why there were few mentions of schoolbusiness partnerships. Clearly the dialog at the conference suggested that the aforementioned problems of the elementary and secondary schools carry direct implications for the practice of technology teacher education. For example the frequently cited shortage of teachers suggests that stopgap measures are needed while the teacher education profession "gears-up" for "regular" programs that will provide technology teachers in the long run. Inservice education and the retraining of existing teachers; including general education, science, industrial arts/arbeitselehre and vocational teachers; where the primary vehicles deemed feasible by the attendees.

It was most disturbing to the authors however, to note the many mentions of a shortage of qualified technology teacher candidates for the various ongoing technology teacher education programs. Where will such teachers come from in the future? How many women and minorities will be among them? How long will inservice education suffice?

Small group discussions on the topic of technology teacher education pointedly reinforced the reality that the problems of the school have direct bearing on the nature of teacher education and vice-versa. Nowhere was this more evident than in Claeys poignant portrayal of the difficulties faced by Belgium's implementation of technology education. Her testimony forcefully pointed out the need for consistency of approach and content, not
only among the schools of a nation but also between the schools and the
teacher preparatory programs serving them.
Consistency with respect to course content from teacher to teacher and
school to school was called for i.e., What and how to teach pupils as was
What and how to upgrade existing teachers.

Duration and Structure of Technology Education
Overall, little mention was made about the most appropriate duration for
preservice technology teacher education programs. In the authors' work
country however, this is currently a major issue. The prevailing thought is
that if teacher education is to be perceived as true professional
preparation, then it must follow the example of other professions and
essentially require five years of preparation for initial entry. In addition to
this question of preservice program length is the entire issue of what kind
of program is it to be. Do technology teachers need to be degree and
certified as in the USA or just certified as in Germany? Where will the
technology teacher educators come from? What will be their background?
Who should control the examinations certifying teacher competency? Are
state or federal teacher credentialing agencies capable of establishing
effective examinations for technology teachers? Will these examinations
include the hands-on component that differentiates between actual
 technological capability and merely the study of technology? These and
other related questions were not widely addressed during PATT-III but they
are crucial to our profession's future.
Similarly the issue of standardization of technology education and technology
teacher education was not discussed extensively in either the papers or
study groups. However, there was recognition of the need for an
international study of technology teacher education in participating countries.
Dialog about structure generally raises questions about which institutions are
involved in technology teacher education. Given the nature of technology,
frequently the advocates of technology education call for business/industry
-- school partnerships to help deliver technology education. However, a few
participants pointed out that some nations are experiencing inadequate
industrial capacity which in turn mitigates against their private sector's
participation in the training of technology teachers. Also since these same
countries often experience a scarcity of inservice industrial training
programs at skill levels they have difficulty is securing technological
expertise to consult.

**The Setting for Technology Teacher Education**

But what should be the setting of technology teacher education? It is particularly difficult to establish the desirable characteristics of teacher education facilities/laboratories and equipment when there is a high degree of uncertainty about what is needed (Claeys). One also has to question whether the prevalence of physics and science personnel at PATT is an artifact of the conference organizer's perspective or whether it reflects a representative sampling of those who actually are interested in the subject of technology? This is not meant as criticism but rather as speculation triggered by several participant's ongoing reference to vocational and technical education and others to physics.

An extension of the preceding question would ask whether physics and/or science teacher education setting as in the Netherlands and Poland are the most conductive to achievement of technology education's goals? Are perhaps the arbeitslehre of industrial arts departments of Germany and the United States of America preferred? Or are vocation/technical teacher education departments more suited to the task? Alternatively, it may even be that a larger question is whether technology teacher education should occur in a pedagogical department as contrasted to a subject-oriented one. These questions remain largely unaddressed and not coincidentally unresolved. But questions of setting involve more than just the type of department. For example in what kind of laboratories and with what kind of equipment should future teachers of technology be prepared? Given that technology teacher education is a movement that is considerably ahead of widespread public and professional recognition of its importance, it is no wonder that teacher education setting have been judged to be faced with challenges of outdated equipment and materials (Depajlier).

Perhaps more insidious than the question of the technological currency of teacher training equipment is the tendency of the profession to fall prey to what Dyrenfurth has termed the "identical element fallacy". Simply put, this refers to the tendency for technology teacher educators to desire industrial level equipment and the closer to that type of equipment, the better a program is perceived. The authors' suggest that it would be much more appropriate to select equipment on the basis of what and how effectively it teaches.
The nature of technology teacher education equipment also raised the question of similarity between the teacher education institution's equipment and that of the schools'. To what extent should the former provide equipment that is representative of what which is found in the schools? Do technology teachers-in-training require such equipment in order to acquire and practice the skills needed to teach at the elementary and secondary school level? Is it not disheartening for the new teacher, after graduation, to arrive at a school and find there is no equipment or at least none of the kind he or she trained on? To what extent do our teacher education programs develop an ability to improvise, to make-do (effectively)? Similarly, how should the laboratories be arranged? Is the technological cluster facility the optimum? Do we need specialized facilities or is one general laboratory adequate to the task?

Analysis of the presented papers revealed minimal treatment of these topics and as such they have potential for directing future conference sessions.

Curriculum and Method
(of technology teacher education programs)

Secondary School Practice Affects Technology Teacher Education

Much of the conference's interaction focussed on questions about the most appropriate curriculum and method to employ in teaching about technology. Although the bulk of this discussion dealt with the secondary example, it stands to reason that if teachers are expected to employ the problem-solving process that they should be schooled in its use. Given that there was much agreement with observations commenting about the outdated techniques and methods of teaching technology such as raised by Petrov in his paper, it would seem important for teacher education institutions to employ deliberate action to remedying this situation in both their pre and inservice programs. Clearly this calls for their setting an example through the methods they use in preparing technology in their own classrooms.

Instructional Materials Needed

Türker and others, after recognizing the absence of adequate instructional materials for teaching about technology, at all levels, called for a strong materials development thrust. Similarly, there was widespread agreement
that teacher education institutions need to engage in an intensive hunt for powerful new examples of key technological processes and principles. Obviously these examples then need to be documented in a form that facilitates their dissemination.

Characteristics of Technology Teacher Education

A. Content
Teacher education programs expose their clients to a curriculum. The word "curriculum" is a concept that means different things to different people. Generally however, curriculum is assumed to be the sum of all the materials, content, processes and learning experiences that are at the students' disposal for learning.

In addressing issues of content, the participants' generalizations from their primarily secondary-school focus included a caveat to carefully address the relationship between technology and technique in the teacher education curriculum. Similarly, Claeys, drawing from Belgium's experiences pointed out that it will be important for the curriculum to address the cultural diversity found in each nation.

Dyrenfurth's paper stressed the importance of strategic vision in developing instructors capable of providing an overview of technology, its emerging concepts and its evolution. Certainly the content also needs to include adequate treatment of the key elements of technology: materials & processes, energy & power and communications. Dugger and our English colleagues emphasized the need for inclusion of the systems view of technology throughout the curriculum. Participants also expressed a caution that is equally applicable to all levels of technology education, including teacher education. This involved a warning to be extremely careful to avoid the teaching of limited concepts and/or excessively narrow portions of technology.

The curriculum used to prepare individuals for teaching about technology needs to involve them in active consideration of questions such as "What is the appropriate curriculum for technology education?", "What should the purpose/s of such a curriculum be?", "What is the most effective sequence and the organization of such a curriculum?", "What philosophical base should the curriculum reflect?".

The preparation of technology teachers invariably included a program
component that develops a basic mastery of technology as well as a
crponent to develop pedagogical skills. Harrison warned about the need to
guard against the compartmentalization of technology teacher education
curricula — a caution which seems equally important in both components.

B. Method
The instructional methodology experiences by teachers-in-training engenders a
significant portion of the effect of any teacher education program. Note
the widely used phrase that "teachers teach as they were taught" as
evidence of the validity of this claim. Since technology is dynamic and
contemporary should not the methodology employed to teach about it be
equally dynamic? can it not in fact need to be dynamic? Indeed it does
and it also need to address educational technology and professionalism as
well as the other key aspects of pedagogy. In this quest, and transposing an
idea from McCuhan, technology teacher educators should carefully consider
the notion that the object technology itself is an instructional method.
With respect to methodology, clearly the largest amount of consensus was
the importance of incorporating problem-solving experiences, as detailed by
Barnes, in the preparation of technology teachers. Similarly, the American
experience has shown that it is beneficial to include methodologies that
deal with didactics found to be particularly effective for targeted
populations, e.g., (youth, adults and special groups such as females and
minorities).

Issues & Problems with respect to Curriculum
Review of both the conference papers and discussions revealed that many
issues and problems related to technology teacher education remain to be
addressed at future venues. In the authors' opinion, the most important of
these is the detailed specification of the slate of competencies necessary to
successfully teach technology education at each desired level. Arp, for
example, also pointed to the confusion about necessary competencies for
technology education (and technology teacher education).
The problem of content specification for technology teacher education is
made significantly more difficult by questions about the constancy/
permanency of technology versus its fluidity/flux. Should for example,
teacher educators teach the constant/permanent aspects of technology in
line with the perennialist notions of education (Deri) or should they teach
about emerging fronts of technology? Not that the former contrasts to the American focus on technology's changing aspects.

The predominant perception about technology accentuates its fluidity and contemporary nature. Mostly people believe that skills and inventions rapidly become obsolete due to rampant change. Often this perceptions leads its holder to assume that the only technological constant is change. Therefore, they claim technology education and technology teacher education should reflect this phenomenon.

It is, however, refreshing to learn that in Hungary the constant and permanent elements of technology are identified and taught both in the secondary school and in teacher education programs. But, their concern is that the latest elements of technology are not taught and introduced into the general education program.

The constant elements according to Deri are the man-made environment, technical systems and technics. Consequently, technology teacher education program content should be based on these elements. The advantage of the constant and permanent elements argument is the confidence it generates in the teacher's ability to master what otherwise is perceived as something far too complex for mastery.

By way of contrast, a significant problem surfaces when too much emphasis is placed on the tremendous amount of change that is so easy to document when describing technology. Given this rate of change and the essentially foreign nature of technology to the uninitiated, it is easy for the latter to revert to "general education". In essence, because they do not understand technology, they cannot identify the constant core in technology. Then because they are overwhelmed with the myriad of changes they call for a retreat to liberal arts education as the only manageable way by which to develop the generalizations necessary to understand an uncertain future. They retreat to "liberal arts", not to Deri's core. The implications of this phenomenon for technology teacher education, is that we need to develop technology teachers with a mastery of both the technological base/core and the changing aspects of technology in order to be able to tie in new developments.

It seems the constancy-permanency tension is more related to technology than to science, because professionals understand that science involves a number of important "constants". In technology education, the lack of understanding of the nature of technology yields the tension between the
argument for generalizable and adaptive skills and the multitude of specifics that seem to be so necessary for survival in today's world.

An entirely separate set of issues surfaces when the PATT proceedings are viewed in the context of gender- and/or ethnic-specific considerations. Many papers and much discussions are focussed on these aspects of technology education. Their implications for technology teacher education include documentation of the need to address the existing teachers' lack of concern regarding interest of girls and their corresponding lack of knowledge about how to teach specifically targeted populations, such as girls, about technology [Motier]. In fact the latter's observations revealed a serious absence of learning activities specifically appealing to girls.

Speculations

The PATT conference organizers were so successful in creating a comfortable environment that in short order, most participants indulged in some speculation about what has happened to date, why, and what the future might bring for technology education. Such discussion often surfaced the desirability of evolving partnerships between industry and the school -- particularly in the attempt to expose students to technology that they would not otherwise experience.

Because of education's limited resources, implementations of technological education invariably lag behind industry, both in terms of equipment and practice. But since the products of the schools ultimately work in industry there is a mutuality of benefit that would reinforce the importance of partnerships.

Another speculative comment was that perhaps we should not just focus on teacher education's form and content, but also on teaching our teachers their role in shaping their profession. Similarly the Chinese presentation raised the possibility of teaching about technology using after-school activity. What other methods of capitalizing on community resources exist and how do we help teacher candidates learn to use them? In fact, who will be the technology teacher when such delivery mechanisms are used?

Professionalism

Observations

Perhaps arguably the most commonly raised question dealing with the issue
of professionalism was the widespread problem in securing qualified technology teachers. Certainly this problem extends to technology teacher education. Where do professors of technology teacher education come from? What is their career ladder? How does their background relate to the recruiting of women and minorities and non-traditional teachers? Another problem identified by those visiting technology education implementations is that not infrequently, these teachers tend to provide students with a narrow view of subject [Petrov]. Such teaching of limited concepts is not conducive to the goals of technology education. PATT participants repeatedly identified the vehicle of inservice training as the primary way to address the problem. However, it is important to remember that inservice education is probably equally applicable to teacher education faculty and hence provision must also be made for their professional development. Although not overtly stated by the participants, one of the implications of their deliberations is that significant attention needs to be paid to the retraining of technology teacher educators.

Yet another provocative implication contained within the conference's discussion was the concept of technology as a leisure activity. This was particularly interesting because the concept of technology education as extra-curricula activity came from China and it mirrored the primary author's experience in the U.S.S.R. There, students who are interested in technology, are provided an after-school program that is lead by interested science teachers and members of the community with sufficient expertise and interest to help the students. Should technology education be considered as a leisure activity in western culture? With respect to the way teachers are prepared, if technology education is viewed as leisure, then teachers prepared for such a program should be more flexible while working with the students. This suggests that the traditional western system of a prescribed curriculum might not be in consonance with at least this purpose for technology education.

Today's technological environment is properly characterized by rapidly advancing technology and accompanying economic and social change. Teachers who attempt to deliver technology education require constant adaptation to new methods of work and to new content. In order to adapt, technology teachers have to learn new values and skills and new attitudes and patterns of coping. PATT attendees raised the question of how teacher education institutions could instill an ongoing drive for the continuous
professional development that seems to be imperative for success in
technology education. Similarly, how can teacher education programs make
non-traditional enrollees feel comfortable in their career choice?

Issues & Problems
The danger of some of the proposed models of technology education needs
to be noted, particularly if our profession allows ongoing use of a very
"loose" definition of technology. For example, if technology is to be infused
into the total curriculum, i.e., into the teaching of each subject, then
would it not also follow that any teacher could be expected to teach
technology education. If this were to occur, would not our profession lose
quality control over their discipline?
Teacher, teacher-educator and teacher-candidate out-migration (to the
private sector) was reported to be jeopardizing the technology education
profession's chances for success. This situation transforms itself into a
professional issue because it leads to the presence of a number of
unsuitable teachers in the classroom -- and this with one of the most
challenging subjects! Examples cited included biology and history teachers
assigned to technology as their primary subject. Also cited were mismatches
of teaching level and strategies.
If nations continue to allow teachers from other disciplines, particularly
those not specifically technological in nature, to teach technology classes
the quality of our profession's reputation will surely suffer. In addition,
because technology education necessarily involves hands-on activity with
equipment and materials, there is a danger to students when unprepared
instructors are guiding them.
Some of the preceding is due to a lack of recognition for technology
education as a subject requiring special certification as to others such as
music and physical education. The need to develop technology teachers who
can integrate technology with science, economics and other general
education subjects as well as master the essential elements of technology
must be forcefully communicated if technology teachers are to be
recognized as professionals.

Speculations
Meta-discipline represents the overall most important single implication for
technology education. We use this term to denote the need for our
profession to agree to march to the beat of a single drummer.
Intra-education sector, in fact intra-technology education, disputes are jeopardizing our chances for success. Achievement of such discipline will demand the formulation of a set of concepts and definitions central to our profession, and then, above all, the consistent use of these terms.

In many ways this meta-discipline can be viewed as a facet of professionalism -- properly developed and matured. If technology education is to survive, we must build, on a central core of beliefs and documented facts, towards skills of investigation, problem-solving, invention, implementation, validation and an ability to manipulate a knowledge base of understanding about equipment, materials, energy, control and communication. We must act to enhance the value dimension including its application to economic, technical and social decision-making as well as to creative activity. Technology teachers must be proud of the work that the profession has done to advance the technological literacy of our charges. We must stand for quality programs that prepare students for the future.

**Enhancement**

**Observations**

Whenever a group of dedicated professionals assembles it is not long before the discussion turns to improvement of the profession. The technology educators attending PATT-III were no exception. However, their comments suggested that technology teaching has not yet matured to the point where we can command the attention of those who "guard the gate" in teacher education. Perhaps this is a function of the early evolutionary stage that technology education is in. In essence the advocates gathered at PATT represented the vanguard and many of their attempting things in advance of widespread recognition and institutionalization of their program. A related observation was that despite misgivings about the effectiveness of current practice in technology education, a lack or research evidence hampers systematic improvement [Petrov].

Additionally it is always important to conduct follow-up studies that chronicle the effects of decisions and policies. It is through such follow-up that we will understand what transpired. It is through follow-up that we come to know our weaknesses and strengths and how they occur. Follow-up tends to open ways for future planning and development. Without follow-up it will be difficult for positive growth to take place. For example, would
not a follow-up study of newly placed technology teachers seem to hold much potential for valuable teacher education program improvement? Unfortunately, in the authors' opinion, PATT-III presenters did not document the existence of much follow-up.

Another barrier to enhancement of the profession's practice is the existence of confusion about desirable directions to pursue. Although some of this confusion may be attributed to our profession's evolutionary stage, another cause is the miscommunication of national directions to the teachers [Claeys].

Finally, funding, or more specifically the lack of it, was also advanced as a problem in the quest for enhancement -- largely because it hinders systematic research and development.

**Issues & Problems**

Linked to the absence of research and development is the problem of the evaluation of progress in technology education. Our profession needs to assemble mechanisms to link information derived from such assessments to the practice of technology teacher education [Claeys]. We need to evaluate the content and method decisions made today with longitudinal studies that extend well into the future.

The absence of PATT participant treatment of teacher testing suggests that apparently our profession is not yet at an evolutionary stage where we are comfortable in testing teacher competencies in the area of technology.

**Conclusions**

The preceding analysis provide quite a challenge for our profession -- particularly the teacher educators concerned with technology. Aside from the problem of survival -- accentuated in this case by the early evolutionary stage of technology teacher education -- there remains a serious issue of form. Clearly the design of technology teacher education programs has not yet coalesced into a form recognizable across national boundaries. Nor have the methodology and content of such programs stabilized.

However, some progress has certainly been accomplished. Technology teacher educators are talking among themselves, and even more importantly, with elementary and secondary practitioners. Additionally, through the exemplary efforts of Dr. Raat and his colleagues, international communication has been
established. But there is so much more to be accomplished and the challenges seem to press so hard. The future will demand the utmost from our little band of technology teacher educators. Our optimism will invariably be taxed severely. But, our efforts will make a panorama of technological vistas made accessible (and safe) to countless younger generations. That will be our legacy -- the increased technological literacy of tomorrow's society!
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## REGISTER OF AUTHORS

<table>
<thead>
<tr>
<th>Author</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alting, Annita</td>
<td>415</td>
</tr>
<tr>
<td>Arp, Horst</td>
<td>536</td>
</tr>
<tr>
<td>Balogun, Taju</td>
<td>294</td>
</tr>
<tr>
<td>Barbafiera Bardini, Lola</td>
<td>364</td>
</tr>
<tr>
<td>Barnes, James L.</td>
<td>209</td>
</tr>
<tr>
<td>Blandow, Dietrich</td>
<td>116,545</td>
</tr>
<tr>
<td>Brand, Marja</td>
<td>428</td>
</tr>
<tr>
<td>Cheng Donghong</td>
<td>49</td>
</tr>
<tr>
<td>Claeys, Chris</td>
<td>57</td>
</tr>
<tr>
<td>Deijsselberg, Willem</td>
<td>498</td>
</tr>
<tr>
<td>Déri, József</td>
<td>564</td>
</tr>
<tr>
<td>Dugger, William E., Jr.</td>
<td>55</td>
</tr>
<tr>
<td>Dudziak, Grazyna</td>
<td>303</td>
</tr>
<tr>
<td>Dyrenfurth, Michael</td>
<td>202,619</td>
</tr>
<tr>
<td>Edwards, Peter</td>
<td>147</td>
</tr>
<tr>
<td>Engelen, J. van</td>
<td>225</td>
</tr>
<tr>
<td>Fekete, Janos</td>
<td>98</td>
</tr>
<tr>
<td>Groenendaal, Wilma</td>
<td>448</td>
</tr>
<tr>
<td>Grodzka-Borowska, Alexandra</td>
<td>309</td>
</tr>
<tr>
<td>Harrison, Geoffrey B.</td>
<td>485</td>
</tr>
<tr>
<td>Harvey, Robert</td>
<td>606</td>
</tr>
<tr>
<td>Hendre, J.</td>
<td>379</td>
</tr>
<tr>
<td>Hylkema-Knottenbelt, Mieneke</td>
<td>456</td>
</tr>
<tr>
<td>Kananoja, Tapani</td>
<td>76</td>
</tr>
<tr>
<td>Kapiyo, Raphael</td>
<td>272,357</td>
</tr>
<tr>
<td>Klerk Wolters, Falco de</td>
<td>39,323,509,598</td>
</tr>
<tr>
<td>Meijer, Tineke</td>
<td>243</td>
</tr>
<tr>
<td>Moore, Jeff L.</td>
<td>370,389</td>
</tr>
<tr>
<td>Morrison, R.T.</td>
<td>580</td>
</tr>
<tr>
<td>Mottier, Ilja</td>
<td>437,473</td>
</tr>
<tr>
<td>Natali, Ilia</td>
<td>89</td>
</tr>
<tr>
<td>Nauta, Margreet</td>
<td>456</td>
</tr>
<tr>
<td>Novakova, Hana</td>
<td>108</td>
</tr>
</tbody>
</table>
Ogar, Jerzy 197
Oleniacz, Danuta 314
Otieno, Frederic 189
Page, Ray 163,246
Petrov, Peter 610
Raat, Jan H. 30,598
Rajput, Jagmohan 337
Rennie, Leonie 397
Saar, Aivo 379
Siegers, Henk 598
Singh, Chhotan 384
Szucks, Ervin 575
Szydlowski, Henryk 285
Tremblay, Diane 464
Traebert, Wolfgang E 136
Türker, A. Vural 587
Velde, Jenne van der 230
Vohra, Faqir C. 11
Vries, Marc J. de 182,448
Technology has a very large impact on our cultural, social, economic and political life, so in fact on our whole life.
Yet in most countries, little or no explicit attention is given to technology in general education. This is understandable, but it is a pity and not correct.
We consider it important that both at primary and at secondary schools more attention is given to technology. At secondary school level (lower level, ages 12-15) we think of a separate subject technology, whereas at primary school level (ages 6-12) we think it is important to give some technological background at least to the teachers.
In many cases the subject technology starts from the zero level. One of the things we need to know is the pupils’ ideas about technology: what is their concept of and their attitude towards technology? This is investigated in the international PATT (Pupils’ Attitude Towards Technology) project.
At the previous two PATT-Conferences in 1986 and 1987 results have been discussed together with the attention for technology curricula.
The main theme of PATT-3 (April 21-26, 1988) was: ‘Basic Principles of School Technology’. In two volumes a mixture of research and curricula-examples is given from 23 countries.
Volume I contains papers with reference to Frameworks for technology education. Volume II contains papers with reference to PATT-research, related research, and its relevance; How to make technology education attractive for girls; The education of teachers for technology education.
Information on the PATT-project is published in TECH-ED-News.
There will be a fourth PATT-Conference from April 13-18, 1989, with the theme ‘Teacher education for technology teachers’.