Logistics today or an integrated life-cycle approach to logistics

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LOGISTICS TODAY
OR
AN INTEGRATED LIFE-CYCLE APPROACH
TO LOGISTICS

LOGISTICS EDUCATION
IN THE UNITED STATES

colloquium by prof. Benjamin Blanchard

Verkorte weergave van de gesproken tekst
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Prof. Blanchard is sinds 1970 Director of Engineering Extension, College of Engineering, Virginia Polytechnic Institute and State University. Daarvoor was hij Manager van het Design Assurance Department bij General Dynamics Electronics Division en daarvoor Supervisor van de Maintenance Engineering Group bij Bendix Systems Division. Prof. Blanchard heeft meer dan twintig jaar industriële ervaring in systems design, testing en logistics support. Daarnaast heeft hij een grote ervaring in het leiden van seminars op gebieden zoals systems engineering, reliability and maintainability, logistics, cost effectiveness en life-cycle costing. Hij is co-auteur van "Maintainability Principles and Practices" (McGraw-Hill) en auteur van "Logistics Engineering and Management" (Prentice-Hall) en van "Engineering Organization and Management" (Prentice-Hall). Hij is bestuurslid van SOLE (Society of Logistics Engineers) en is voorzitter van het SOLE - National Education Committee dat onlangs een inventarisatie maakte van logistics opleidingen in de V.S. De door hem gehanteerde SOLE definitie van logistics luidt:
"the art and science of management, engineering and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans and operations".
LOGISTICS TODAY OR AN INTEGRATED LIFE-CYCLE APPROACH TO LOGISTICS

It is a pleasure to be here, this is my first coming to the Netherlands and it is quite a challenge to discuss logistics with you. I am not sure that we in the US are really clear on the term logistics. A lot of things are happening, and I thought that I would discuss logistics, its growth, a little bit of background and history. A little of what I see is going on from the standpoint of industry, the educational community and some of the professional organisations.

The concept of total integrated logistics support

Definition of logistics:

"The art and science of management, engineering, and technical activities concerned with requirements, design and supplying and maintaining resources to support objectives, plans and operations".

Society of Logistics Engineers (SOLE), August 1974.

When we talk logistics let me start off and refer it to our concept of integrated logistics support. Certainly logistics has been, how well we may define it, growing at a rapid pace because of the technological, sociological and particularly economic conditions. And there has been a considerable increase in logistics on a broad scale. Now, in terms of background and experience, what we now call logistics from a standpoint of a life-cycle approach, evolves from several sources. One is the military area; years ago the defense organisation started paying attention to supporting systems. We were looking at things like supply, support, maintenance, data, tests-equipment, support-equipment, personnel, training, handling and transportation. We were looking at these things from a downstream, "after the fact"
basis. And of course logistics in the States in this context evolves from the old military term of movement of man and materials to an area, which includes maintenance, support equipment, supply, support and all those elements under what we call integrated logistics support. Because in the past we have not integrated these things very well, we have treated the elements of support as individual entities. We have produced systems and equipment which have not been very well supported from the integrated standpoint, and the costs of support have been extensive. So we can look at logistics as evolving from the military or defense aspects of moving man and material, to a concept of integrated logistics support.

Historical view of logistics.

Military Logistics. - The "movement of men and materials": - a composite of items to include:
A. Personnel and training
B. Supply support - spare parts and inventory requirements
C. Test and support equipment
D. Transportation and handling functions
E. Facilities
F. Maintenance planning
G. Logistics Management.

Primary emphasis. - System/product use and sustaining support phase.

In the commercial sector, the non-military context, we have another emphasis in logistics, the business- or industrial logistics approach, involving the flow of material from source of supply to the production-line, and from the production-line to the warehouse and to the consumer, considering such things as material procurement, material flow, physical distribution, transportation, traffic management and generally the business aspects of system/product distribution, primary emphasis being in production operations and product distribution.
Industrial logistics. The movement of flow of materials from: source of supply to beginning of the production line; and from the end of the production line to the consumer. It includes:

A. Materials procurement and acquisition
B. Inventory requirements and control
C. Warehousing, packaging and containerization
D. Physical distribution
E. Transportation and traffic management
F. Customer service.

Primary emphasis. Production or manufacturing operations phase.

So we really have two areas that have been classified under the term logistics in the past: the military, defense approach and the business approach more oriented towards the management of the material flow. In the universities, colleges we look at the first element, the integrated logistics approach, more from an engineering standpoint, and we look at the second element, the industrial or business logistics approach more from a business standpoint. So we have quite a wide dichotomy of interests within the broad spectrum of logistics. Now we have again found that in the military approach the emphasis of logistics has been primary down in the area of system product use and life-cycle support of products in the field being used by the consumer. In the business approach the emphasis has been pretty much in the production area, where we had again material flow through the production operations and then distribution, transportation, traffic management, what not, to the consumer. So the area of logistics has been under these two broad definitions or areas, has been primarily concentrated down to this part of the life-cycle.

System/product life-cycle

System/product planning and conceptual design  System/product research, design and development  Production, distribution and/or construction  System/product use and sustaining support  System/product phaseout and material disposal  

primary logistics emphasis
From the standpoint of looking at the economics of the things, we have been more and more pressed by economic situations, cost of products and systems have increased tremendously. Above and beyond the rates of inflation we have found that in many cases looking at total costs, many of the costs are hidden and you can look at the iceberg-effect as being fairly representative of what is going on. We have acquisition costs, to include research and development, designing and we have production and constructions costs (in other words producer costs of a product) (see fig. 1).

Economic posture is further complicated by lack of total cost visibility (particularly in the logistics support area).

We now have to look at the distribution costs, the maintenance costs, the support equipment costs, the inventory costs, the training costs and data costs and certainly now the retirement and disposal costs. We can no longer produce products, use products and then let them rot away in some field. We have to do something with them, we have to recycle them. Our environmental requirements are such that we have to design now and plan for retirement and disposal. But in essence, the total cost has be-
come a major factor life-cycle cost to include all the aspects of a product, not only the acquisition but the utilisation or the operation and support cost. In many cases the costs in this area are somewhat missing, not visible. We cannot adequately determine these costs, we know that these costs contribute to a significant aspect of the total cost. Experience has indicated that you have to look at the life-cycle from planning conceptual design, preliminary design, detailed design and development, production, construction and the ongoing product support aspect, system use and life-cycle support. These are the areas we discussed from a logistics point of view in the past. If we look at that, and we look at life-cycle costs and we look at actions or decisions that may affect life-cycle cost, we find that a good part of the total life-cycle cost is affected by decisions made during the product-planning, conceptual design, preliminary system design area (see fig. 2).
In other words - if you look at fig. 2 and the numbers of course vary with each individual system - what we are saying is that of the total projected life-cycle cost, 66% is in essence committed by decisions made during product planning and conceptual design. Now looking at life-cycle cost shows that the bulk of the costs is in the support area, which means that we have to consider major support-type decisions.

We have to look at the total support area in the product planning, in the conceptual design, in the preliminary system design. We are saying that by the time we come out of what we call preliminary system design (before going into detail design, where we have a system specification), that about 85% or certainly a large proportion of the life-cycle cost is affected by decisions that are made here.

Current dilemma

- Systems/products have become more sophisticated and complex.
- Logistics requirements have increased.
- The total cost of systems/products has been increasing at an alarming rate.
- Cost growth (due to inflation and other causes) combined with decreasing budget allocations results in less funds available for:
  A. Acquiring and operating new systems or products
  B. Maintaining and supporting existing items.

Where in the past we have considered logistics primarily down in this phase of the life-cycle, we are now looking at costs and affected relationships and we are finding that we have to include considerations for logistics in the planning and we have to include areas like definition of the maintenance concept in the conceptual design. In respect of the maintenance concept I am talking about a before-the-fact series of illustrations, statements, figures that indicate how this system is to be supported in terms of numbers of levels of maintenance, in terms of type of support equipment, in terms of plain basic concepts of supply, in terms of personnel skill levels required to support the system, data requirements. We are looking at a main-
tenance concept here that in essence establishes criteria for design. We are including such factors as reliability, meantime between failure or meantime between maintenance, or design to unit life-cycle cost, looking at the total cost, or maintenance manhour per operating hour, in addition to the performance characteristics of a system such as size, weight, accuracy, capacity and so on. Further we are looking at different design alternatives now, in terms of not only the basic characteristics of design from a performance point of view, but also from a support point of view. Given two or more alternatives in design, which is preferred from a life-cycle cost point of view, life-cycle cost to include all of the support costs as well as the initial design cost. Which alternative is preferred from the standpoint of material resources in the area of support, which is preferred from a reliability point of view, or from a maintainability point of view, and so on. So again there is a very active effort, that we can include under the aspect of design for supportability (if you want to call it that) or reliability and maintainability, that these decisions significantly affect the follow-on support, both in the business aspects of material flow and distribution, and also in the sustaining consumer life-cycle support aspects. So, we really are looking at logistics to include planning, to include the analysis and design, to include of course the production and distribution as we have discussed and the sustaining life-cycle support. And the emphasis - because of the life-cycle cost aspect - really should be on analysis and design. Not that the other areas are not important, but if you look at the cost and effect relationships the total support aspect is heavily influenced by analysis and design. So we are doing more in this area, such as logistics modelling, such as life-cycle cost analysis, such as reliability and maintenance analysis, again trying to influence design such that we can support a product in an effective and efficient manner.
Analysis and design

- Design requirements (criteria).
- Design for logistics support to include reliability, maintainability, producibility and cost considerations.
- Logistics support analysis.
- Design review.
- Test and evaluation.

Through this evolution logistics has become somewhat of an integrated life-cycle concept, to include various facets of maintenance, and - at the word - we can introduce some confusion in trying to come up with a definition of logistics. I wanted to put it up to indicate that we are really talking about logistics in sort of a conceptual manner. We really consider it as both an art and a science, we are really looking at it from a management point of view, we are looking at it from an engineering point of view and of course the requirements self of design and supplying and maintaining resources to support objectives, plans and operations. We talk about resource management, life-cycle costing as a good tool to look at total life-cycle, the interactions that go on between the design and the support from the standpoint of resource management, large proportion of these resources being in the support area.

Now let us go a little bit further and have a look at where we find logistics and what are some of the trends that are occurring. If we look at the marketplace-academic institution-professional organisation interface (see fig. 3) we find that industries, business and government agencies are moving towards that total concept of logistics more and more. Different industries are assuming or using this type of terms and definitions to varying degrees depending on, of course, their particular organisation, their product-line, the competition, the economic pinch and so on. Certainly in the defense industries, for a number of years, we have been using this integrated logistics support concept. As a management tool in order to insure the integration of the various aspects of product support while the consumer is using the product. In the commercial area many companies
are assuming the defense-type approach to logistics to achieve an integrated support. Just about all companies look at logistics from the business standpoint of product distribution. Not all companies call it logistics, they call it e.g. physical distribution or they call it transportation and traffic. But even in that area we find that there is a need for integration of these elements into a total logistics approach. A lot is going on here, if you look at the adds in a city newspaper, if you look at the needs we see, more and more needs in the area of logistics and maintenance, logistics under that broad spectrum, the definition that we stated. In some cases, managers or engineers are specified in terms of a logistics manager or logistics engineer, but in many cases various jobs are classified or called differently, but yet are directed towards this total approach. If you look at the academic institutions, there has been some reaction to the needs in connection with the changing concepts of logistics. Academic institutions by nature move a little bit slower, at least
certainly in the States, than perhaps industries, but there has been
growth there - I will talk about this in a minute - certainly in
professional organisations, such as technical societies, there has
been quite a bit of growth. The society of logistics engineers is
one example which I will discuss a little bit later.

Now again - and to add to the confusion a little bit there is not a
clear cut - we see needs for expertise in logistics falling in the
various categories. We see jobs being advertised under the area of
business logistics, customer service, facilities design, integrated
logistics support manager, some under logistics engineering and ana­
lists to do a better job of analysing design alternatives from a total
support point of view; supply, production operations, nothing new,
but looking at production operations now from a business logistics
standpoint; material requirements is nothing new, but is looked at
from a total point of view. So again you say, "what is different",
well I think the difference from what is going on now to what has
been happening in the past is the introduction of the concept of lo­
gistics and particular the interrelationship of all these various
items under a total life-cycle broad spectrum approach. The market­
place shows a lot of different recalls when I am home, because I am
involved in the National Education Committee of the Society of Logis­
tics Engineers, and the calls are more and more towards a: "do you
have anyone" that will fit into one facet of logistics (as we have
mentioned it) but that can work under this total concept of inte­
grated logistics from a life-cycle point of view. In the academic
community, in the area of basic degree programs - what we would call
say our initial learning experiences leading to a bachelors degree
or a masters degree - there are a number of new programs, more par­
ticularly a number of new courses.that address various aspects of
logistics as we discussed it. They enable continuing education, in
the ongoing lifelong learning process, including going back to school
for advanced degrees.after having been in industry for a while, in­
cluding congresses, seminars, short courses, symposia, workshops and
of course correspondence courses and individualised self-instruction. There has been quite a bit of recent growth in this area, but more effort is required.

Looking at basic degree granting programs, in 1967 the Society of Logistics Engineers initiated a survey to various universities and colleges, inquiring as to whether they had logistics programs or whether they had logistics courses. And of course traditionally as you know — I guess you are pretty much alike — if once a course has started and appears successful then maybe two courses are added, and if that is successful, then it proceeds into an option, if you will under a degree program, and of course if there is enough growth then getting into a degree program. Out of about 300 questionnaires about 20 institutions responded and indicated that they had either programs or options in the area of logistics. Most of them in the business-logistics area were described.

There may be an option in logistics in the school with emphasis in transportation and traffic-management, or logistics with an emphasis on physical distribution, but yet the term logistics is pretty much used. In 1975 we repeated that type of survey, not necessarily covering the same schools, but taking about the same number of samples, and about 65 institutions responded that they had programs in this general area. In 1977, about 96 responded. Again there has been somewhat a slow but yet positive indication of a change in one way or another from the formal traditional type of programs. The major included as I mentioned the business logistics and the engineering aspect of logistics, which deals more with the analysis, the reliability, the maintainability, the design aspect, with courses in statistics and mathematics and computer science or data management, in engineering economics and that type of things. We had some that have been in the broad aspect of management, particularly at the graduate level after someone has the basic undergraduate engineering, then getting into industry for example, or perhaps going back to school and taking something in management. In the area of marketing
in the commercial sense, since many of the marketing decisions affect that life-cycle support, there were a number of schools of business that in their marketing department will have logistics options. And then of course we are getting into the transportation issues. Particularly when evolving more and more into an international type of activities, where transportation, traffic management and shipping of products all over the world becomes a major concern.

Continuing the education it is certainly evident that we want to go through for the technical school or college or institutional learning that you attained a certain level of knowledge, and of course it is certainly true that job experience brings you up to this knowledge base or whatever. This is illustrated in a kind of a subjective chart (see fig. 4), how we feel that for the growth, to respond to the

FIG. 4, CONTINUING EDUCATION REQUIREMENTS
increasing needs, we need to attain this level, and of course there is quite a bit going on in the area of what we call continuing education, for people, particularly out in business, who want to go back to school either for a degree graduate type program or for three-day course or a five-day course in this area or that.

Some of the continuing education programs in the last several years have been particularly popular, such as design and manage to life-cycle cost, because of the emphasis on the economic aspects and of looking at the life-cycle. From an engineering sense we have in the past of course done a lot in the distribution and warehousing, but because of the economics we were more concerned towards optimum ordering, packing, picking, storing, access to supply, to inventory and that type of thing. Integrated logistics support was treated in quite a few courses in that area. I mentioned the life-cycle costing, this, more from an analysis point of view.

We get into maintainability, a characteristic in design that leads to the ease economy, efficiency accomplishing maintenance. Maintenance planning programs, in many cases in the commercial area preventive maintenance programs, have been introduced and are becoming quite costly, so there is an interest in looking at preventive maintenance a little closer, and of course we get down in the other aspects that are primary in the business logistics area, materials requirements planning. Reliability-engineering is a very popular item looking at cost and relationship with the frequency of maintenance, the logistics resources required when maintenance actions occur. We get quite a hell into reliability and maintainability, and of course the transportation and traffic-management and other things.

If we look at what we have done by taking a survey of about 118 programs, all added under the broad spectrum of logistics as we described it since about '65, the growth-trend in continuing education has been kind of going along these lines, and certainly is continuing to increase.
In a professional organisation you find a lot of engineering type professional organisations, such as the American Institute of Astronautics and Aeronautics. They are involved in continuing education programs, as a matter of fact one them sponsors a life-cycle cost program in Amsterdam on the 19th of June. The American Institute of Industrial Engineers, is another sponsor for this life-cycle cost program and a sponsor for a number of logistics programs. The Society of Logistics Engineers which is a society of about 5500 members, some engineers and some not engineers; the name is a little bit misleading because there are many people in the society that fall under this broad spectrum of logistics, people that are interested in logistics as we described it, but that are not necessarily what we call graduate engineers. But never the less the society has been growing at a rate of about 20% per year over the last 3 years. And the society has been directly involved in about 84 continuing education programs since 1970. We need more clarifications, certainly from the industry point of view, as to what the logistics needs are. There has been a rapid growth in interest in logistics, but we have not arrived yet at any nice, little, neat definition. We have put the various facets of logistics under this broad concept (see fig. 5). This broad

**SOCIETY OF LOGISTICS ENGINEERS (SOLE)**

**OBJECTIVES**

- SUPPORT THE "INTEGRATED" LIFE-CYCLE APPROACH TO LOGISTICS.

- ESTABLISH AN EDUCATION PROGRAM TO SERVE CURRENT MEMBERSHIP NEEDS AND ATTRACT NEW MEMBERS.

- ESTABLISH RELATIONSHIPS AND WORK CLOSELY WITH OTHER ORGANIZATIONS TO FURTHER PROMOTE LOGISTICS AS A PROFESSION.

**FIGURE 5.**
concept really tries to promote the total management life-cycle approach of the various facets that we have called logistics. We certainly need recognition of logistics in the academic community. We do an awful lot of inplant, inhouse type training, within industries, business and government agencies to try to bring individuals up to speed with some of the changes that are going on, again logistics being somewhat of a fast growing area. In retraining people after they come out of school, we need to do more here. There is quite a bit going on, on a relative basis in terms of normal academic growth. You will find that the professional organisations are, in respond to the needs, really taking over a lot of what perhaps the schools should be doing in the United States in conducting and in sponsoring continuing education type programs. And this is more and more occurring, that professional organisations such as Societies are getting involved in the educational business. Of course there are mixed emotions in the US, just the way the professional societies should be actually involved in setting up education and training programs. Certainly, very definitely, they should be involved in professional growth, but hopefully the schools and universities will do more in terms of not only education, but in terms of training to respond to these needs in conjunction with professional organisations. And of course we need to continue to improve the interfaces between the user, the academic community and professional organisations. With that, let me stop if you agree and I shall be glad to get into any questions which one might have, and go from there.

What I tried to do is just to give you a very basic overview of some of the things, some of the terms.
Summary

- Logistics is rapidly growing in recognition - much broader spectrum than in the past.

- Logistics is an integral part of each phase of the system/product life cycle.

- Logistics must be planned in the initial phase of the system/product life cycle if we are to realize continued improvement in the utilization of our resources. Should not be a "downstream" effort.

- Logistics must be adequately addressed in system/product design and development.

- The various elements of logistics must be properly planned and integrated if we are to reduce overall system/product life cycle cost.
DISCUSSION

Prof. Geraerds: If we look at all the labels you mentioned, and try to fit that into the concept, I wonder if the concept is one concept indeed, or is it more or less a collection of a lot of concepts?

Prof. Blanchard: I think you are probably right one. The term is certainly growing, the definition is certainly growing. It is not a precise definition, and if you are looking for some precise definition, you might say "total life-cycle system product support." And that still includes a lot of different things. It might be a collection of concepts, and it probably really has grown as a result of nothing else being available in terms of a banner or spectrum under which these various things fit. And certainly the intend is to emphasize that total aspect of material flow and product support. And I guess in its growth there are a number of things that previously are covered elsewhere, that have been known as something else that has been kind of broad under this concept, with the emphasis maybe being somewhat different.

Prof. Geraerds: Do you have any experience with an industry which decided to take up logistics as an explicit element in its policy, and where something showed up in terms of before and after the treatment?

Prof. Blanchard: In the defense area very definitely. If we look back to the early 1960's, the various elements of support were looked at individually, because of each element going off in its own way, and products going out in the field that were not really supportable because the test equipment did not necessarily go along with design of the prime equipment, and the personnel skills did not really match the test equipment requirements and the supplies, spares were not adequate. And then along came the concept of integrated logistics support, and within companies, defense companies particularly, they may place the emphasis in management; in many companies right under the vice-president of a division or the president, on a level with the chief-engineer, with the production manager, you have an integrated logistics
support manager. Now realising that if that manager, support manager, is going to do all those things that he has been charged to do, not only to include the production of or the acquisition and production of elements of support, but influence the design then we know that although his title is integrated logistics support manager, and design may be a different function he has to work with that design chief engineer, and try to get support considerations in that design.

Logistics support analysis

An iterative analytical process by which the logistics support necessary for a new system/product is identified. It is a tool that aids in:

- the initial determination of logistics requirements for design
- the evaluation of design in terms of supportability
- the acquisition of logistics support elements
- total system evaluation in terms of overall effectiveness & efficiency.

In many cases you will find a reliability and maintainability organisation over a design or a systems engineering organisation, which is really looking out for the support aspects during the design process. So, I am saying logistics in this concept although broad in nature, covers a number of activities. I am not suggesting that logistics as we defined it here be set up as an organisation for say, but be looked at as various functions to be included within several organisations.

Now that is what happened in the military, and you can go to most defense contractors such as Westing House, such as General Electric, such as Boeing, General Dynamics and what not, and you can find a logistics support manager or a product support manager at a very high level. You can find requirements in different programs for support, you can find policies at corporate level for support, and committees at corporate level if there are several divisions involved for support.
Now in the commercial area, you see a number of things going on. Some companies have assumed, although they will not necessarily admit it, the concept of military integrated logistics support and have implemented this within their own company, particularly companies where maybe one division has been sort of military product oriented, while other divisions produce commercial type products; Controlled Air Corporation being one, IBM being another. Though other companies, that because of the fact of competition has become pretty strong, that have looked at the military defense type approaches, which have been sort of driven by very stringent requirements, and perhaps are moving or have moved faster than the commercial. You find other companies that are in a very competitive market, have adopted some of this type of concepts, and there may be a product support manager, or there may be a logistics manager, or there may be something along that line, I am thinking of e.g. Xerox, certainly not military, but IBM, 3M, and other companies have come along and have given Xerox quite a bit of competition. Xerox at one point in time was pretty much of a monopolistic type company, where they had pretty much most of the market in terms of copiers. Well they grew and had quote many products around the world, and in one year, this was about in 1967, they increased the number of products by about 1.25 times of what they had the previous year. The same year they increased the number of customers service field engineers from about 6000 to about 14,000.

Vraagsteller: Concerning integrated logistics support in my opinion there seems to be 2 different fields of application, but both are together in your society. Can you point out which are the common aspects between those fields?

Prof. Blanchard: First I put out that the business logistics I mentioned, the business-logistics definition if you will, and the integrated logistics approach not so much as definitions, but as activities in the past, in which they were kind of going independently. Now along comes a Society of Logistics Engineering and looks at these two areas. The society includes membership involved in the
two areas, the business and the integrated logistics approach, and has come up with a broad definition which is somewhat conceptual in nature. Now in addition to that - I am kind of leading up to your question - people that have been in the defense area, who have been involved with material flow and distribution of products and inventory from the customer, consumer-use face, have in some cases evolved into the manufacturing operations of commercial industry, and there are some commercial people on the other hand that have gotten into defense. Now the communality is, starting of with the raw material stage and going to the flow with material, to a flow which could be concluded under production operations, or if you look at the engineering aspects under industrial engineering, manufacturing engineering, and followed by what is required to support that flow throughout the factory on out in the warehouse and consumer distributions.

And then what recently has developed is the inclusion of the liability in the products support from the producer for that consumer product, like the automobile that has a warranty-period. So that is going further out into supporting consumer products, because the consumer is looking for support policies, repair policies, warranties, several types of policies, more and more. So there is the flow of material certainly from a manufacturing point of view on out and onwards.

The military approach on the other hand has been primarily aimed at the period after the product is delivered to the consumer and then the support. Some of that support type of activities are turning out to be the same type of activities in the commercial. Both these areas are beginning to turn more to the ILS-approach, are beginning to look at the design facts. So, although the product is different, although the emphasis of the life-cycle in business is more oriented to production, distribution of the product and forget the consumer, the consumer now has to be considered. The ILS-approach is support the consumer, not so much production. Both of them are expanding, and there are some communalities of test, although it is difficult I realise to relate one direct to the other. So because of that in looking at the total life-cycle aspect of material flow, transportation, distribution support include maintenance, because of that it was decided to try to integrate these
things. Not that you get the transportation-traffic manager to think ILS from a military point of view, or the ILS-guy from a military point of view to think of physical distribution. But in many cases the concepts are somewhat the same, the physical distribution of commercial products, the physical distribution associated with supply and inventory for customer support in the military context, the transportation and traffic management from a military point of view. So because of the interactions both of these things are kind of expanded over the lifecycle, and there is some talking going on between the elements and some attempts to learn. The Society of Logistics Engineers, I might go on on more things if I may, the Society has done one thing to try to promote this further by setting up a certification program under which, there is an exam which contains four parts. This exam covers both of these areas. So we are saying the integrated support type has to learn a little bit about physical distribution, and the physical distribution manager has to learn a little bit about designing for support.

Vraagsteller: Is there some collaboration, in courses and programs, with other societies?

Prof. Blanchard: Yes, one example is the National Council for Physical Distribution Management. They are strong in the distribution aspect of products, getting together with the Society of Logistics Engineers sponsor joined approach. An other example is that every January we have a reliability and maintainability conference, that usually draft between 600 and 700 people. And that is sponsored by IEEE, and AIIE and IEE and so, and others. There is a Society of Reliability Engineers that is small. The AST&T, the American Society of Transportation and Traffic Management, we have had a lot of interaction with them on certification programs, exchange of information. The American Production Inventory Control Society, APICS, has their certification program, and our program, U.S. International Education Commission of SOLE (Society of Logistics Engineers) has been tighted with the APICS. And I would say, perhaps SOLE has a broader spectrum, whether by design or by chance, because of this logistics element, and those include the interest and SOLE does cooperate with these other organisations. But you do have in
the Society of Logistics Engineers a rather broad spectrum of backgrounds and interests. A lot of this has come about because of the frustration of being in one area, and then looking at all the interfaces that are now going on and that we are forced to do in terms of better planning. So it is an evolutionary type of situation.

**Ir. Smit:** In your book the principles of military standards on maintainability are applicable to all kinds of systems, mechanical and non-mechanical, and electronic industries. The applications, however, in your book are mainly directed to electronic systems. Is it so that in fact only the electronic industry makes use of those principles, or are they also used for mechanical systems?

**Prof. Blanchard:** I think that you are right that the book is a little bit narrow in scope. I guess the electronic industries have been somewhat driving, at least back in the mid-fifties and early sixties, because of the requirements to get "more in smaller spaces", and I guess because of the fact that we have more data available on electronic systems. I would say, within the last ten years there has been an increasing emphasis on mechanical equipment, hydraulic equipment and other types of equipment from a reliability and maintainability point of view. In many cases a lot of analysis has led, for mechanical systems, to what I would consider good design decisions from a reliability and maintainability point of view. In other cases, in many commercial products, although reliability and maintainability analysis has been done, you sometimes do not get as quite as much maintainability or reliability as you want from a consumer point of view. But, definitely, the principles are equally applicable.

**Ir. Smit:** But mainly applied in the American military systems industries.

**Prof. Blanchard:** I would say: now, yes, military categories definitely, commercial more and more so.
Ir. Smit: Do the U.S. Army specify any reliability or maintainability figures?

Prof. Blanchard: Yes, they have all kind of systems. They have figures on "meantime between maintenance" or "meantime between failure" or "mean corrective maintenance time" or "maintenance manhour per operating hour", and now even maintenance cost. And as I mentioned life-cycle cost, there is a very strong emphasis on, at the time of designing, the cost from a life-cycle point of view, not just acquisition cost or acquisition price, but design in view of the life-cycle cost. So there are a quantity of factors being included in the early planning, conceptual design looking at the life-cycle cost. I might mention one other thing: American automobiles, how unmaintainable they are. I think mid, early sixties, you could do a lot better job in maintaining cars, and of course most of us did maintain our own cars. Of course that was contrary to the producer or manufacturers interest, because service organisations were set up to do this. But I think it was more a political thing, I feel that we have had more maintainable cars in the past, than we do now. But I think again that was aimed at protecting the serviceman's interest, which is not a technical, but a political thing. Still a lot is going on. It is amazing how these cycles turn, because in the late forties reliability came along, then in the mid fifties maintainability, in the early sixties there was not too much emphasis, we got to get the product out, "forget the reliability as long as it performs". And then we got along to an equipment containing not only mechanical but also a rapidly increasing amount of electronic components. In today's economic tension life-cycle cost is coming in and showing high cost of support, which are caused by unmaintainable, poor reliable systems. So now we are going back into a renewed interest of reliability and maintainability.

Drs. de Jong: The defense authorities are about the biggest consumers of equipment in the U.S. Can we expect in the near future developments comparable to the AQUAP's in quality control? In other words, do you expect that defense authorities will put some stress upon the industry
to accept specifications covering a system of total integrated logistics support before any deliveries can be made?

Prof. Blanchard: Yes. Well right now that is going on. If you look at defense we can distinguish planning and conceptual design, preliminary design - sometimes it is called advanced development - detailed design, and of course production. Now our requirements are very well established, and now we go down the phases illustrated in fig. 6, and outward come the system based on what the requirements were. In the beginning a system eventually did not meet the requirements specified originally. Now we are doing a better job of defining what is necessary in the initial stage.
We have in the defense what we call defense systems acquisition review type committees. And there is a what they call phase zero review, and then there is a phase one review, a phase two review, a phase three review. What they are saying is that in the phase zero review, you the services (the Department of Defense services) must define all your mission requirements, operations requirements, your maintenance concepts, your "before the fact concept" on how you are going to support the system. You must establish certain basic system level design requirements, before passing review the services must have specified certain quantified requirements, not only in the performance, but also in the reliability and maintainability area. Further going down into this review, before going into preliminary design, again you must formulate a maintenance concept, mission requirements in order to find a technically feasible approach as to what technologies you are going to use, a justification on why you are using this technology versus that technology. And you must define several other things satisfactorily, otherwise you will not be allowed to go into the next phase. In respect of the phase before "detailed design", requirements in defense now say that, although we consider life-cycle cost here (and hopefully you establish a quantity of figure of merit for cost here) that you cannot go into next phase without defining a quantity of life-cycle cost figures at this time. And that includes acquisition cost as well as operation and support cost. In the past we have not concentrated on very good mission requirements definition, and as a result we have come out with something that really did not meet the requirements. It has been costly to modify this. Now we are paying much more attention to analysis and planning as early as possible.

**Logistics Planning**

Includes:
- Market analysis (as applicable)
- Technical feasibility studies
- Definition of operational requirements
- Definition of the maintenance and support concept
- Production and distribution requirements
- Advanced program plan(s)

Must consider total system/product flow.
One other thing that did happen a few years ago is that one would end up with a cost-price fixed fee type contract at a very late stage, certainly a broad contract requiring flexibility because of lack of definition of the system. Now support is considered much earlier, and you may end up with an incentive contract. Then certain factors can be considered after you get into operations, let us say two years, after you can make a measurement, and different progress type payments may be used in which payment of the contract is depending on whether the requirements were met.

So I am saying, not only is the life-cycle planning improving, but the method of contracting is improving. And many contractors have been forced to change their methods of operations to go along with it.

Now in the commercial sector I am familiar with some addressograph system which is used to make basic copy machines. Control Data, Xerox, they all have sort of phase management review system in their own products. Well they look at certain things, and of course the name of this has changed into "marketing analysis", which must have more included than in the past. This goes not for sales price only, but also for operation costs, maintenance costs, even consumer costs, which have feed-back effects on future sales and producer type operations. And of course, when you get to the profit and loss statement, profits are significantly affected by costs. A high percentage of your cost is based on either recycling in the plant, because something does not work, or because of warranties being brought back in their place, or because of the high costs of their own support, and as a consequence these aspects are taken, more and more, into consideration. Also in the military they have done a lot, because they got away from the old days, where we have a traditional C5 project, concerning a transport airplane which could not be realised as originally specified, but still led to substantial costs before the project was stopped. There was no contractual method of cutting it off in an earlier stage. Many programs do not get beyond the conceptual phase, some will get beyond the preliminary design phase. Of course what they are trying to do is to cut down the number of start ups, the number of new programs that have been started. There is quite a bit of activity in this area.
The definition of logistics, and the activities within this broad spectrum certainly vary quite a bit from company to company, but yet all relate. What I would like to do now, is to continue on to go back to this market-place/academic institutions - professional society interface and to talk more about the educational type of activities. I mentioned some of what is going on in the universities and colleges. Remember the survey that I discussed, which related to numbers of institutions that had logistics programs or options in logistics. And of course this has been increasing from 20 schools to the 67 to the 97 schools, of the survey of about 300, that we found were involved in logistics in one way or another.

I would like now to get into some of the professional societies' activities, and then go back to the academic programs and some of the material that has been specifically covered. Again looking at it from a general approach I mentioned the Society of Logistics Engineers as being an organisation, which belongs to the professional organisations in that block of three, the society being one of a number of professional organisations involved in continuing education in the logistics area overall. To give you a little background, the society was established in 1966, the membership is around 5500, there are what they call "local chapters" of which there are 63 and there are about 21 countries that are represented by the membership. It has been growing at a rate of about 20% per year. We talked about the broad definition of logistics. What I am going to, is lead in some of the society activities, such as the area of certification programs, and other activities aiming at the promotion of this broad definition of logistics as a conceptual definition, and to the promotion of the interchange between the business aspects of logistics and the engineering aspects of logistics. The society is certainly supporting this life-cycle approach,
and is oriented to production, distribution and the military defense aspects and primarily oriented towards consumer use and sustaining life-cycle support. In looking at life-cycle cost - because of cost and affected relationships - we now look at logistics in addition to being somewhat of a downstream activity. It has been developed in the design and certainly in the early planning and conceptual phases of a program, in taking into consideration the design from an overall supportability or reliability and maintainability point of view.

Elements of logistics have been addressed "downstream" in the life-cycle and are "fractionated".

The society objectives are to support that integrated approach. An educational program, or rather an elaborate educational program overall, has been established. Like the National Council of Physical Distribution, like the American Society of Transportation and Traffic and others. Now let us look at educational activities briefly.

There is a professional certification program that I will discuss. Continuing education we discussed briefly, but I would like to touch on what the society is doing in this involvement in continuing education, joined activities with universities and colleges. There is quite a bit going on at the local chapter level, working with universities and colleges to try to develop courses, groups of courses, options within a given program and of course programs. There is an educational foundation, Logistics Educational Foundation, as a separate incorporated agency, set up for funds, donations, collecting funds and for the expenditure of funds in educational, related activities. The society right now has about $24,000 in the Logistics Education Foundation. The society is sponsoring on a yearly bases a number of $1,000 scholarships. Not a lot of money, but certainly this has been a growth above and beyond what has been done in the past. In the interest of promoting student activities, we expect the candidate who receives a $1,000 scholarship to be involved in some logistics program or some program that is related to what we mean by logistics, and to have a B-average or better, and to be recommended by several academic sources and certainly from an outside source if appropriate.
If we are talking about funds for scholarships, we are talking about funds for promoting research-type projects, to improve in this overall area of logistics, to improve any given facet thereof. And we are also talking about one or two chairs in the universities, although we have not quite got to that point yet. But in any event, this has been a growing thing. The Logistics Educational Foundation was started in 1974. Now, about three years later, we have £24,000, so it has been a pretty good situation in terms of growth, technical publications in journals and what not, which are traditional with any society, and of course the activities of working with other organisations. Briefly about our certification program, we have established within the society, what we call a certain level of attainment or the recognition of a certified professional-load distinction, which again is a pretty broad title. We felt that a person with this title should have broad knowledge in the various facets of logistics as we have defined it, as the society has defined it.

We have said that we know that you are, as an individual, an expert in the design area, or in the spares provision area, or in the physical distribution area, but we feel in addition to that - if we are to promote this life-cycle approach to logistics - that you also should be familiar with some of the design and development activities if your speciality is not in that area, or some of the other activities mentioned if your speciality is design and development. We have tried to establish a given level of attainment to which individuals within the society should persevere. Under the broad logistics definition I mentioned, and talking about planning and management, we say that looking at logistics educational programs requirements, there certainly are aspects of planning for support, in addition to the organisation, management control and other of the traditional management things with emphasis in logistics.

Logistics
  . Planning
    . Analysis and design
    . Production
      . Sustaining support
We further say that the design activity - because of the cause and effect relationship, and because of the design and the whole system design area being significant in terms of the followon support - is a major area of emphasis. Therefore we feel that a person should know something about reliability, about maintainability, about logistics support analysis, about some of the design support activities (see figure 7). In addition we have established a section on de-

**LOGISTICS SUPPORT**

**ANALYSIS APPLICATION**

![Diagram](image)

**Figure 7.**

sign, on the acquisition and production support which again gets into the definition of consumer support requirements on the provisioning in contracting, on the production operations aspect, oriented towards logistics as we defined it. Finally we talk about the business aspects of physical supply and distribution and material flow, about the life-cycle customer support in the field, about modifications and of course the material phase-out and disposal. Our objective
was to attain this level of recognition, for an individual having knowledge in all these areas. Therefore we have set up an examination program in each of these areas, each part being one category of an examination in four basic categories. Each examination covering the four categories, includes a hundred questions (multiple choice questions) for each category, two hours allowed to take each category of the exam, leading to an eight hour exam overall. We require that someone would like to be a certified professional logistician, does take an eight hour exam to include all four categories, to include 400 questions, and does pass all four categories to be successful.

The basic categories representing the four parts of the Certified Professional Logistician (CPL) qualification examination are:

- Systems management
- System design and development
- Acquisition and production support
- Distribution and customer support

We have written an Education and Training Guide for the society. In this guide we have listed specific areas and within each of these areas the specific topic areas that we feel a person should know. Further we have weighted these various topics in terms of: what is the degree of importance, that we feel is essential. Finally we have tried to develop our examinations to include questions that follow this particular list, and - hopefully - the proportion of questions on the exam will indicate the relative weighting based on importance of the topics, that we feel is necessarily under this overall broad spectrum. One can look at our Education and Training Guide and specifically see what we mean. We have mixed defense oriented people and we have commercial oriented people in our society (SOLE). This enables us to create somewhat of a communication across this broad spectrum of logistics from the military to the commercial. I think that we are doing that somewhat also through the type of exam mentioned. Fig. 8 shows the growth in continuing education programs form 1966 to 1977, in which the development since the first CPL examination in 1974 must attract attention.
Like a lot of other situations we had our "grandfathers clause", which was sort of a review of those people that felt that they were qualified, reviewed by a committee for a period of one year, and, if approved, they were identified as "certified professional logis­
ticians"; a 196 got through that process. Then we decided to cut that off, replacing it by strict certification through examination. A 105 got through that process. All 301 have gotten through the total process out of a membership of about 5500. Our pass percentage has been about 40 percent, which is not too different then what we found in other certification programs like the American Society of Quality Control, like the American Society of Transportation and Traffic Management and other societies.
It is interesting to know that since we started this program that 17 applied in 1974, 63 applied in 1975, 86 in 1976 and 122 in 1977. So there has been an increased interest in this particularly type of project. I think this is a very definite indication of at least a lot of the society in the interest in the broad spectrum of logistics as we have defined it. Further we, that is SOLE, have gotten off of providing continuing education, even if many of the programs in continuing education have been generated by the society, some of which in response to individuals preparing to take the certified professional logistician examination.

1975 Survey of Logistics Education and Training

This survey was conducted because there appeared to be an increased awareness in the need for logistics education which accompanied the development work being accomplished in the Society of Logistics Engineers (SOLE). In pursuing this objective, an extensive screening of university/college was made, and 219 universities, colleges and schools whose catalog indicated possible offerings in logistics were identified. A questionnaire was then designed, and the current SOLE definition of logistics was used as a frame of reference.

Of the 219 mailed questionnaires, there were 93 responses. Twenty-eight (28) responses indicated that their schools offered no logistics course. The Deans of the responding institutions were asked to enumerate the courses which they regarded as logistics courses and to use the aforementioned definition of logistics as the criterion.

By grouping the courses under the same general classifications as in a previous (1970) study, one can make a general comparison as illustrated on the next page. Although comparison is difficult to accomplish on a direct "one-to-one-basis", there is definite evidence that there has been a significant increase in offerings at both the undergraduate and graduate levels.

It was very significant that there were so few (only one) adverse reactions to the SOLE definition of logistics. This could be indicative of real progress in SOLE's pursuit of logistics education/training, if not a real world understanding of logistics.
## Comparative Study Results

<table>
<thead>
<tr>
<th></th>
<th>1970 Study</th>
<th>1975 Study</th>
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<tr>
<td></td>
<td>UNDERGRADUATE</td>
<td>GRADUATE</td>
</tr>
<tr>
<td>Logistics</td>
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<td>34</td>
</tr>
<tr>
<td>Transportation</td>
<td>31</td>
<td>45</td>
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<tr>
<td>Transportation Policy and Regulation</td>
<td>12</td>
<td>17</td>
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<tr>
<td>Transportation and Logistics</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Transportation and Physical Distribution</td>
<td>4</td>
<td>16</td>
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<tr>
<td>Physical Distribution</td>
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<td>24</td>
</tr>
<tr>
<td>Physical Distribution and Logistics</td>
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<td>3</td>
</tr>
<tr>
<td>Production</td>
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<td>6</td>
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<tr>
<td>Production and Logistics</td>
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<td>6</td>
</tr>
<tr>
<td>Marketing</td>
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<td>Marketing and Logistics</td>
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</tr>
<tr>
<td>Purchasing</td>
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<td>6</td>
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<tr>
<td>(Total)</td>
<td>167</td>
<td>118</td>
</tr>
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Figure 9.
I mentioned the growth in continuing education in general in the logistics area. Because of the growth of logistics, we have had a lot of interest, including the interest for short preparation courses of 6 weeks, 8 weeks, 10 weeks in duration, getting ready for the examination.

We have set up an annual joint SOLE Logistics Education Foundation university symposium. The idea here is to get the academic people to discuss what they are doing and to get the industry people, the government people to discuss what their needs are. To get a dialogue going on why aren't the universities, the academic communities leading the needs as the industries perceive in this case. And to somehow promote communications, between the market place and in essence the academic institutions. We have got two of these conferences and they have been quite successful. The National Education Committee within the society has been involved in surveys with the universities, exchange of materials and also the design and development of the certification program. The society has a quarterly journal "Logistics Spectrum". Again the objective is to try to include more articles of a wider variety to make the journal more of a professional type document, and to promote the general life-cycle approach to logistics. Short term information is given in monthly newsletters. Also other technical journals and activities of a lot of other societies these are oriented towards logistics.

What about the future. The society is looking for a better clarification of industry, business and government needs in logistics, for growth of recognition of logistics in the academic community, and for increased society activities in this respect in particular whether to concentrate on improvement of the certification program or on recertification. Recertification is a very unpopular issue, but once you are certified, do you maintain the technical competence that you need to go on. In many cases the experience in a job type situation does not do it by itself. So you again end up with continuing education. We have not gotten very far in recertification, but we are thinking about it. And of course the idea is, at the same time, to improve or close the gap in that particular marketplace academic institutions professional organisations relationship.
Fundamental areas where basic knowledge is required for cert.prof. logistician

| Mathematics review  
| Matrix algebra, vectors, calculus fundamentals |
| Principles of statistics  
| Statistical parameters, distributions, density, functions, etc. |
| Fundamental concepts of operations research  
| Modelling, gaming, simulation, linear dynamic programming, etc. |
| Computer methods  
| Applications, hardware, software interfaces, languages, programming, data processing, etc. |
| Economics & economic analysis  
| Time value of money, interest rates, investment and evaluation criteria etc. |
| Principles of Management  
| Planning (task definition and scheduling), organizing (work packages, work breakdown structure, organization structure, task assignment), directing, and controlling (management information system and corrective action) |

Basic topical areas covered by the four (4) parts of the cert.prof. logistician examination

**PART 1**

**System management**
- concepts of systems and logistics;
- logistics requirements;
- logistics planning; organization interfaces;
- directing and controlling

**PART 2**

**System design and development**
- conceptual design (feasibility studies);
- preliminary system design (systems analysis, functional allocation, reliability and maintainability analysis, logistic support analysis, human factors and safety);
- detailed design (design criteria),
- design support, design review, testing and evaluation

**PART 3**

**Acquisition and production support**
- acquisition of logistics support requirements (requirements, pricing and source selection, provisioning and contracting, analysis and control);
- production support (production requirements, planning, production operations, production control, quality control)

**PART 4**

**Distribution and customer support**
- Physical supply and distribution (material management, packaging, transportation, warehousing);
- customer support (field engineering, data, modifications); equipment phase-out and disposition.

**Figure 10**
Now let's go back to the chart on certification (see figure 10) and consider some of the content of material that is illustrated in there. Primary questions concern "what is needed" and "what we are trying to promote" - not only from the point of view of the society, but considering logistics in general - and concern the differences to be made between education and training (and when I say "education" I am referring to that fundamental body of knowledge that we feel is necessary, versus training which is more responsive to an immediate problem and, more perhaps, job-related directly). Now let us consider the engineering aspect first, as we described it, and then get briefly into the business aspect. In engineering schools in the U.S. - at the undergraduate level, at the bachelors science level - there is not too much in the area of logistics. In fact there is very little of what we have defined as logistics, except in perhaps industrial engineering type programs or programs that are more systems oriented.

Our engineering council for professional development (which constitutes a group of academic people that review other academic programs) feel very strongly that in mechanical engineering we need more thermal dynamics, and even if management is needed, more thermal dynamics or heat transfer is needed than a logistics course, etcetera. So, there is a strong push to the undergraduate level to try to get primarily more technical subject areas in there, which may be all along good, but it appears to be difficult to get new concepts, new ideas into some of these programs, at the undergraduate level if the considerations are based on a strict technology standpoint.

Now where logistics is accepted and being introduced, these types of subject areas that we talk about are in the programs that have a little more flexibility at perhaps the undergraduate level. There is quite a bit going on in that area. At the graduate level, after the bachelors level, the people that have been on the outside working and have gone back to school, both the on-campus and the off-campus, there is a lot of flexibility. It is there where most of the activity is currently going on. From an engineering point of view we are talking
about a good course in statistics and probability. You really cannot
do very much in design for reliability unless you have a very good,
fundamental knowledge of statistics. We are talking about a good
foundation in engineering economic analysis. Not so much the micro-
ecconomic or the macro-economics, but the basic ability to be able to
evaluate alternative design considerations in terms of economics. And
of course we are talking about courses that are applicable to all
branches of engineering, such as some fundamental knowledge in com-}
puter science. Not so much from being able to program something, but
certainly from an understanding of the tools that are available to do
some of the analysis that we require. We are talking about a fairly
good fundamental knowledge in operational research, some of the
methods and techniques such as simulation, queuing theory, linear
programming, dynamic programming, because — if we now look at logis-
tics in context to the design for optimum support, whatever that may
be — we have got to get into the analysis methods that are required
in the upstream part of the life-cycle to look at what is the best
approach. We are talking about the basic concepts of management. And
of course the question comes about, what about the communication
methods, and what about some of the interfaces. We are talking about
contracting, some basic knowledge of contracting, we are talking
about transportation and traffic, that is some of the international
aspects of logistics, e.g. how do you get parts, products from here
to Iran and from Iran to somewhere else.
If you are talking primarily in the management business logistics
area and look at business schools, again we get into the material
flow, into physical distribution, into inventory, transportation and
traffic management (sort of the international aspect of logistics),
into the marketing aspect, and hopefully we see a little bit of the
business schools maybe having one survey course or two that covers
the engineering aspects.
We see a little bit of this interchange going on. And I think one
mechanism for this occurring are conferences, such as I mentioned,
that involved the academic communities, the business industry-world
and we get some kind of a dialog going. So, if we are talking about
these things as areas of interest, and we look at the educational re-
quirements for these things and the fundamental body of knowledge,
we are talking about more basic type things, basic things that you
can use not only in logistics but everywhere else.
Now that was a general overview about what is going on in the acade-
mic community, let me stop here and, again, try to respond to ques-
tions.
DISCUSSION

Prof. Geraerds: When you made a survey of the demand, up to what extent did the industry express the need for people educated this way at the university level, and at what age do they usually start this education?

Prof. Blanchard: Industry more and more has been complaining because they had to retrain or re-educate their own people to resolve specific problems. They were continually harping at the academic institutions as were "too theoretical", "not responsive to their needs". You know, they are in a world of their own. More and more I think the academic institutions, and some more than others, are trying to be more responsive to industry needs. The school that I am with is a state supported university. State supported universities in the U.S. have not only the teaching and research missions, but also what they call extension missions. Extension meaning take courses off-campus, conducted at night so that people working in industry can get degrees at night or can get continuing education either at night or day. But to get back on your question, yes the industry complaints are going up and up. They are criticizing the academic institutions for not being completely responsive.

I do believe there is a lot of need, but we still have that communication between the academic community and the industry.

Prof. Monhemius: Is the problem you just touched the more general problem between, say, industry and market place, and universities or economic institutions? Industry quite often wants people that are qualified for a very specific goal, requiring people having had a specific limited training, while the universities in general attempt to educate people much more generally. I am afraid that there will always be this gap between the market place and universities, unless of course the universities will, are willing to go themselves into vocational schools.
Prof. Blanchard: At least the academic institutions will never get to that point. But I think you can go a little way; let me indicate what I see in engineering in the States where there is a trend to go one step closer to perhaps the practical application area. What I am leading to, I guess, is the universities response, may be in the form of graduate type courses for degree credits combined with continuing education training. In the university that I am with, I myself in engineering teach fifty courses off-campus, who are located about 400 kilometers from Washington DC. We fly professors two hundred kilometers away, we teach courses off-campus for graduate credit. One of our more popular programs is a systems-engineering program, which cuts across in a matrix form across the mechanical, the civil, the electrical and the various branches of engineering and this program is a masters level.

But in many cases, in addition to these fifty courses that I am responsible for off-campus, I also have 85 continuing education programs, that I conduct at off-campus locations, anywhere from a one-day to a three week program, which is more training problem oriented, conducted within a company and serving that particular company. And hopefully I think this mix does it.

Drs. de Jong: I would like to put forward that, in general, logistics is more an art than a science, most of the time even a management concept. Are those people joining these courses coming from management ranks?

Prof. Blanchard: Different areas. Not very many people in the logistics area evolve from logistics because there have not been basic degrees in logistics. As an example I started off as an electronic designer, ending up in the field service for a given company, in the supporting equipment field, and back in design, then in the reliability area and back in design and that type of variation. But we also see examples of e.g. an engineering guy, in the ranks of designer, that all of sudden has to do a trade-off study that involves the total life-cycle cost that we talked about and all the logistics elements, looking for help. If I look at our graduate program in sys-
tems engineering where we have logistics courses, there are people from management, there are people from engineering backgrounds, most of them of engineering, or science backgrounds such as physics, chemistries, maths and statistics. I think you are right, we are talking about a management concept, we are talking about an art. But within that overall broad spectrum we are talking about the specific aspects of analysis simulation modelling or inventory control or some of the areas that bring more of the principles of statistics and operations research and computer methods and that type of thing.

**Drs. de Jong:** Has there been any survey in the US concerning the use of the integrated approach of logistics in the industry?

**Prof. Blanchard:** Yes, definitely in the defense orientated industries a lot of companies are using it. In the business orientation, also a lot of companies. And in some cases the integration is occurring at least to the recognition that these things all relate. If you are looking for a company with one big guy in the top saying he has got all of it, organisationally speaking, no. If you are looking for a company where the area of logistics and the integration is recognised at a very high level under a product support manager or distribution manager, yes. So if you look at the functions that are going on, and their integration, its a long way to go.

**Drs. de Jong:** You do not put much emphasis on the procurement?

**Prof. Blanchard:** I did not mean to exclude it, if I did, because I look at purchasing as being a very significant part. But purchasing methods and techniques, not necessarily addressing the lowest price. There is still that conflict between procurement policies, life-cycle cost, budgetary constraints, and how the budget is allocated on the year to year basis. There is one thing that I see happening more and more, which is procurement based on life-cycle cost, and not strictly on lowest initial price.
Prof. Monhemius: Do you know what percentage of students stops at the undergraduate level, and what percentage is going on to get a masters or doctors degree?

Prof. Blanchard: Well, let me just answer it this way. In our college of engineering we have 4800 graduate and undergraduate students, of which about 10% are graduate students. In engineering the trend is to go on, without going out to work first to the undergraduate level, but the trend to go on to graduate engineering is decreasing, because there is enough demand for engineers and the salary is pretty good. The reasoning is: "why would I stay on school and go on with a masters degree, when I can go out and start without any experience at $ 15.000 a year". So the demand is such that most engineers are going out to work. Now it is hard to determine how many are coming back to the school. All I know is that the demand for a continuing education in the form of going back to school for graduate courses is increasing. So in terms of continuing, we on campus are quite concerned, because you need graduate students to help with research projects, to keep viable programs going, and what we see is that the number of graduate students in engineering are kind of going down. Now in other areas, such as English history, the humanities, forrestery and wildlife - and I use our campus as an example, where the job market is not that great - you have more people going continuing on in graduate school, because they cannot get a job. So I would say it varies from curriculum to curriculum and primarily depends on the job market. If in the job market situation the salaries have been damned good, then people are going out after the bachelors level.
The rewards are on the job progress and what has been done. The companies will support students going back to school, but coming out with a masters degree, very often you get nice work perhaps, but no raise.
We have now I think, in engineering alone, 350 students on off-campus working during the day and going to school at night. And this is increasing.

Well thank you all, and I hope it has been somewhat beneficial.

Eindhoven, september 1978