The energetics of management

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ARTICLES

*G. B. Feekes**

The Energetics of Management

Introduction

For the origins of both the words energetics and management one has to search in the distant past.
Energetics stems from "en-ergon", used by Heraclitus (~ 600 B.C.) in his book 'On Nature' and means "source of activity".
Management has been derived from the french word "ménagerie" which came into use in the 17th century for superintending or administrating the "housekeeping" of nobility. It stems from the latin word mansio which means "house" [1].
Nowadays management is used to express the guidance and control of a business, industrial- or public organisation. Such an organisation can be seen as a system encompassing people, capital goods and materials, producing products for and/or rendering services to society on the principle of survival.
For all kinds of managers it is of importance to have a clear insight in the processes that are implicit in this definition. They are: informationprocessing-, group-, human- and macro-economic processes. Exerting influence on these processes is the object of management, which explains the choice of the title "Energetics of Management".
The word energy was taken up in Western Europe long after Heraclitus introduced it. De Bernoulli namely labelled with it the product of weight and distance in a system of levers in 1725.
Dimensional analysis has many applications for explaining physical phenomena and in subsequent paragraphs it will be used.
In this way a universal energy picture will be unravelled encompassing diverse forms of energy also related to life.
A "system" is a collection of mutually related components that display a well-structured unity.
Now physics has developed an isomorphic model to explain the relationships between the different systems of energy. Moreover, trends can be shown that this model is also relevant to the social sciences. The overall picture of the energy systems that exist in our environment is based upon more than conjecture [6] and paragraphs 2, 3 and 4 deal with the development of the general energy theory. The possible expansion of this paradigm to include management systems will be discussed in paragraphs 5, 6, 7 and 8, with the fundamentals of macro-economics, industrial management, industrial

* *Dr. Gerrit B. Feekes, Department of Industrial Engineering and Management Science, Eindhoven University of Technology and Management Science, Eindhoven, The Netherlands.* *Manuscript received February 1983.*

psychology and group dynamics. Paragraph 9 describes an actual situation in which human, group-, management- and economic powers are recognised.

The Energy Paradigm for Inanimate Systems

The word "energy" was introduced by Heraclitus ca. 600 B.C., although he did not define it. In 1725, De Bernoulli called the product of weight and distance by the same name: later, in the nineteenth century, it was demonstrated that there were other forms of energy. It was only after Einstein's "Theory of Relativity" that energy was accepted as being independent of any medium for its storage or transportation. Nowadays, there are physical definitions for kinetic, potential, electrical, magnetic, pneumatic, hydraulic, chemical, thermal, accoustic, nuclear and other forms of energy. Many scientists have contributed to a general energy theory in particular, W. Heisenberg [7], H. M. Paynter [8], D. Karnopp and R. Rosenberg [9] and Thoma [10]. Their theories can be summarised as follows:
"The total amount of energy in the universe is constant and its various forms are interchangeable. In general, the energy system can be formulated in terms of its persistence (p), extension or medium for its persistence (e) and time (t)".

rate of flow (v) $= \frac{de}{dt}$

momentum (I) $= pv$

force (F) $= \frac{d}{dt}(pv)$

energy (E) $= Fe$

power (P) $= \frac{dE}{dt} = \frac{d}{dt}\int F \cdot de = \frac{d}{dt}\int Fv \cdot dt = Fv$

The relationships between the main components of the energy system are shown schematically in Fig. 1. The triangle represents the functional limits of the system. The linear dimensions of these components can be expressed according to the MLT notation, as follows:

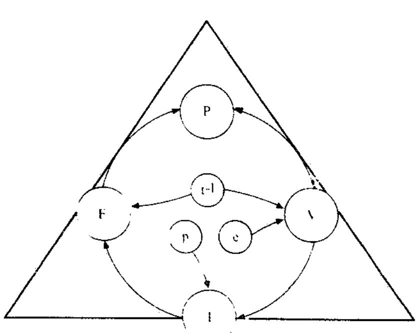

Figure 1: Dimensional Paradigm

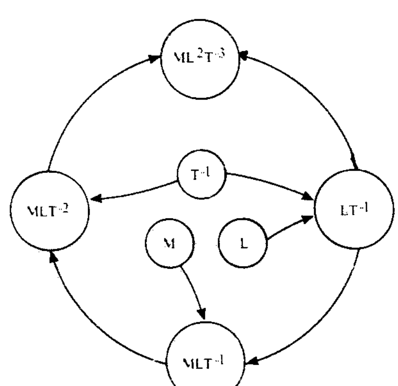

Figure 2: Paradigm for Classical Mechanics

rate of flow (v) = LT^{-1}

momentum (I) = MLT^{-1}

force (F) = MLT^{-2}

power (P) = ML^2T^{-3}

A scheme to illustrate these basic dimensions is shown in Fig. 2. Next, the components of the energy system can be considered in terms of the MLT dimensions related to other engineering systems.

1. *Planear system* – using a base of L^2

area = L^2

mass per unit area = ML^{-2}

time = T

surface impulse = L^2T^{-1}

surface velocity increase = MT^{-1}

areal tension = MT^{-2}

2. *Hydraulic system* – using a base of L^3

volume = L^3

hydraulic inertance = ML^{-4}

time = T

volume flow = L^3T^{-1}

hydraulic impulse = $ML^{-1}T^{-1}$

pressure = $ML^{-1}T^{-2}$

3. *Torsion system* – using a base of L^4

second moment of area = L^4

4. *Elasticity system* – using a base of L^5

volume elasticity = section modulus (L^3) x axial cross-sectional area (L^2)
= L^5

5. *Crystal system* – using a base of L^6

crystal growth = $L^3 \times L^3 = L^6$

The paradigm for these energy systems are shown in Table 1. The dimensional progression in those forms of energy can be formulated as an Evolution Law of Energy, as follows:
"All forms of Energy (En) are the product of a force and an extension factor" or

$$En = \left| \frac{E}{L^n} \right| \cdot |L^n|$$

n = level 1, 2, 3 ...

Table 1

System	Basic Components			Derived Components			
	Time	*Persistence*	*Extension*	*Flow*	*Momentum*	*Force*	*Power*
Crystal physics	T	ML^{-10}	L^6	L^6T^{-1}	$ML^{-4}T^{-1}$	$ML^{-4}T^{-2}$	ML^2T^{-3}
Volume-elasticity	T	ML^{-8}	L^5	L^5T^{-1}	$ML^{-3}T^{-1}$	$ML^{-3}T^{-2}$	ML^2T^{-3}
Torsion	T	ML^{-6}	L^4	L^4T^{-1}	$ML^{-2}T^{-1}$	$ML^{-2}T^{-2}$	ML^2T^{-3}
Hydraulics	T	ML^{-4}	L^3	L^3T^{-1}	$ML^{-1}T^{-1}$	$ML^{-1}T^{-2}$	ML^2T^{-3}
Surface of liquids	T	ML^{-2}	L^2	L^2T^{-1}	MT^{-1}	MT^{-2}	ML^2T^{-3}
Classical mechanics	T	M	L^1	L^1T^{-1}	MLT^{-1}	MLT^{-2}	ML^2T^{-3}

6. *The dimensions of the extension factor* (Ln) relate to the space dimension of the system concerned and they can be arranged into two groups of three.

Group one: distance (L^1)
plane (L^2)
volume (L^3)

Group two: torsion ($L^1L^3 = L^4$)
volume elasticity ($L^2L^3 = L^5$)
crystals ($L^3L^3 = L^6$)

The Energy Paradigm for Animate Systems

The progression from energy in the form of crystal systems to energy in the form of animate systems is indicated by the simple viruses and cells. In plants and animals, viruses cause infections, but the different forms can be distinguished only with an electron microscope. Chemically, they comprise protein molecules that surround a nucleus of DNA or RNA.

A virus can reproduce only within a cell of its host; outside this cell, it is inactive and cannot grow. Under favourable circumstances, one virus can reproduce itself a thousandfold by fission in the space of a few hours. Living organisms are composed of minute *cells* comprising a cell-wall enclosing the protoplasm or living matter. The vital functions of life occur in the protoplasm under the control and coordination of a nucleus. When the nucleus is removed, a cell will soon die. The nuclei of different cells in a multi-cellular organism communicate with one another in order to coordinate the whole system. This communication is called symplasm and in plants the protoplasm of one cell passes through apertures in its cell-wall to contact the protoplasm in neighbouring cells. Cells that are united and continuously coordinated are called, collectively, parenchymatic *tissue*.

Differentiation

Simple *organisms* like bacteria and certain algae are unicellular which means that they are in direct contact with their environment, usually water. The elements that are needed for growth are absorbed directly from the water or air surrounding the cells.

As the number of cells comprising an organism increases, only those in the outside are in direct contact with the environment and nutrients have to be transferred to the inner cells via the filaments of protoplasm.
As an organism grows, the inner cells become more distant from the environment, because the surface area increases by the square of the diameter whilst the contents increase by the cube of the diameter. All nutrients for the central cells of a spherical multi-cellular organism have to be transported to it through the medium of the protoplasm of the surrounding cells. The distance can be reduced when the cells are in a flatplane so that each cell of the uni-cellular plane will be in contact wit the environment. This method of surface enlargement is common in plants particularly, leaves and fronds. When it is not possible to increase the surface area, differentiation of cells creates special channels for transportation; for example, from the roots of a plant to its leaves. As the size of an organism increases, it needs greater rigidity and certain cells are differentiated to form a rigid framework.
The principle of differentiation is wide-spread in animate systems, both within an individual system and between individuals within a social system.
In the development of organic systems, the dimensions of the extension factor are increased beyond the L^6 of crystal systems. It is postulated that the extension factor of a cell is one dimension more than that of a crystal, whilst tissue has one more than a cell and an organism has one dimension more than a tissue. Thus:

extension cell $= L^7$
extension tissue $= L^8$
extension organism $= L^9$

These three forms of energy comprise the third group in the hierarchy of energy forms and it can be demonstrated that a fourth group comprises:

extension neuron $= L^{10}$
extension ganglion $= L^{11}$
extension cerebral cortex $= L^{12}$

The Energy Paradigm for Behavioural Systems

It is postulated that the development of social behaviour follows the same pattern as the development of organisms by a process of differentiation beyond the creation of individual organisms. The first stage includes human personality, group behaviour and social organisations. Then, the second stage will include a one-dimensional-, a two-dimensional- and a three-dimensional management information system.
Expressing these stages of development in the hierarchy of energy-forms it appears that in successive interpretations, mass plays part in an increasingly complex form of extension $\left(\frac{M}{L^{2n-2}}\right)$. This can be indicative of a continuing process of differentiation of persistences. The basic and derived components and their relationships of energy-systems are given in table 2. The aim of this hierarchy of energy-systems is to demonstrate how the successive phenomena in evolution can be related to energy so that they can be expressed in the basic dimensions of mass, length and time. It follows that

the energy paradigm incorporates all dynamic systems and defines their basic and derived components.
For practical purpose however, the progression from persistence – extension – flow – momentum – force – power to energy remains to be formulated in proper units, as for example the well-known sequence in the case of electricity:

– Henry (H) – Coulomb (C) – Ampère ($C \cdot T^{-1}$) – Weber ($H \cdot C \cdot T^{-1}$) – Volt ($H \cdot C \cdot T^{-2}$) – Watt ($H \cdot C^2 \cdot T^{-3}$) – Joule ($H \cdot C^2 \cdot T^{-2}$).

The Energy Paradigm for Macro-Economic Systems

1. The characteristic of neo-classical economy is a search for relationships between production outputs and the factors that influence them. For example, between the volume of production (G) and the resource inputs, such as labour (L) and capital (C). It is seen to be a physical relationship that changes with time, according to the production function $G = f(C \cdot L)$.
Although capital, in this instance, is estimated statistically, Rudolf Henschel in "Wachstum und Konjunktur" (see Bombach 1960 [11]) argued that the magnitude of capital goods is also determined by the level of technology in an particular community. Also, Jan Tinbergen [12] pointed out that the level of education plays an important part in raising production.
In the energy paradigm, the technical factor, persistence, can be related to capital input and the labour input is introduced as the labour extension per unit of time instead of a quantity like man-hours.

2. *Labouriousness* is the term used for labour extension, since it involves incentive as well as work effort. The average quantity of labouriousness in an economic system is determined by the motivation of the workers, work disciplines, labour relations, rest periods and workdays per year etc. The labouriousness of two countries with different numbers of working days per year can be the same when the fewer working days promote greater rates of work output. This is explained in Fig. 3 in which the labour extension factor, or labouriousness, per unit of time is expressed as LT^{-1}.

3. *Level of technology* is regarded as the amount of technological knowledge used for fulfilling economic demands. Factors that influence this level include the standard of education and research, the degree of industrial modernisation, the ability of management, mobility and the state of public health.

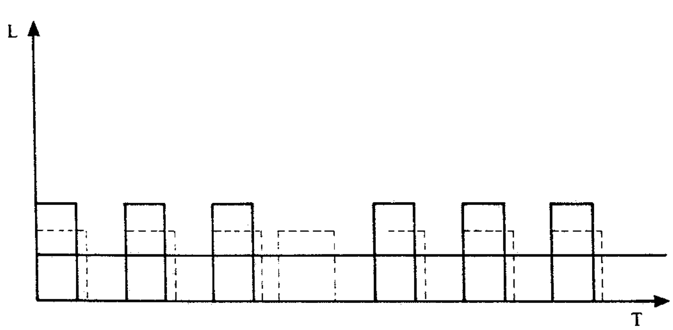

Figure 3: Labour per Unit of Time

Attempts at measuring the level of technology have used different starting points, like: the investment in research or the number of people engaged in research work, or the number of scientific publications or applications for patents; or the number of university graduates in technological disciplines. Though it is difficult to devise an overall quantitative measure for the level of technology, it will be represented by the symbol for persistence, H.

4. *Economic momentum* is the product of labouriousness and the level of technology. It can be concieved by the effect of financial aid to Western Europe after Second World War with the aid given to developing countries. During the war, much of the European industry was destroyed, but help from the Marshall Plan enabled reconstruction to take place more quickly because of the high level of technology and labouriousness that existed already. Any financial aid to the third world that exceeds the economic momentum will be ineffective. Economic momentum, $I = HLT^{-1}$.

5. *Capital goods* represent the investment in manufacturing industry. The amount of capital goods is a measure of production capacity per employer and it is found by dividing the total industrial investment by the numerical size of the work force. Figures were calculated for 1968 by the Netherlands Econometrical Institute for the following countries:

U.S.A.	$ 23,605 capital investment per worker
Sweden	$ 20,389 capital investment per worker
The Netherlands	$ 14,526 capital investment per worker
France	$ 14,221 capital investment per worker
Belgium	$ 12,493 capital investment per worker

The level of investment in capital goods can be maintained only by an equivalent level of technology which is expressed as the economic momentum per unit of time,

$$C = (HLT^{-1})\,T^{-1} \text{ or: } HLT^{-2}.$$

6. *Gross National Product* (G.N.P.) comprises the total national revenue that is derived from goods and services.
Dividing the G.N.P. by the number of production workers in a country provides a measure of the production function and it can be shown that there is a technical relationship between G.N.P. and labouriousness and the investment in capital goods. This relationship is expressed as $G = f(C \cdot L)$. The values of G in 1968 were calculated by the Netherlands Econometrical Institute for the same countries above:

U.S.A.	$ 9,217 G.N.P. per worker
Sweden	$ 6,285 G.N.P. per worker
The Netherlands	$ 4,878 G.N.P. per worker
France	$ 4,734 G.N.P. per worker
Belgium	$ 4,622 G.N.P. per worker

7. *Results* of calculations for the values of all the components in the energy paradigm have been tabulated in table 3 for the countries investigated in 1968. From these calculations, it can be concluded that:

1. Labour contributes most to the production process in Belgium and the least in Sweden
2. The level of technology is highest in Sweden, lowest in Belgium
3. Labouriousness is highest in the U.S.A. and lowest in Sweden.

Table 2

System of Energy	$E = \text{Force} \cdot \text{Extension}$, $E_n = (M \cdot L^{2-n} \cdot T^{-2}) \cdot (L^n)$; n = level 1, 2, 3 . . .							
Dimension	Time	Persistence	Extension	Action	Momentum	Force	Power	Energy
System	[t]	[p]	[e]	$[v] = [et^{-1}]$	$[pv] = [pet^{-1}]$	$[F] = [pvt^{-1}] = [pet^{-2}]$	$[P] = [Fv] = [pe^2 t^{-3}]$	$[E] = [Pt] = [pe^2 t^{-2}]$
Macro economy	T	ML^{-36}	L^{19}	Productive actions	Impulses	Cap. goods	G.N.P.	Energy
3D Info-syst.	T	Control		Managerial actions	Impulses	Planning syst.	Power	Energy
2D Info-syst.	T	Control		Managerial actions	Impulses	Planning syst.	Power	Energy
1D Info-syst.	T	ML^{-30}	L^{16}	Managerial actions	Impulses	Planning syst.	Power	Energy
Organisation	T	Values		Interactions	Impulses	Ordering	Power	Energy
Group	T	ML^{-26}	L^{14}	Interactions	Impulses	Norm-setting	Power	Energy
Homo faber	T	Perception	Motivation	Actions	Impulses	Ability	Power	Energy
Cerebral cortex	T	Sense organ		Info-transport	Impulses	Memory	Power	Energy
Ganglion	T	ML^{-20}	L^{11}	Info-transport	Impulses	Node	Power	Energy
Neuron	T	Receptor cell		Info-transport	Impulses	Node	Power	Energy
Organism	T	ML^{-16}	L^{9}	Stimuli	Impulses	DNA (coded experience)	Power	Energy
Tissue	T	Receptor membrane		Stimuli	Impulses	DNA (coded experience)	Power	Energy
Cell	T	ML^{-12}	L^{7}	Stimuli	Impulses	DNA (coded experience)	Power	Energy
Crystal	T	ML^{-10}	L^{6}	L^6T^{-1}	$ML^{-4}T^{-1}$	EL^{-6}	ML^2T^{-3}	ML^2T^{-2}
Volume elasticity	T						ML^2T^{-3}	ML^2T^{-2}
Torsion	T						ML^2T^{-3}	ML^2T^{-2}
Hydraulics	T	ML^{-4}	L^{3}	L^3T^{-1}	$ML^{-1}T^{-1}$	EL^{-3}	ML^2T^{-3}	ML^2T^{-2}
Areal energy	T						ML^2T^{-3}	ML^2T^{-2}

Table 2

System of Energy	E = Force · Extension, $E_n = (M \cdot L^{2-n} \cdot T^{-2}) \cdot (L^n)$; n = level 1, 2, 3 ...							
Dimension	Time	Persistence	Extension	Action	Momentum	Force	Power	Energy
System	[t]	[p]	[e]	[v] = [et^{-1}]	[pv] = [pet^{-1}]	[F] = [pvt^{-1}] = [pet^{-2}]	[P] = [Fv] = [pe^2 t^{-3}]	[E] = [Pt] = [pe^2 t^{-2}]
Macro economy	T	ML^{-36}	L^{19}	Productive actions	Impulses	Cap. goods	G.N.P.	Energy
Translation	T	M	L^1	L^1T^{-1}	MLT^{-1}	EL^{-1}	ML^2T^{-3}	ML^2T^{-2}
Rotation	T	ML^2	L^0	L^0T^{-1}	ML^2T^{-1}	E	ML^2T^{-3}	ML^2T^{-2}
Electro magn.	T	ML^4	L^{-1}	$L^{-1}T^{-1}$	ML^3T^{-1}	EL^1	ML^2T^{-3}	ML^2T^{-2}
Nuclear energy	T						ML^2T^{-3}	ML^2T^{-2}
Chromo dynamical energy	T	ML^8	L^{-3}	$L^{-3}T^{-1}$	ML^5T^{-1}	EL^3	ML^2T^{-3}	ML^2T^{-2}
Diffraction	T						ML^2T^{-3}	ML^2T^{-2}
Pulsing of universe	T						ML^2T^{-3}	ML^2T^{-2}
Primeval atom	T	ML^{14}	L^{-6}	$L^{-6}T^{-1}$	ML^8T^{-1}	EL^6	ML^2T^{-3}	ML^2T^{-2}

Table 3

	G.N.P.	CAP.	Momentum (100 000 $ hours)	Labo-rious-ness $ c.	Tech. qual.	Labour	Time
U.S.A.	$ 9,217	$ 23,605	425	39,0	10,9	$ 702	1800
Sweden	$ 6,285	$ 20,389	367	30,8	11,8	$ 554	1800
The Netherlands	$ 4,878	$ 14,526	290	33,6	8,5	$ 672	2000
France	$ 4,734	$ 14,221	284	33,3	8,6	$ 666	2000
Belgium	$ 4,622	$ 12,493	262	36,9	7,1	$ 775	2100

The relationships between the components of the energy paradigm are shown diagrammatically in Fig. 4. Plotting the values from the table of results graphically shows the scale of isoquants in Fig. 5.

With the aid of these two figures, it can be deduced that France and Sweden need a higher investment in capital goods per capital to achieve the same level of prosperity

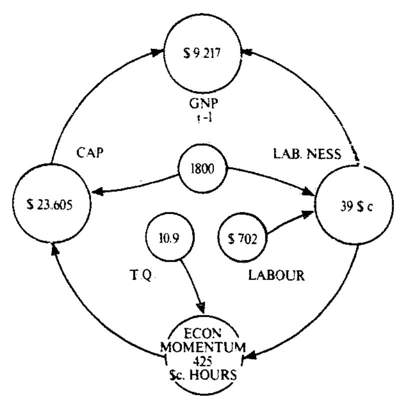

Figure 4: Paradigm for Macro-Economics

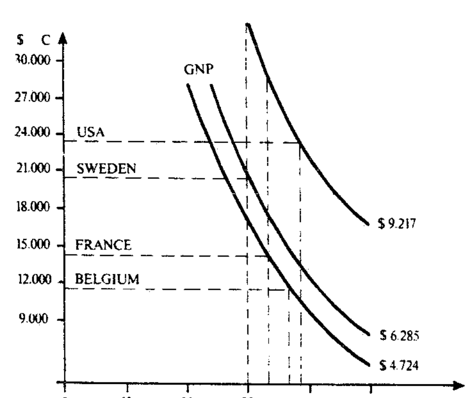

Figure 5: Scale of Isoquants for G.N.P.

as the U.S.A. Assuming that labouriousness is constant in these countries, then, France would need $ 13,000 more and Sweden $ 10,000 more investment. The increase of G.N.P. would be $ 4,500 and $ 3,000 respectively. Therefore, through increasing its investment by 30% over Sweden, France achieves a 50% higher increase in G.N.P. This could be attributed to the greater labouriousness in France of 33.3 cents as compared to 30.5 cents in Sweden.

8. *Purpose and restriction of the macro-economic model* are apparent since it is used to investigate economic trends over several decades. Factors investigated should include the development of populations and values for capital investment, labouriousness and level of technology, especially, in relation to their influences on production capacity and living standards. The model ignores short-term fluctuations and confines itself to general trends that exclude financial considerations which have more effect on short-term trends. Also, the economy is considered as a whole in order to eliminate problems of individual goods and markets.

The Energy Paradigm and Managerial Performance

1. A manufacturing, or a commercial system are sub-systems of a larger system, such as the national system. The Systems Analysis approach shows how systems are organised and it led to the development of organisation theory. At the start of this century, scientific management began with the work of Taylor, followed by the theories of administrative management proposed by Fayol, Gulick and Urwick. Then, research focussed more upon human relations and industry, including the work of Mayo, Roethlisberger and Dickson after the First World War.
Recent trends in management research have been guided by the decision-making school of thought attributed to Leavitt, Simon and March [13]. In other words, general approaches to management have become more specialised.
The systems approach to the structuring of business organisations was used by Simon in 1958 in order to develop functional management structures in which lines of authority and responsibility provided a framework. Later, Ansoff [14] analysed the performance of management more profoundly and defined management (M) as a complex information processing system whose purpose is to guide and control a business.

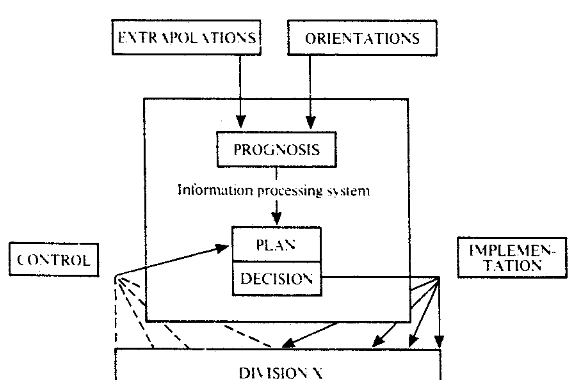

Figure 6: Information Processing System

Within this system, three processes play an important part, they are planning (P), implementation (I) and control (C). Planning is the process of establishing the purpose, framework and constraints of an organisation. Implementation is defined as the process of making the organisation conform to the plans, whilst control is the process of evaluating its behaviour.

2. *Planning* starts with the determination of policies for operating an organisation and continues with the objectives for subsequent activities. Planning involves selecting from a number of strategies the ones that conform closest to the requirements of the policies.
Different plans are required for the functional divisions of management like Marketing, Production, Finances and Personnel. Each plan is influenced by its implementation environment; for example, marketing plans are affected by the economic climate in which the business operates. Many factors that influence a plan will be outside the control of management and its decisions will have to be based upon market trends or statistical forecasts, but short-term plans have the highest probability. Other factors that influence plans include competition from similar business, political decisions made both at governmental and local levels; stock market, social welfare and other outside influences, also, have to be assessed. A procedure for improving the accuracy of assessments is shown in Fig. 7.
Good planning leads to better implementation which can be represented symbolically as $P > \rightarrow I >$ .... (1)

3. *Control* breaks down when too many variables are involved and management must learn to separate the vital few from the trivial many by a process of selectivity. Management control is improved by using trend analysis and management ratios.
Selective control leads to better implementation and it is expressed symbolically by $C < \rightarrow I >$ .... (2)
Combining (1) and (2) shows that the three processes of management are inter-related in the form: $\frac{P}{C} = I$ .... (3)

Management performance can be expressed as: $M = P \cdot I$ .... (4)

4. These management activities are depicted in Figs. 6 and 7.

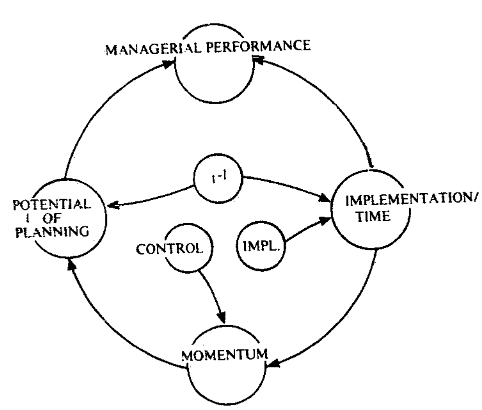

Figure 7: Paradigm for Managerial Performance

The Energy Paradigm and Industrial Psychology

1. Industrial processes require the mental and physical efforts of man in order to satisfy economic demands and industrial psychologists study ways for improving the efficiency of doing work. Much research concerns methods of improving work-performance under different circumstances.

2. *Performance* varies according to workers and Vroom [15] in his book "Work and Motivation" analysed work-performance and proved that it is inter-related with ability and motivation.

PERFORMANCE = ABILITY × MOTIVATION/TIME

3. *Ability* was isolated from performance by Vroom and he prepared a scale for measuring it.

4. *Motivation* gives direction to ability; therefore, it affects work-performance. The word "activation" was used by Lindsey [16] in 1957 to describe this concept. He observed that work performance increased with the degree of activation up to an optimal level. Likewise, Vroom proved that performance is a function of both ability and motivation.

5. *Perception* is the sensory awareness by organisms to their environment. Stimuli are received by the sensory organs which convey this information to a control centre for future use, it is known as experience and it influences work ability; therefore, ability must be a function of perception as well as motivation.

ABILITY = PERCEPTION (p) × MOTIVATION (m)/TIME

6. The components and their relationships described in this section are shown diagrammatically in Fig. 8.

The Energy Paradigm and Group Dynamics

In general, qualitative models preceed quantitative models and this has been established in the behavioural sciences by Eaton, Gross, Riggs, Deutsch, Levy, Chamberlain, Kuhn and Miller. Human behaviour is very complex, because it involves so

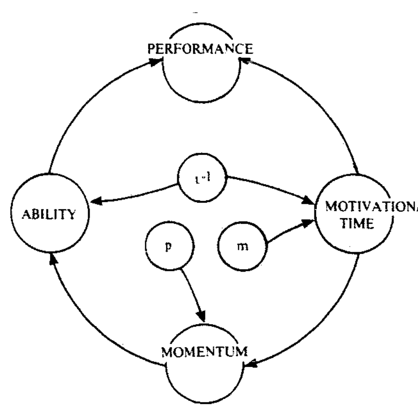

Figure 8: Paradigm for Work-Performance

many interacting systems, each of which has a range of variables so that the whole is virtually unpredictable. In order to cope with complexity of this magnitude, social scientists have examined the components individually and at depth. However, difficulties arise when considering those individuals as part of a dynamic system. Models to explain behavioural patterns have to be probabilistic, of necessity.

1. *Structure-performance models* assist analysts to select those variables which are most appropriate to specific situations.
Some researchers take a system's performance for granted and concentrate upon its structure; this is unrealistic because they are unaware of changes within the dynamic whole. Other analysts concentrate upon performance. This is equally in-appropriate, because any well-rounded view of society must deal with both structure and performance together. Structures can be regarded as slow processes of long duration whilst performance comprises rapid processes of short duration.
In reality, it is desirable to define structures and performance more specifically in order to develop models for them. For example, in a social system, the structure consists of people and other resources grouped into sub-systems that inter-relate among themselves and with their environment. On the other hand, performance of a social system consists of activities that conform to patterns of behaviour.
The components of a social system and their relationships are shown in Fig. 9.

Group Performance = Normsetting × Interactions/Time

Normsetting = Value × Interactions/Time

Distinguishing Managerial, Individual, Group Dynamic and Economic Power

A number of American businesses have introduced so-called "management services rooms", where one can find all the information relevant to management, such as:

- progress of prices for raw-materials
- stock-exchange quotations of competitors
- planned and realised purchases
- investment progress reports
- work in hand
- costs versus budgets
- and so forth.

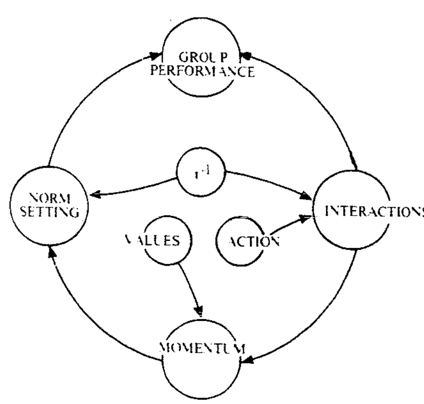

Figure 9: Paradigm for Group Dynamics

These items are displayed on wall charts assisted by computer programs. The frequency of the forecasts depends on the interest to management. Generally, sales returns are posted daily, whilst profit and loss reports are prepared monthly.
Next to this management information, there have been prepared operation research models with computer programs, which help management to reach conclusions and make decisions.

Examples include:

- what will be the profits if the prices are reduced by x%, taking into account the expected increase in turnover and a lower cost price?
- what are the consequences for orders that have been accepted already, if a substantial rush-order is being accepted?
- which factory must be allocated a new product, taking into account the production and distribution costs, etc.?

Use of Management Services Room

Management services room is connected with the management offices and replaces all routine information. No statistics for individual use are distributed.
The Management Service Room:

- procures for management recent and relevant information about the *macro-economy*
- procures for management recent and relevant managerial information (*planning, implementation, control*)
- promote industrial communications between members of line and staff (*group dynamics*)
- promote *individual performance.*

There the following meetings are being arranged:

- of managers each Monday with reference to the state of affairs (45 min.)
- staff discussions each week to consider results (30 min.)
- top-management get together each month to discuss progress (2 hrs.).

One would expect that this framework would lead to a more centralised management, but in practice it is not the case. The useful information frees management from involvement with daily routines and they have more time for important matters and long-term problems.
The framework develops a new sort of management that is more energetic and shows a higher measure of perception and motivation. This keeps managers on the right line for adapting themselves quickly to social and market changes and to internal events, which is necessary in our fast developing society.
Alertness requires firstly a good cooperation based upon motivation which can be obtained only if those involved see and understand better what goes on outside their own departments.
The full development occurs in three stages:

1. Collecting data and procuring information in a way that is appropriate to the needs of management so that it leads to a greater ability to survey and manage.

2. The greater ability to survey activities leads to the promotion of policies for optimalising a number of economic aspects.
3. This quantitative approach includes the preparation of better decision models for policy-making.

References

1 George. C. S.: "History of Management Thought". Englewood Cliffs. Prentice-Hall. 1968.
2 Merton. R. K.: "Social Theory and Social Structure", Free Press, 1968.
3 Gross. B. M.: "The State of the Nation – Social Systems Accounting". New York. Barnes & Noble. 1966.
4 Bowler. T. D.: "General Systems Thinking". New York. North Holland. 1981.
5 Miller. J. G.: "Living Systems". New York. McGraw-Hill. 1978.
6 Adams. R. N.: "Energy and Structure. A Theory of Social Power". University of Texas Press. 1975.
7 Heisenberg. N.: "Physics and Philosophy". New York. Harper & Row. 1962.
8 Paynter. H. M.: "Analysis and Design of Engineering Systems". Cambridge. Mass.. M.I.T. Press. 1961.
9 Karnopp. D. and R. Rosenberg: "Systems Dynamics an Unified Approach". East Lansing. Mich. M.S.U.. 1972.
10 Thoma. J.: "Bond Graphs for Thermal Energy Transport and Entropy Flow". J. Franklin Institute. 292. 1971. pp. 109–120.
11 Bombach. G. U. A. (Hrsg.): "Wachstum und Konjunktur". Darmstadt: Leske. 1960.
12 Tinbergen. J.: "Selected papers". Amsterdam. North-Holland, 1959.
13 March. J. G. and H. A. Simon: "Organizations". New York. Wiley, 1961.
14 Ansoff. H. I.: "The Expanding Role of the Computer in Managerial Decision Making". Informatie 9. 1967. pp. 46–64.
15 Vroom. V. H.: "Work and Motivation". New York. Wiley. 1967.
16 Lindsley. D. B.: "Psychophysiology and Motivation". In Nebraska. Symposium on Motivation. 1957. M. R. Jones. e.d. Lincoln: University of Nebraska Press. 1957.