

# THE MANAGEMENT DIMENSION IN ENGINEER FORMATION

A commentary on "Engineering Our Future"  
(Finniston Inquiry Report, Cmnd 7794)

by

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1. The Committee of Enquiry into the Engineering Profession, under the chairmanship of Sir Monty Finniston, ranged widely in its examination of the crucial role of engineering in ensuring national economic viability. Its recommendations are the outcome of much impressive thought and judgement about numerous factors which determine the formation of engineers and their value as employees in U.K. industry. However, one aspect of critical importance was omitted from argued consideration, namely the relationship of management to engineering. It would appear from its Report that the Committee received little evidence on this aspect in response to its initial invitation and it did not actively seek any subsequently. The nature and context of its many references to management demonstrate the absence of a rationale about the interaction of engineering and management.

2. It is of vital importance to establish the relationship of engineering and management on a sound and well-understood basis. The interpretation of this relationship will have far-reaching effects on the implementation of the Government's decisions arising from the Committee's deliberations. Unless there is a clearer understanding of management in relation to engineering there could be a deterioration in engineering-based economic performance rather than an improvement.

3. This paper presents an examination of "Engineering Our Future" from a management perspective. Suggestions are put forward which do not in general conflict with the Committee's recommendations: they are more in the nature of additions which redress the balance of an Inquiry which not unnaturally assumed a substantially engineering stance. The numbered paragraphs and lettered Appendices of the Committee's report are referred to in parenthesis as also are some of the references to the numbered Appendices of this paper. Bibliographic references are raised and underlined.

4. On a personal note, I write from the standpoint of a person trained as a scientist, who became an engineer and then a senior manager, who has alternated between industry and education and has been involved in professional institution activities, with particular reference to engineering design, measurement, publications and membership. Recently, I have specialised in teaching management to professionals as well as research into attitudes of scientists and engineers to management and management studies. At the same time I am practising and obtaining a broad perspective of management as a member of a Local Authority and of a Health Authority.

## Management as a Process

5. In the Chairman's Preface to the report, Sir Monty Finniston explains the absence from the Committee's deliberations of linguistically precise definitions and says that nevertheless there should be no difficulty in understanding the usages and meanings of certain key words. This is certainly true in some cases - for example a reasonably consistent 'flavour' of engineering emerges. In the case of management, however, this is not so. For example, consider the following extracts:-

- (a) a clear perception and understanding of the nature of the engineering dimension should lead managements to create and develop . . . . . (2.36)
- (b) unions covering all workers below management (App E,40)
- (c) the application and management of the best of current knowledge and expertise (3.24).
- (d) another spectrum to be covered extends from 'hard' engineering at one end to management subjects at the other . . . . . (4.118).

6. Again on a personal note, many years of teaching management to scientists, engineers and teachers, as well as practising management with those and other professionals such as doctors and lawyers, have provided ample evidence of the enormous variety of senses in which the word "management" is used. Much of the contention about the place of management studies in under-graduate engineering courses has, in my view, arisen from the differences in meaning attached to "management." To form and deploy engineers to best effect, a clear and useful conception of management is required.

7. It is helpful to categorise usages of "management" as follows:-

Management considered as a group of people - 5(a), 5 (b) above.

Management considered as a process - 5(c) above.

Management considered as a set of subjects - probably 5(d) above.

The process usage has been found to be of particular value in teaching management to engineers (and other professionals) especially when presented in the form of the following "conceptual pragmatic" definition<sup>1</sup>:-

Management is the process of organising the use of resources to achieve objectives.

Some important outcomes of this approach are that management can be envisaged as being practised by individuals at all levels in an organisation, to varying degrees and whether or not there is responsibility for the work of others. As a corollary, the concept of self-management emerges. Management is not necessarily seen in terms of hierarchy or power and is regarded as an activity rather than a field of knowledge.

It is suggested that when considering its relationship to engineering, management should be regarded as a process in which the use of resources is organised to achieve objectives. (See Appendix 1).

#### The Management Content of Engineers' Jobs

8. The managerial component in an engineer's work can be virtually zero. For example, consider a lone engineer solving a "hard" engineering problem or carrying out an investigation to obtain technical knowledge. Such work can take place without consideration of time or cost, be conducted in a haphazard manner with little or no thought of the facilities and knowledge available or needed, proceed with only a very hazy or with a frequently changing idea of the objective of the work and be accompanied by a marked lack of concern about communicating progress or results. An engineer working in this way has little awareness of resources let alone the organisation of their use and in any case has no clear idea of the objective to be achieved. This approach can in rare circumstances be justified, especially in pioneering work of a scientific nature (in the case of Oliver Heaviside for example). However, for the vast majority of engineers, including "loners" on "hard" engineering work, a significant management content is desirable. This, at the least, can be in the form of self-management. (See Appendix 2).

9. As engineers rise to the top in industry there is an increasing and changing managerial content in their work activities. A typical line career development from a first appointment as a member of a small group with no responsibility for the work of others, is:

- leadership of a small group
- leadership of a section consisting of two or more groups
- management of projects
- management of a functional department
- general management.

Each of these categories of posts has associated with it a characteristic range of management attitudes, skills and knowledge. In addition, some managerial attributes specific to the particular organisation and post are needed in each post-holder. Engineers also fill staff types of post, e.g. of a liaison, co-ordination and advisory nature, which often require different managerial qualities from those implicit in the line appointments. Accompanying the developments in managerial activities are changes in approach and involvement in engineering. The two types of engineer - the leaders of manufacturing activities and the developers of new technologies - which it is proposed the R Eng (Dip) formation should provide (4.44) will

have considerably different sets of both managerial and engineering functions. Yet another set is likely to be found in the "product champions" (2.35).

10. There is a notable lack of any widely recognised framework by which practising engineers may perceive or measure the managerial aspects of their activities and assess in what directions they should or could develop. In a recent survey of engineers taking MSc Engineering courses it was found that a number of group leaders responsible for the work of several engineers, did not regard themselves in any sense as managers. A "Management Content Framework for Engineering Posts" would be of considerable value not only to practising engineers in post but also in determining the nature and location of the management content within initial and continuing engineer formation programmes. The framework should identify whatever kind of attribute is considered desirable or necessary, for example attitudes<sup>2</sup> (Appendix 3) as well as skills and knowledge. It is strongly recommended the Government should stimulate, by whatever means are appropriate, industry and education, managers and engineers, to draw up a "Management Content Framework for Engineering Posts." Some preliminary thoughts on a format for such a framework with an indication of content are shown in Appendix 4.

Field surveys<sup>3</sup> should form an essential part of the process of establishing and verifying the framework.

### Obstacles to Effectiveness as Engineers

- The Committee received a great deal of evidence about the shortcomings in the non-technical attributes of engineers, for example:
- generally poor communicative skills (4.5)
- narrowness of outlook (4.5)
- lack of understanding of factors in the commercial success of their employing organisation (4.18)
- without understanding of constraints under which engineering work is conducted in practice (4.19).

Some of these deficiencies may be attributable to secondary school education (4.5) but whatever improvements may in due course be brought about in that sector, specific provision needs to be made in the initial formation of engineers to develop appropriate non-engineering abilities and understandings. There was a notable absence of comment on such aspects in the Committee's reports of its investigation of engineer formation in other countries.

12. An appropriate starting point in determining the non-engineering content of initial formation programmes is to consider what attributes are needed for effectiveness as "hard" engineers. Clearly, technical knowledge and the application of engineering principles are of great importance but so too are non-engineering aspects. Time spent during initial formation in developing some managerial attributes can produce a more effective engineer, of greater value to employers in both the short-term and the long-term than if the same duration is allocated to "hard" engineering tuition. At present, the highest priority is usually given to the latter. Preferably, however, the management component should be considered as on a par with the engineering content in contributing to effectiveness and an appropriate balance sought between the two<sup>4</sup>. Thus it is advocated that in considering the management content of initial formation programmes and its relationship to the engineering curriculum, a key principle should be the maximising of the effectiveness of engineers engaged in "hard" engineering.

### Similar and Dissimilar Managerial Attributes

13. Some of the basic characteristics of engineers are of considerable value in the practice of management - for example mathematical ability, analytical skill and scientific approach are needed in most kinds of company operations. Management, however, also requires some other attributes which differ from those possessed by or engendered in engineers<sup>5</sup>. These include abilities to cope with uncertainty, handle people and make decisions. A recent survey<sup>6</sup> (Appendix 5) has shown that a number of "hard" engineers recognise the need for managers to possess dissimilar attributes. It would appear that in the U.K. we are not too successful in producing engineers with the appropriate blend of aptitudes. The British system does not give

students sufficient grounding in the synthesis of technical, human and financial considerations nor does it adequately encourage the development of the wider skills and outlook required for engineers within the engineering dimension" (4.39). U.K. employers report that "some engineers do not have the aptitudes or wish to develop their careers into wider managerial jobs" (3.44) and that "few engineers are properly equipped to take on broader managerial responsibilities" (4.39). Apparently however, in Canada most engineers on graduating pursue a managerial career (App.E, 6) and in France the majority of Dip.Ing. engineers develop as technical administrators capable of managing (App.E, 53). These national variations may be due to a number of factors, including differences in cultures, primary and secondary school systems, and industrial climates. Whatever the causes, the effects highlight the critical importance in the U.K. of the initial formation period in safe-guarding if not developing the dissimilar management attributes which may be necessary in the later career of the graduate engineer.

14. One of the major issues to be considered when determining the content and form of an initial formation programme is whether or not dissimilar attributes are temporarily suppressed, atrophied or even in some cases permanently destroyed by the existing U.K. forms of engineering education. We do not have enough "hard" information on this crucial topic. However, there have been anecdotal reports by a number of top managers with engineering backgrounds about having to "undo" some engineering attitudes and approaches to obtain senior management posts. Also, a recent comparison by the author of responses of business studies and engineering under-graduates to an exercise which aimed at developing dissimilar attributes gives tentative support to this view. Because of the importance of the development of dissimilar attributes it would be wise to assume, unless overwhelming evidence is obtained to the contrary, that in this respect much of current practice in engineering education can have a suppressive or damaging effect. It is therefore strongly recommended that in drawing up initial formation programmes particular attention should be paid to the maintenance and where appropriate the development of managerial attributes dissimilar to those required for "hard" engineering.

#### The Management Content of Formation Programmes

15. To meet the twin aims of enhancing effectiveness as engineers and paying due regard to dissimilar attributes, the management content of initial formation programmes should emphasise:

- self-management rather than management of others
- understanding management rather than developing skills for the management of others
- management concepts rather than techniques
- "what is" rather than "what should be"
- the immediate manufacturing company environment rather than society at large
- integration with rather than separation from "hard" engineering tuition
- process and content evaluated personal involvement in group problem-solving rather than detached problem analysis and synthesis with content assessment only.

These ground-emphases have been incorporated with satisfactory results in management studies courses for engineers at both under-graduate and post-graduate levels. Each course embodied a series of exercises based on situations arising in a fictitious engineering company (ADL - see Appendix 6) and covered the following:-

#### Self-Management

Education      - understanding the concept of self-management  
                          - identifying personal resources  
                          - identifying personal objectives

Development   - of personal resources such as

- ability to communicate
- ability to work in a team
- making more effective use of time

## Organisational Management

- Education
- understanding the managerial environment in which engineering activities take place
  - understanding the processes associated with the evolution of products (similar to understanding the engineering dimension).

16. The technology and management streams of the proposed R Eng (Dip) engineers (4.44) would require different treatment so far as management studies are concerned. The developer of new technologies will need both similar and dissimilar management attributes of a rather different kind from those of a leader of manufacturing activities. It is most important that students should have an opportunity to show potential in the two sets of non-technical attributes before selection for the R Eng (Dip) route of engineer formation. There should therefore be a substantial management content of the type outlined above during the diagnostic first year (4.55) or whatever period is regarded as appropriate before division into the R Eng and R Eng (Dip) routes. Some of the content of EA3 (4.64) should therefore be provided from the beginning of the initial formation programme. Similarly, the system of supervision by responsible senior engineers (4.72d) should take into account the management potential of each trainee. Thus, for example, "hard" engineers should supervise "hard" engineering trainees and managing engineers should supervise potential leaders of manufacturing activities. This distinction carries with it certain implications regarding accreditation and registration.

17. Management education, development and training for the continuing formation of engineers is already significant and is likely to become at least as widespread and necessary as updating and extension in "hard" engineering topics. Some of the less obvious causes of intensification of management content of continuing engineer formation are:

- the regular carrying out of engineering manpower audits which identify management as well as engineering aspects
- the management development of "product champions"
- organisation development to create an environment conducive to the contribution of "product champions"
- developing in existing senior managers an awareness and understanding of the engineering dimension
- the development of whole engineering teams
- conversion tuition for engineers transferring from one function to another
- fostering the integration of management and "hard" engineering considerations in the evolution of new products the application of a Management Content Framework for Engineering Posts.

The management content in the continuing formation of engineers should be accorded the same status and receive the same care and attention as the engineering content.

### Management Experience

18. The maintenance or development of dissimilar attributes gives rise to a need to pay particular attention to the staffing of formation programmes and to the teaching/learning methods employed. Management is too often taught as a "hard" subject in which aspects similar to engineering science are stressed. Management teaching within engineering departments of educational institutions is often carried out by "hard" engineers with little or no experience of industry or management who are consequently constrained to present an engineering-like facade to management. A very close look should be taken at this problem. One generally applicable solution may be to form a team of staff who collectively have the desirable range of knowledge, understanding, skills and attitudes. Involvement in public affairs <sup>6</sup> and the Learning Company method previously mentioned (which could, perhaps, with advantage be coupled to the Teaching Company arrangement) can be beneficial to both tutors and students in fostering dissimilar as well as similar attributes. Another powerful method is the evaluated assignment in which management concepts are applied to solve a series of real problems in the mature Student's own work situation. Again this can be of considerable benefit to the tutor as well as to the student in that in supervising and assessing each

assignment a great deal is learnt about actual activities and events occurring in industry. Moreover, the tutor can be kept up to date by a succession of assignments with different students from one year to the next. This and other methods by which staff may maintain contact with industrial reality should be built into continuing formation programmes with a view to applying the beneficial effects to initial formation programmes.

19. The nature of links between industry and education should be closely examined, with particular regard to the quality of management experience. An engineer with management responsibilities will be of greater value in the formation of engineers if he or she has thought about experience in terms of models and concepts of management as it has occurred. Management educators should be able to help considerably in this respect. It is also important to ensure that engineering departments in educational institutions are subject to broadening influences. To this end it should be considered whether or not as a matter of policy the provision of the management content in both initial and continuing formation programmes should be the responsibility of the management department within the institution. In this way the "hard" approach to management may be avoided. Certainly consultation with educational institutions by government or industry should not be confined to engineering departments: management studies units should also be involved.

20. Any Registration and Accreditation arrangements put into effect should include consideration of the management content of each category of post held by engineers. The code of practice to which registered engineers might commit themselves (4.112) could also make provision for management education, development and training in lieu of some updating of technical expertise, provided this is related to an engineering activity.

21. Management education, development and training, with its significant behavioural content and participative learning methods has its threshold for course viability established at a lower intake than for many if not most under-graduate courses. In view of the vital importance to the nation of engineering, the accepted norms for initial formation courses for engineers should be challenged: staffing should be on the basis of what is reasonable to produce effective engineers and potential managers. From the management point of view, the proposed Regional Consortia to enable M Eng intakes of 25 or more to be achieved (4.88) ought not to be necessary on grounds of viability. Links with Regional Management Centres on other grounds could be very advantageous. Similarly, having regard to the crucial importance of management studies for greater effectiveness as engineers and potential managers, any preferential funding should include the management contribution to engineer formation within its scope

#### Sustained Effort

22. Finally, what is needed is a sustained effort by both industry and education in investigating and clarifying the management aspects of engineer formation and engineering activity. Much useful work of this type has remained at a preliminary stage. Every encouragement should be given to bringing such vital effort to full fruition.

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## The Many Meanings of Management

In the process of defining "management" it is easy to become entangled in a semantic jungle. Unlike some entities in certain fields of knowledge and human endeavour - for example in physics - there is no authoritative definition which is universally recognised throughout the world. Any definition of a word such as management is, in effect, a proposition. Moreover it is a proposition which need not be accepted by others, who may prefer their own equally valid meanings. However, although it is open to each individual to use the word management in whatever manner is appropriate to the occasion, it is helpful, for heuristic reasons at the least, to state a conceptual pragmatic definition i.e. one which embodies fundamental concepts and is useful for some purpose. It is also of value to establish a framework which facilitates the determination of the sense in which "management" is used on any particular occasion.

"Management" is accorded a variety of meanings which may be classified as:

- different in kind
- restricted versions of the same kind
- associative or selective versions for purpose of influence or change

Three different kinds of meanings are:-

### 1. Management as a group of people

This is generally the sense in which the media use the word e.g. management as distinct from labour, management in contrast to unions. It implies "the group of people in overall control" or "the top people".

Restricted versions of this group kind of meaning are:

- the users of a particular company dining room
- the people with the word "manager" in their job title

Management in the group sense is often distinguished from Council, Authority, directors, owners.

### 2. Management as a process

In this sense management is regarded as an activity or set of activities, for example: management is the judicious use of means to achieve ends

- management is the act of converting unorganised resources into useful enterprise
- management is the process of organising the use of resources to achieve objectives.

Restricted versions of this process kind are:-

- management is a social process entailing responsibility for the effective and economical planning and regulation of the operations of an enterprise, in fulfilment of a given purpose or task, such responsibility involving:-
  - (a) Judgement and decision in determining plans and the development of data procedures to assist control of performance and progress against plans;
  - (b) the guidance, integration, motivation and supervision of the personnel composing the enterprise, and carrying out its operations.
- management involves getting things done through and with people.

Management in the process sense is often distinguished from administration, supervision, stewardship.

### 3. Management as a subject

Many educationalists attach a subject meaning to management. In this sense management:

- consists of several schools of management theory which give rise to very heterogeneous knowledge
- is a confluence or lake of related theory contributed to by several rivers of knowledge.

A restricted version of the subject kind is:

- management is psychology, law, economics, statistical method.

It is worth noting that a manager can be considered in terms of the first two kinds of meanings of management, i.e. a member of a management group or a person carrying out the process of management. It is, however, difficult to envisage a manager in relation to the third kind i.e. a person is not a manager by virtue of subject knowledge alone.

The word management is sometimes used simply because it has favourable or unfavourable connotations in a particular context and will therefore exert an influence or help an argument. Meanings are also sometimes attached to "management" or its associated "manager," which are in the nature of slogans to bring about change or alter the balance of a situation, for example "vision and responsibility define the manager".

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### Self-Management

If management is regarded as the process of organising the use of resources to achieve objectives, self-management is practised when an individual consciously applies his or her own resources to attain personal objectives. Self-management can be considered in relation to:

- work activities only
- private or domestic activities only
- the whole of life.

### Objectives

Personal objectives can be a mixture of:

- financial, intellectual, social, spiritual, survival, etc., etc.

Some personal objectives may be in harmony with the objectives of the individual's work organisation, others may be in conflict.

As in organisational management, organising the use of resources includes:

- deploying existing resources
- developing existing resources
- acquiring new resources.

### Resources

Examples of an individual's resources are:

- internal, such as knowledge, health, experience, personality, skills, motivation . . . . .
- external, such as money, contacts, reputation, time . . . . .

### Self-Management Development

Some examples of development are:

- clarifying personal objectives
- deciding on priorities in the attainment of personal objectives
- planning for more effective use of time
- improving communication skills, such as in report writing and making an oral-visual presentation
- obtaining and applying new knowledge
- learning and using a new ability such as an additional language.

Synopsis of 1980 SEFI Conference Paper

Starting a Company: The personal experience of two engineers.

by

M.A. Plint and J.G. Weaver

The authors, both engineers, are respectively managing director and production director of an engineering company which they founded 25 years ago in partnership with a professor of engineering, now deceased.

The company, which now has a turnover in the region of £2m per annum and builds laboratory equipment that is exported all over the world, continues to be run by engineers.

The authors reflect on their initial infinite ignorance of business affairs, and on the process by which in the course of time they added the skills of the businessman to those of the engineer.

They recall the inadequacy of their own professional training and suggest ways in which the engineering student could better be prepared to undertake the role of entrepreneur.

They believe that the inculcation of the right attitude of mind to business activity is of greater importance than the imparting of specialised knowledge, and attempt to analyse the qualities and attitudes necessary to the achievement of business success.

Format for Management Content Framework for Engineering Posts

(with some illustrations of what could be entered under each heading)

Type of Post	Relationships to Others	Type of Activity	Non-Technical Requirements		
			Knowledge Understanding	Skills Abilities	Attitudes Approaches
Development Engineer			Elementary Cost/time relationships. ----- Basic managerial style models.	Writing progress reports. ----- Planning use of own time	Co-operative
Group Leader				Control of cost/time relationships ----- Application of basic managerial style models.	Results-orientated
Section Leader					
Liaison Engineer (overseas)	Reporting to Project Manager. ----- Lateral relationship to foreign partner in Consortium. ----- No subordinates	Ensuring compatibility of parts of engineering system	Ethos of foreign country. ----- Contracts	Negotiation. ----- Committee work. ----- Communicate in language of partner	Attention to detail. ----- Persistent.
Project Manager					
Head of Functional Department					
General Manager				Application of advanced managerial style models	Healthy scepticism re management subjects

Extract from 1980 SEFI Conference Paper  
The Management Dimension in Engineering Education

by  
 Harold Beck

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The survey was carried out by means of questionnaires provided at the beginning and end of a 30-hour management studies course which formed part of a comprehensive scheme of study leading to the award of the CNAAs (Council for National Academic Awards) MSc degree in Engineering.

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Only 5 of the 41 full respondents had previously received management tuition so that perceptions of management brought to the courses by the overwhelming majority were probably based on general impressions obtained from the media, their working environments and domestic backgrounds.

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Perceived attributes of engineers and managers Course members were asked to envisage the extremes of an engineering/management continuum, i.e. engineers with no managerial functions and managers without engineering aspects to their jobs, and then to choose (A) the most appropriate general statement, (B) the most important area of understanding and (C) the most important skill for a good engineer and good manager respectively. "Good" was considered as that of which the respondent approved. The choices are shown in abbreviated form in the Table together with the responses at the beginning (B) and end (E) of the courses. It should be noted that there were individual transitions against the trends shown in the Table.

For "good engineers" there was, in all three categories, considerable consistency in the beginning to end responses. Broadly, the courses had no effect on the perceptions engineers had of engineers. It is perhaps surprising that the decision-making skill should be rated so low for engineers, bearing in mind the choices which must be made in engineering design.

The attributes of "good managers" were perceived from the beginning as quite different from those of "good engineers" and this probably reflected what the respondents had observed or would have liked to have seen in their own "bosses." In many cases their managers were themselves engineers. It is interesting to note that 8 respondents chose "coping with uncertainty" before the courses led others to make the same choice. For the areas of understanding, there was initially a roughly equal response for decision-making and human behaviour (individual and group), with a modest shift over the courses towards the former. There was little emphasis on a manager's understanding of general principles obtained by scientific method. Decision-making again featured strongly in the perceived skill requirements of a manager, with communication a fairly close second.

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Table : Attribute Responses of Engineers at Beginning and End of Management Courses

<u>Attribute</u>		<u>Good Engineers</u>		<u>Good Managers</u>	
		<u>Beginning</u>	<u>End</u>	<u>Beginning</u>	<u>End</u>
<b><u>A General</u></b>					
	Born - not made			1	
	Understand subject	22	27	8	2
	Cope with uncertainty	1	2	8	25
	Good with people	2	2	11	4
	Unusually aggressive				
	Well-balanced			7	4
	Very intelligent	2		1	
	Highly creative	13	10	3	4
	Non-existent			2	1
	Other	1			1
<b><u>B Understand</u></b>					
	Scientific principles	31	33	3	2
	Specific cases	1	1		
	Behaviour of individuals			12	10
	Relationships between groups			11	8
	Decision-making	3	1	15	20
	Mathematical relationships	5	6		
	Other (e.g. combined)	1			1
<b><u>C Skill</u></b>					
	Make decisions		1	17	17
	Handle people			6	5
	Apply 'technical' knowledge	33	33		
	Influence 'bosses'				1
	Analyse complex situations	5	4	6	6
	Communicate	3	2	11	10
	Other (e.g. combined)		1	1	2

ADL : A Learning Company

Alpha Displays Limited (ADL) is a fictitious, £2 million turnover batch-production electronics company which manufactures and markets high-quality equipment for industrial, commercial and educational markets.

The company provides a setting for a system of management situations which are all closely modelled on actual events and actions in several similar real enterprises. ADL may therefore be considered as a tenable amalgam of companies. Where appropriate, distortions of reality have been introduced into the situations to provide greater learning opportunities. ADL can thus also be regarded as a specially created learning company.

As in real life, participants build up their knowledge of the organisation and come to understand its ramifications gradually. As the exercise progresses, their roles range from individual external commentators, through membership of the ADL management team, to acting as ADL functional managers. A diversity of learning methods are employed including syndicate tasks, in-tray simulation, CSV evaluation and role-playing.

The response of participants to each situation is generally evaluated on a multi-disciplinary basis, though with versatile tutors this does not necessarily mean that more than one tutor is involved. The systems nature of the exercise also allows for the progressive development of a particular discipline or approach, with reinforcement of learning taking place from one situation to the next. For example group processes are examined in general terms in an early part of the exercise and then later in more depth.

The current ADL exercise comprises 8 Stages and 4 Episodes (See Table). The Stages and Episodes have been used successfully on a variety of undergraduate, postgraduate and post-experience courses with considerable differences in time structure.

Each Stage requires the carrying out of one or more Tasks, the performance of which is evaluated. Associated with most Stages are Input and/or Outcome sessions which are, respectively, to provide general preparation for and to take up issues arising from the Tasks.

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Table : ADL Tasks and Roles

S = Stage  
E = Episode

<u>S/E</u>	<u>Task</u>	<u>Syndicate(s)</u>	<u>Functions of Individuals</u>
S1	Write impression of ADL	None - individual managers external to ADL	Not specified
S2	Write agreed impression of ADL, give financial information and estimate number of employees on basis of industrial statistics	Representing group(s) of managers external to ADL	Not specified
S3	Write report recommending product design and development facilities and procedures for controlling product evolution	Representing consultancy organisation(s) external to ADL	Not specified
S4	Analyse consultants' reports and make recommendations for adoption	Representing ADL managers	Not specified
S5	Prepare for recruitment of R&D Manager	Representing ADL managers	Not specified
S6	Apply for R&D Manager Post. Short list, interview and select R&D Manager	Representing ADL selection panels, with individuals acting as applicants	Managing Director, Personnel Manager and applicants
S7	Make product proposals. Hold first meeting of New Products Committee to assess product proposals.	Representing ADL New Products Committees	Managing Director, R&D, Marketing, Works Managers, Co. Chief Accountant.
S8	Hold emergency meeting of New Products Committee to consider withdrawal of a product	Representing ADL New Products Committees	Not specified
E1	Describe emergence of organisation	Working as study group(s)	Not applicable
E2	Advise on or participate in reorganisation interview	Representing Managing Director and advisers, Production Services Manager and advisers	Managing Director, Production Services Manager and advisers/observer:
E3	Formulate product policy and short list product proposals	Working as study group(s)	Not applicable
E4	Establish preliminary negotiating position for specific manufacturing licence	Representing ADL managers	Not specified