Shortage and Utilisation of Engineering Skills in the Electronics Industry : a Case Study in British Television Manufacturing.

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ABSTRACT.

This research drew on the findings of the Finniston Inquiry on the shortage of engineering skills in the U.K.. It is a critical evaluation of much of the relevant research conducted before and since that inquiry and is a record of an original case study conducted in the British electronics industry.

The plant chosen manufactured Televisions, Video Cassette Recorders and Printed Circuit Boards, and was experiencing a technical skill shortage. The firm had recently undergone internal reorganisation in response to changes in the product market.

The investigation took the form of a questionnaire survey, in depth interviews and non-participant observations. The results showed links between the perceived skill shortage and labour turnover, dissatisfaction among the engineers and poor skill utilisation, poor market performance and inappropriate organisational systems.

This thesis therefore suggests that the perceived engineering skill shortage in the firm studied is symptomatic of a company adapting to a dynamic and volatile product market, and that the problems facing the U.K. engineering industry as a whole are unlikely to be solved by isolated strategies aimed at raising

salaries or status, improving education or increasing investment.

Companies must focus attention on developing Human Resource Management policies which reflect the conditions of the product market, the internal and external labour market and which, by reducing dissatisfaction and turnover, maximise the utilisation of the skills available. This, it is believed will work to the benefit of the company, the industry and the engineering profession in the U.K..

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THE PROBLEM OUTLINED

1. INTRODUCTION

The questions which comprise this thesis sprang from my attempts over the past few years, to come to terms with a variety of problems alleged to be facing the British Electronic and Electrical engineering industries. My concerns developed since first studying the report of the Finniston Inquiry into British Engineering, presented in 1980, and the context in which the recommendations were set.

Through the preceding years, it was widely acknowledged that there was a serious decline in the world competitive position of the British Engineering industry, that there were considerable misgivings among engineers about their status and pay, and, that for a variety of reasons, few engineers were properly prepared for work in industry by the time they had completed their formal qualifications. But little in the Finniston Report, or other literature seemed to have produced satisfactory explanations or solutions.

What can be argued is that both the Finniston Report, and the accumulation of literature both before and since, show a disproportionate concern with two issues; the first issue relates to the professional identity of engineers in industry, and the second, to the numerical shortfall in the supply of engineers from our Polytechnics and Universities. What is equally conspicuous in the debate since Finniston, is the recurrent echo of advice concerning the need for a national strategy to bring about 'the regeneration of U.K. manufacturing industry', and the rejection of such advice by the present Conservative government, who prefer to rely on the opening up of competitive pressures to bring about enterprise renewal. In Finniston's recommendations, the government were urged to " take every possible measure to foster a financial environment more conducive to investment in manufacturing industry, and especially, to direct such investment towards the design, manufacture and sale of products for world markets."(1980: para 2.17) It is still very doubtful how much progress has been made.

The current problems facing British engineering cannot, I believe, be defined simply in terms of skill shortages, professional standards or investment in manufacturing. This seems evident from the continuing deterioration of the situation. What is still necessary in the long run is a systematic national strategy addressing all these issues, and others besides. These problems involve company Personnel and Business policies and practices in addition to changes in the external labour market practices which are the context for such policies. Clearly, questions must be raised concerning the goals of the secondary and higher education system with regard to engineering, the training philosophy of engineering firms and the utilisation and career patterns of the engineers employed by those firms. However, dealing with these questions must lead to a more thorough understanding of the aspirations of engineers, the nature and role of their professionalism, and a fundamental re-evaluation of the assumptions made by politicians, employers, educators and trainers regarding the utilisation and development of engineering talent.

My immediate concern in this chapter, is to present clearly the problem facing British engineering as it is widely perceived, the symptoms as they are described, and some causes and solutions suggested.

Throughout the thesis, with the exception of limited cases, "engineers" are referred to in the masculine. This should be understood to refer to engineers of both sexes, though it must be born in mind that in Britain, and the case studied here, the proportion of female engineers is completely outweighed by the proportion who are male.

The term 'engineer' in this study refers to technically qualified and technically competent staff who are employed under such a title and within an engineering department. Whilst the majority of the engineers studied were university graduates, several occupants of engineering posts had been promoted into them, over time, on the merits of their experience and technical qualifications and were therefore not excluded from the study.

In "Engineers in Britain: A Sociological study of the Engineering Dimension", Glover and Kelly (1987) make a clear distinction between engineers and scientists saying that "engineers make things, scientists study them" (p77). They stress that " the typical work of engineers and the typical work of sectors of employment known as engineering, is concerned with the making and use of concrete objects . . . .and almost all of them bought by users for their utility" (p181). This focus on the tangible product of engineering is particularly relevant in the case studied here, a firm manufacturing electronic consumer goods in a competitive market.

Before looking more closely at the nature of the problem, it is necessary to note one final definition. Where the "electronics industry" is referred to below, the term may be understood as the category described in the Standard Industrial Classification which includes the following activities;

a) Telegraph and telephone apparatus and equipment manufacture. (A.C.T. 3441).

b) Electrical instruments and control systems. (A.C.T. 3442).

c) Components other than active components, mainly for electronic equipment. (A.C.T. 3444).

d) Active components and electronic sub-assemblies. (A.C.T. 3453).

e) Electronic consumer goods and other electronic equipment. (A.C.T. 3454).

The extremely fast technological change in the last decade, in terms of hardware and software, has made electronics a central industry for any advanced scientific economy.

2. WHAT IS THE ACTUAL PROBLEM ?

From the diversity of solutions to the U.K. engineer's `problem' proposed in the media and academic research it is apparent that the problems which exist, are perceived at several levels. At the most concrete level the `problem' is usually defined as a <u>persistent shortage</u> of skilled electronics engineers and technicians in Britain, and indeed much of the industrialised world.

Employers, trainers and educators, and politicians all claim to have become aware of how the issue is manifesting itself, and what the probable consequences will be for industry and the economy if appropriate action is not taken. Some have gone further than identifying the problem, and from their own experience, have conjectured that the solution lies in training, others in reforming the education system, some in raising salaries for engineers, and still others in half a dozen other equally plausible proposals, including raising the relative status of engineers.

All the proposals are substantially reasonable, and many, in one form or another have been applied to the `engineering question' at some time, which raises the question, why do we still have such an issue ? The fact remains that there are an increasing number of companies anxious about their escalating shortage of electronics engineers and technicians, at a time when the industry as a whole is facing very serious international competition.

The situation raises a complexity of issues and, when solutions which have been applied have met with only imperceptible success, the question must be asked ; how thoroughly do we understand this issue of the shortage of professional/technical specialists ?

If there is a 'shortage', what is it understood to mean in economic terms ? If there is an excess of demand over supply, what does this imply about conditions in the internal and external labour markets, and thus, the courses of action firms should pursue ?

Taking the issues one at a time, we must first look at what is meant by a 'shortage'.

3. SHORTAGE BY WHAT CRITERIA ?

There are obvious difficulties inherent in the several attempts made to quantify the shortage. Many assumptions are made in manpower planning and forecasting, concerning the desired quality of the labour, the degree of current under-utilisation and other variables which can reduce the value of the exercise.

There are inevitably variations in the extent to which the shortage is experienced. As Thomas and Deaton (1977:15) point out "there is no reason why each firm should experience the same extent of shortage and some may even have a stock surplus when there is a shortage in the market as a whole but in such circumstances the typical firm will be experiencing a shortage."

What is currently being experienced in the electronics industry appears to be a stock imbalance in the market as a whole, being transmitted to the firms via the flows which the firms experience. It could be argued that to some degree, the firms themselves are responsible for the market shortage, but even if an individual company starts in a position of stock and flow balance it may soon find that the excess demand in the external market will generate higher quits from the company and difficulty in recruiting, which may well ultimately lead to a stock imbalance within the firm. This is not uncommon.

4. THE SIZE OF THE SHORTAGE.

(a) Quantitative

First let us look at the gap between the number of first degree engineers graduating and the numbers demanded by companies.
Limited information is available regarding the supply of new graduates, but in a recent publication by A.S.T.M.S. (Association of Scientific Technical and Managerial Staff) the relative positions of the U.K. West Germany and the U.S.A. were outlined. It was stated that the proportion of engineering graduates in the

U.K. in relation to the level of manufacturing employment was less than half that of West Germany, and similar relationships were reported with regard to technicians and skilled workers. The situation compared to Japan was described as "even worse".

It appears to have long been a problem facing the U.K. In 1975 in the U.S.A. for example, 47,000 engineers graduated, and 21,000 in West Germany in 1978, both figures representing a similar proportion to the level of manufacturing employment in each country. In the U.K., however, by the same proportional relationship, we would have expected to have almost as many engineers graduating as West Germany. However, in the 1970's the U.K. had between 8,000 and 10,000 engineers graduating each year. In absolute terms in 1978, Japan produced over ten times more degree qualified engineers (71,167) than the U.K. (6,897). Japan, by 1980 had 273,102 university educated researchers in industry and a further 153,706 in government; their 112,109 engineers graduating that year, was equivalent to the total number of U.K. graduates from all disciplines.

The evidence that is available suggests a deteriorating position, with the shortages of new graduates increasing at between 4% and 9% per annum, depending on the specialisation and the sector of the industry. In their submission to the Finniston inquiry, the EEA suggested that the weighted average prediction for long term increases was 8 or 9% per annum.

Similarly, little accurate data is available regarding demand. In 1977, a survey conducted by the Electronic Engineering Association covering 176 firms within and outside the engineering industry showed vacancies as a percentage of total employment amongst "electronics technologist engineers" as 11%, amongst electrical/electronic technician engineers as 10%, and drawing office technicians with electrical experience as 15%.

A study conducted in 1983 by the Scottish Economic Planning Department suggested that demand for Electronics engineers, between 1979 and 1983, had risen by 50% , and faster still in the Electronics industry itself. The demand for technicians had risen by 15% for the same period. Clearly the demand is considerably increased by firms outside the engineering industry requiring employees with skills in electronics engineering, computing and software.

In a recent report by the Confederation of British Industry (C.B.I. October 1989), member companies had listed `shortages of skilled labour' as the second most likely factor to limit output during the first six months of 1989, the most likely factor being `orders or sales'.

The Engineering Council estimated in October 1989 that " by the mid-1990s Britain will need another 40,000 chartered engineers and about 200,000 more of those with qualifications as incorporated engineers and engineering technicians." (Sunday Times. October 15th 1989.pE8.) The council believes this will be partly as a result of British engineers being "poached" by firms in other EC countries following the opening of the single market in 1992, and the preceding acceptance of the professional designation, "Eur Ing".

In the same article, however, the Director General of the Engineering Council, Denis Filer, is quoted extolling the qualities of the engineer which make him or her ideal candidates for posts in "top management". It is ironic that the qualities perceived as likely to enhance the standing of the engineer and thus attract others to the profession are the very qualities for which engineers are recruited into management positions thus compounding the engineering skill shortage.

(b) Qualitative Judgements.

In addition to the numerical shortage, an absence of "quality" engineers and technicians is widely reported. Many of the submissions to the Finniston inquiry alleged that engineers were not educated and trained to the standards which companies required. In Competence and Competition (1985) evidence was given that suggested the supply of highly competent and experienced professional engineers in the U.K. appears to be a problem of comparatively greater proportions than the situation in the U.S., West Germany and Japan.

Shortages of new graduates is clearly exacerbated by `wastage' of engineering graduates who leave engineering positions for other jobs, while shortages of experienced engineers is increased by deficits and limitations in the skill formation processes of the main manufacturing companies who train and develop new engineers.

Therefore, while the data about the size of the overall shortage of experienced graduate engineers is limited, it is nonetheless instructive.

Having identified some of the ways in which "the problem" is perceived, it is helpful to consider some of the causes suggested in the literature, and some of the solutions which have been put forward by various bodies.

5. SUGGESTED CAUSES.

Many "causes" have been suggested ,some from a societal perspective, some from an industrial perspective and some more closely related to the individual engineer. These causes have been attributed to pay levels, the image of the engineering industry in society, the status and professional recognition given to engineers, the limitations of the career routes open to engineers and the roles they are expected to fulfil within industry.

Associated with each suggested cause are a range of strategies which have been identified by their exponents as routes to overcoming the shortage being experienced. Many of the strategies have been directly or indirectly adopted, some with greater success than others. For example, since Finniston, several degree courses have been lengthened to include periods of management training; pay levels in certain sectors of the industry have increased considerably and endeavours have been made at many levels to improve the "image" of engineering work in the eyes of society. All these measures amount to attempts to retain the stock of engineers and to reduce `wastage'. However, such longer term strategies could be argued to force the short term problem largely into the hands of the industry, the professional associations and the relevant trade unions.

The solutions suggested originate from assumptions about the causes of certain symptoms, which we will consider below. These include dissatisfaction on the part of the engineers with their roles, status and pay, and, the poor utilisation of engineering talent by firms in the engineering industry.

6. THE DISSATISFACTION OF U.K. ENGINEERS

There is considerable evidence of a high degree of work dissatisfaction among engineers and technicians in Britain, in almost all fields of engineering. High turnover among engineering employees reported by numerous large electronics firms, complaints from engineering associations to Finniston on behalf of their membership regarding status and pay, and the high "wastage" of talent at graduate level to other occupations all illustrate this. What is less clearly understood are the sources of the dissatisfaction.

This is of considerable significance in our understanding of engineering labour turnover. When the role requirements projected in the training situation are distinctly different from those characterising the job situation, the engineer will not "know what behaviour will be considered as evidence of success" (p188 Miner.1969). The consequence is role conflict. The changes produced and expectations raised in the engineer during training are retained, but with a high cost to the individual in terms of stress and confusion. The consequences for the organisation, according to Miner, are likely to include "internal conflict, and, in many cases, the eventual loss of a potentially valuable . ." engineer. (p188)

It is therefore, necessary to identify the expectations and aspirations a student brings to an engineering course, a graduate to his first job, and an engineer to his career.

7. ENGINEERS' ROLES

Through his experiences in secondary and higher education, the engineer formulates a set of expectations of the role he will fulfils upon qualification.

Engineers' expectations and aspirations vary from the purely technical and specialist roles, to roles involving a significant degree of managerial influence. It can be argued that the expectations are predetermined by his perception of the characteristics of the industry he plans to enter. This would logically imply that the engineers' choice of work would be made with a view to minimising the degree of discontentment to be experienced. Let us therefore, focus on the engineer whose presumptions about his role prove, on beginning a career, particularly in manufacturing, to have been hopelessly misplaced.

In their representation to the Finniston Inquiry the Electronic Engineering Association ((no date): para 8.4) described several potential causes of serious discontentment related to role, albeit in defence of the degree of "professional autonomy" appropriate to his ability, within which they considered the individual must be able to operate. These included the following:

a) "the employment of technical people in roles which call for skills, knowledge and expertise which they do not fully possess or which do not exploit those they do possess". This refers to both under-utilisation and mis-utilisation.

b) employment in " very narrow aspects of the total technical discipline in which they have been educated and trained". Again this refers to an under-utilisation of the engineers' potential.

c) absence of training and re-training "necessary to equip them to give of their best in the roles to which they have been assigned ". This was found to be common in this research and in other related studies.

d) Finally, isolation from "the ultimate consequences of their contribution to the product market " because of their employer's failure to involve them in "the broader issues which surround their individual activities." This organisational phenomena, if true, may reduce the competence of the engineers to a narrow technical specialist expertise and may reduce the motivation of engineers to persist with their professional careers.

This 'isolation' was found within the case reported here, and in several others in the literature (Burns and Stalker. 1961), and all four of the above problems are widely reported in the literature.

Having used Shepard's categorisation (1956:298) to describe engineers as "locals", whose interests are predominantly in the workplace, and "cosmopolitans" who are allied primarily to their profession, Ritti (1971:47) suggests that development engineers, for example, often in reality aspire to producing goods which will sell in the market place, rather than pursuing technical excellence. In this situation, dissatisfaction arises out of the gap between their expectations and the tasks available, which is often exacerbated by in-built organisational rigidities of role specialisation. Again, this was found in my own research, and other studies (Burns and Stalker. 1961).

Considerable discontentment has been expressed about the opportunities for managerial involvement and influence. However, such involvement, of itself would be argued by some to represent a mis-utilisation of engineering talent. It could also be suggested that engineers often pursue managerial responsibility, not because they wish to exercise more influence over the implementation of their innovations, but simply because they see it as an opportunity to acquire the status, recognition and, perhaps, the salary they were not afforded whilst working under the label of "engineer."

I would suggest however, that it is naive to advocate solely the pursuit of either technical or managerial careers as a solution to the issue without reference to the context of the employing organisation and society as a whole.

In the following chapter, further attention is given to the socialisation of the engineer, and the values he and society ascribe to aspects of his work-life, which both mould his self-image and predicate certain actions on his part.

8. THE STATUS ISSUE

In the literature on engineering roles, considerable emphasis is placed on engineers' status. Several issues however interact here, for example relative social status with other professions and relative status within the organisation. Some writers advocate engineers pursuing a pure professionalism (see next chapter) while others see a move into management as an inevitable step for engineers who wish to progress.

There appears to be an inconsistency in popular expectations of the commitment of an engineer, compared to that of many other professions. In relation to this professional commitment, Perrucci and Gerstl (1969) quote Theodore Caplow (1954:106) who suggested that the ex-lawyer or ex-physician is likely to be regarded by society rather like an unfrocked priest; someone who has proven unworthy of great professional responsibilities. They point out that, significantly, the engineer turned executive, or sales manager is not so regarded, in fact there is often an implicit expectation that the engineer will "advance to something better".

One of the most recent and extensive pieces of empirical research giving evidence of engineers' dissatisfaction with their status, was completed by the Policy Studies Institute for the Department of Industry in 1980 (Berthoud et al. 1980). This study was based on a sample of 4,371 engineers whose responses were invited on a variety of issues, through a questionnaire. In one question the engineers were asked to state "if they had one complaint to make, or disappointment to express about engineering as a career", what it would be. The table below summarises the results.

Table 1.1

ENGINEERS' COMPLAINTS ABOUT THEIR CAREERS

Type of Complaint	%
Various aspects of status, respect, importance.	44
Pay.	28
Promotion and career structure	10

Source: (Berthoud et al. 1980;6.6.1)

Obviously, the meaning of 'status' here is open to interpretation. However, this does give us some indication of the weight of feeling. The apparent discontentment with pay will be discussed later, but let us first take a closer look at the specific complaints about status.

The following table taken from the same study, provides slightly more insight into the nature of the dissatisfaction.

Table 1.2

SPECIFIC COMPLAINTS BY ENGINEERS ABOUT STATUS

	As a percentage of	
	the whole sample	**those complaining about status.**
	%	%
In comparison with other professions.	12	26
Confusion with lower grade workers in the engineering industry.	9	22
Engineers are not recognised as valuable to industry/society.	9	21
The status of engineers in the U.K. is lower than in other countries.	6	13
The status of engineers is lower than it used to be.	1	3
The engineering function has low status in the company.	1	2
I am conscious of low status in social relationships.	1	1

Source: (Berthoud et al. 1980;6.6.2)

It is necessary if further research is to be of any value, that we understand the focus of the engineers disaffection. It could be inferred from the table that the focus of discontentment was within a societal context, as the highest proportion of those complaining suggested that their status relative to other professions was the greatest source of their dissatisfaction.

This inference might appear to be supported by the proportion claiming that "engineers are not recognised as valuable to industry or society", and that "the status of engineers in the U.K. is lower than in other countries".

In their report, the researchers suggest, however, that the impression they gained from informal conversations with the engineers, was that the focus of their envy of accountants is mainly within a `work' rather than `social' context. The engineers were reported to have complained that accountants tend to exercise control over companies while the engineers, maintaining that they know much more about the essential problems of the business, do not. (1980:6.6.3) So why is there the apparent inconsistency ?

What is being expressed seems to be an aspiration of engineers towards attaining managerial power, rather than a perception of low engineering status per se. If their dissatisfaction concerned only their engineering status, the proportion claiming that the engineering function has low status in the company would be expected to be higher than just 1%. If, as the table implies, the engineering function is not perceived to be of low status in the company, then there would be little ground for concern among the engineers that potentially inappropriate decisions might be made by non-engineering managers.

Management in the U.K. can attract considerable financial rewards and there is evidence to suggest that many engineering graduates either never enter engineering, but follow a career with apparently higher financial and status rewards, or they may take an engineering post with the aspiration of attaining a management post in the organisation.

It seems from this that the engineers envy of accountants and lawyers in Berthoud's study had more to do with blocked career paths than the engineers own lack of organisational status.

It cannot be ignored that a contributory factor to this problem is historically part of the conflict in U.K. society between managing and producing. It is argued that British culture has a tendency to praise the acquisition of knowledge more than the making of three dimensional artefacts. Even the engineering giants of the industrial revolution receive acclamation today not primarily for their technological innovations but for their entrepeneurial flair and business acumen. Glover and Kelly (1987) even explain the current increase in the description of engineers as "technologists" by this argument. Adding the suffix "ology" to the definition of the engineers work, they maintain, implies a formal knowledge, not a three dimensional artefact, thereby in some way making the image more socially acceptable.

One way to begin thinking about the significance of status to the problem of the labour shortage is to understand how and by whom the status is ascribed to the individual. The strength of the interrelations between role, status, pay and utilisation will then become more apparent.

It is evident that defining the problem as a shortage, implies accepting standards of labour quality and cost, which may or may not be appropriate. Many of these norms are established by industry, for example the value of the "skill" may be largely demand determined. Concerning status, therefore, it can be appreciated that the value of work, and thus the status afforded to the worker, can depend upon <u>whose</u> evaluation is being applied; whether the assessment is in social, personal or economic terms, whether the criteria used for measurement are of moral or material nature and what dimension of the work is the focal point of the assessment.

The 'status' problem therefore, cannot be seen out of the context of the complex relationship between the engineer's self-perception, and the evaluation of his position by the firm and by society. This is clearly so if the relative status of engineers in other European countries or Japan, is considered.

For the individual, the extent to which he values one kind of work above another, depends not simply on the values of the society in which he lives and works but on other options available at the time, and on other constraints and obligations.

The status given to the engineer in his actual work role to a degree determines the extent of his identification with his work. Within the organisation there may of course be many levels of engineering roles according to age and experience, and perception of low status <u>may</u> be concentrated among junior engineers. Given that `alienation' (i.e. feelings that the `role' does not provide recognition of the real worth of the individual) is arguably at it's height where the engineer has negligible control over the value of his product or innovation, and is least where he initiates the work effort, organises the work resources, and can identify with the product and the value of the product, then the relationship between role, status and identification with the work becomes more apparent.

Concerning status at the national level, in their submission to Finniston, the Electronic Engineering Association suggest the following. The reasons for "the stark inadequacies in both the quantity and the quality of engineers, available to industry, lie primarily in deep rooted and mostly ill-informed social attitudes towards the engineer and industry, partly arising from national policies detrimental to industrial profitability and employment resulting in too great a divide between education and industry, and secondly in too narrow initial education and training." (No date: 2.1)

Numerous other causes of the engineers' poor status and low regard have been suggested. These include allegations that trade unions inhibit the drive of able engineers, which discourages recruitment " especially of high achievers, and encourages some flight from the profession ". (Engineering Professors' Conference 1978;5.4.1 iii)

It is therefore apparent that 'status', in the case of engineers, is dependent societally on many factors, as it is within the organisation, some of which will be explored more thoroughly in the next chapter. What is equally clear is that the status of the engineer can not be modified without first addressing all of the factors which influence it.

Thus, it is not in dispute that the perceived status of engineering roles, amongst many others, is an important issue, which demands attention if the current labour problems facing firms in the electronics industry in Britain are to be resolved. It is, however, necessary to reassess the primacy of place it has been accorded by several contributors to the debate.

9. THE PAY ISSUE.

> "We firmly believe that the attractiveness of any profession and it's status is closely related to pay and that our industry's recruitment problem and the status problem will not be resolved until engineers are better paid."

Such were the convictions expressed by the Electronic Engineering Association in their submission to the Finniston Inquiry on this issue (No date: 6.4). This sentiment has popular support among many engineering bodies today, and indeed the Engineering Council's own Survey of Professional Engineers, published in 1983, indicated that in their sample of 22,275 chartered engineers and 1,522 technician engineers, only amongst the highest earning 25% were the real incomes any higher than they were in the tax year of 1974 to 1975.

However, in a recent salary survey conducted by the Institution of Mechanical Engineers (1986), in which about 25% of the institution's members participated, it was found that the average salary of £17,000 for Chartered Mechanical Engineers represents an increase of about 28.5% on the figure for 1983. It was found that professional mechanical engineers actually earn less than professional chemical or electrical engineers. Given that some geographic variations were recorded, the second highest average salary was found to be that of engineers involved in electricity generation and distribution (£19,500), with the oil and allied products industry being first (£22,500). Clearly, while there is a case to claim that pay, in some fields is relatively low, with salaries like the above, the cause of the shortage cannot be attributed only to salaries. Table 1.3 presents the incomes of chartered engineers and technician engineers in selected occupational groups in 1983. It should be noted that the data includes experienced engineers.

Table 1.3

INCOMES OF CHARTERED ENGINEERS AND TECHNICIAN ENGINEERS IN SELECTED OCCUPATIONAL GROUPS IN 1983

	% in Field of work		Gross Median Income		Average Age	
	Chartered:	Technician:	Chartered:	Technician:	Chartered:	Technician:
			£	£		
General Management	4.8	12.9	17,000	12,500	47	46
Production	3.4	2.8	11,035	10,617	38	43
Research and Development	10.3	3.3	10,780	9,986	38	39
Software Development	2.0	0.4	10,700	-	34	-
Design	10.6	7.5	10,000	8,949	37	39
Project Engineering	13.0	9.4	12,000	10,000	39	40

Source: The 1983 Survey of Professional Engineers. (Engineering Council ,1983:12)

How would pay adjustment be used in practice to influence the skill shortage? There are a variety of adjustment instruments which the firm has at it's disposal but these are all subject to a variety of constraints. Equally, at national level, a range of both wage and non-wage adjustments are available, although it is the non-wage adjustments which are more often favoured. It would be inconsistent with any counter inflation policy, to encourage radical wage adjustments, which in any case may be ineffective where there is a widespread labour shortage.

Thomas and Deaton (1977:206) argue that there is evidence to suggest that wage adjustments are generally becoming more costly relative to non-wage adjustments. They suggest that there is a growing mismatch between the areas covered by labour markets, and the areas covered by pay adjustments, which they suggest is due largely to two factors; the use of wider pay comparisons, and the growth in the size of firms. "Wider pay comparisons make it difficult to increase the pay of a single group without setting up pressure for similar increases from other groups. The growth in the size of firms tends to extend bargaining units over a wider range of labour market conditions and to create internal labour markets, which increases the range of possible non-wage adjustments by permitting more internal training and mobility."

Thomas and Deaton report several studies (Lester 1954a and 1954b, Rees and Schultz 1970 , Robinson 1968) which would suggest that overt wage changes may play only a relatively minor role in adjusting to a labour shortage, and that the most commonly observed action has involved attempts to expand the sources of labour supply and vary the quality of labour hired.

Three areas can be identified where the instrument of wage adjustment could possibly be applied to the situation; re-establishing differentials within the same organisation between grades, modifying labour flow between firms in the same industry, and, influencing the amount of inter-industry flow, between the external labour market as a whole, and the stock for the engineering industry. In order to evaluate the effectiveness of wage adjustments, it is necessary to look in more detail at each area of application in turn.

First let us consider internal labour market differentials. The re-establishment of salary differentials within the organisation between technicians and professionally recognised engineers is largely to do with status. It is understandable that as a means of seeking to preserve their organisational status, graduate engineers would attempt to re-establish salary differentials between themselves and technicians, which Berthoud's study indicated had diminished somewhat up to 1983. At a practical level, it must be acknowledged that this would be a very expensive adjustment instrument to use. Union opposition to such a sectional pay adjustment could be expected, as union membership is concentrated in the technical grades and additional costs may be incurred through union pressure to re-organise work practices and priorities.

Also, as it is unlikely that such adjustments to internal differentials would have much influence over the quantity of supply in the external labour market, any rationale for attempting to reduce the labour shortage by this means must be viewed with caution.

The second of the possible applications of wage changes has the purpose of modifying the flow between firms in the same industry. Where all other aspects of the employment are equal between firms in the industry, and the engineer is personally committed to remaining within the industry, then salary may be the most significant distinguishing feature. Under such circumstances, price elasticity of demand would be high, and the engineer or technician could be expected to move to another firm offering a higher salary. There is considerable evidence that to some extent, this phenomena may explain the flow patterns observed within the electronics industry. Many firms reporting a shortage problem, allege that the principal 'bait' of the 'poacher' is higher salary. This clearly has little to do with overcoming the shortage globally, simply correcting it at a very local level.

The third application of wage instruments would be aimed at enticing into the industry technicians and engineers who are about to begin their careers, or students who are choosing a course of study.

Cain et al (1973) argued that the key determinant of the success of wage adjustments in achieving influence over the supply of technical labour, is the proportion of individuals without strong occupational preferences, who are on the "margins" between technical and other careers. If the number of 'marginal decision makers' is high, then, they allege, supply will appear to be elastic with respect to wage adjustments. Equally, they maintain that if there are few, then supply will be relatively inelastic to financial incentives.

Salary increases under such circumstances, might to a degree initiate some movement into the industry from among "marginals". If they could enjoy equal 'job satisfaction' in a number of occupations, presumably, with a financial incentive, some might actually move into engineering. However, it must be remembered that "marginals" are not only school-leavers but they arise wherever such decisions are taken at various career stages. If an individual was enticed by financial reward, it could be expected that he would move to another industry, should the wage levels cease to be sufficient to retain him. Clearly this would be more likely to occur with employees with relatively low skill levels and without a well developed occupational commitment, i.e. among the very "marginals" that have just been attracted. This seems to be the case with the flow of new engineering graduates into accounting and financial organisations as starting salaries are more favourable than for engineers in manufacturing firms.

Finally, if price elasticity of demand is low, and the incentive to enter an occupation is the product of a number of factors of relatively greater importance than salary, it would follow that an immense financial inducement would have to be offered in order to influence the choice of individuals in favour of engineering. Such a measure would clearly be very costly, and a relatively in-effective, short-term remedy.

I would suggest, therefore, that there are noticeable weaknesses in the argument for proposing salary increases as a fundamental route to resolving the shortage problem. More attention needs to be given instead to the issues which cause the dissatisfaction at the root of turnover, for which engineers seek compensation through higher pay.

Therefore, whilst the influence of wage levels is not denied, I would suggest that this factor may not be the overwhelmingly significant one, and that a sphere of vital concern is missed if the issues are simply reduced to a discussion of pay rates.

Let us therefore, now return to the impact on the problem made by the existing patterns of utilisation of engineering talent.

10. THE UTILISATION ISSUE.

It has been suggested that much of the frustration experienced by engineers, arises from a difference between professional expectations and the reality of the tasks available. When coupled with organisational rigidities of role definition, this in turn actually prevents adaptation to that reality. (Ritti. 1971)

Ritti (1971) describes the problem as being two-fold; under-utilisation and mis-utilisation. Mis-utilisation he defined as a product of working on tasks beneath one's abilities. He sees this as strongly related to the problem of insufficient technical support. Under-utilisation he illustrated by quoting from his unpublished doctoral thesis an engineer who, expressing his frustration, said that he felt he had forgotten more in the two years he had been with his company than he had learned.

Although many writers appear to acknowledge the problems associated with utilisation of the skills of engineers currently employed, few go further than exhorting firms to avoid such practices. However, I would suggest that this is at the heart of the skill shortage problem, and an area where great progress towards a solution could be made.

The utilisation problem appears to be inextricably linked to the firm's adaptation to the product market situation. So, briefly, what is the product market situation in electronics ? In 1982 the National Economic Development Council conducted a survey (Electronics Economic Development Committee. 1982) which revealed a disturbing picture of the plight of the U.K. electronics industry. They reported that during the latter part of the 1970s the U.K. market for all electronics products was expanding at about 17% per year in current prices. This growth, however, was increasingly being met by imports. A trade surplus in 1975 of about `100 million, had been transformed by 1980 into a trade deficit of over `300 million (1982:1).

Perhaps as a result of the nature of Government research and development spending, which appears not to relate spending directly to commercial priorities indicated by changing markets and technologies, it has been argued that few U.K. firms in the industry seem to base their business strategy on the development of internationally competitive products, designed for world markets, particularly not domestic electronic products.

A situation has developed in which the state, primarily the Ministry of Defence, accounts for over half the U.K. electronics market and funds nearly 60% of the total U.K. electronics research and development.

The increasing penetration by imports into the U.K. market has been accompanied by extensive cuts both in the labour force, and in output, across almost all sectors of the industry.

In a recent Engineering Industry Training Board survey, the decline was described in more detail. The basic electrical equipment sector suffered a rapid fall in output between 1978 and 1981 which was matched by a fall in employment which represented just over 27% of the workforce. Between 1978 and 1983, employment in the electronics sector fell by 16%, although a 35% increase in output was achieved over the same period. Significantly, there was also an increase of 45% in the employment of scientists and technologists over the five years. The telegraph and telephone apparatus and equipment industry suffered an employment reduction of just over 13% and even in the electronic component industry, the labour force decreased over the five years by 24%. In consumer electronics, the total workforce declined during the five year period by over 40%. Output between 1979 and 1981 fell by 17.5%, although it has since improved slightly. During this period, there was even a 13% decrease in the number of technicians employed.(1984:8-15)

The over emphasis on low volume, high value output from key firms in the industry has clear implications for the labour force. Competition is keen in this field also, and firms are competing on the world market for overseas contracts. The international competition is, however, felt most strongly in the consumer electronics area, which is the focus of this thesis. Poor response to market trends has pushed many firms into closure or take-over by overseas companies. Poor utilisation of engineering skills has not enhanced the performance in the market of many organisations.

11. UTILISATION AND TRAINING.

One phenomena related to this market situation, is that companies tend to give far more attention to recruiting and training new graduates than to retraining existing employees. (The Electronic Engineering Association. No date:8.5)

One of the inevitable outcomes of the lack of continuous training and development of the technical labour force by firms in the electronics industry, is obsolescence of their knowledge. Seifert (1964:143-154) pointed out that where the proportion of individuals in an organisation who are suffering from technical obsolescence becomes too high, then the firm itself becomes obsolescent. He saw three clear consequences of such a situation being allowed to develop, all of which have been experienced by certain sectors of the U.K. electronics industry.

a) The firm's products will continue unchanged over long periods of time,

b) other competitors become increasingly successful at eroding the firm's markets, and

c) very few new ideas develop.

12. THE CAREERS ISSUE.

In the literature presented to the Finniston inquiry, a lot of attention was given to the issue of engineers' careers, and the impact their structure had on the skill shortage.

Conditions in which graduates are used in 'technician' posts, and where some engineers move to managerial posts, serve as an obstacle to the development of acceptable career structures for both engineers and technicians.

A very narrow view of career structures appears in the literature where an 'either or' situation is described; technical, or, managerial. Implementing a discrete `technical' career structure, creates certain prerequisites for the engineering staff; an ability to invest their identity in their science and profession, and an ability to be innovative in isolation from the firms global objectives. Consequently, with regard to overcoming turn-over, a dysfunctional career pattern develops where inevitably some engineers will identify more readily with their profession than with their employers.

Equally, if a firm adopts the philosophy that all engineers aspire to something 'better', and that as their professional careers 'level off', they will undoubtedly seek attachment to the managerial hierarchy instead, then the implications for the firm are equally detrimental.

Thus, to focus the debate only on the provision of a dual career path, could seriously restrict our understanding of the problem, by the application of a solution which is actually inappropriate.

Clearly, there are innumerable determinants of an individuals career choice and development, and this issue is considered in greater depth in the next chapter when we look at theoretical studies in this area.

13. A SUMMARY OF THE ENGINEERING ROLE PROBLEM.

The twin problems of the professional identity of engineers and the persistent shortages of technical specialists have coexisted in the U.K. electronics industry since World War II with the clear decline of much of the industry in terms of it's competitive advantage. They do not explain this decline but the issues discussed are symptoms of a deteriorating situation.

Much of the evidence presented in the recent debate has been very insubstantial, and has tended to focus on a very narrow range of issues. None of the issues outlined in this chapter, namely roles, status, pay, utilisation or careers, contain in themselves adequate explanation of the problems facing the electronics industry in the U.K. They are all, at best, half truths. Policies for solving such issues will not in themselves solve the economic problem outlined above. Clearly, increasing pay for example, cannot hope to 'prop up' the labour force in an industry facing relative decline, whose business strategies are inappropriate for the labour and product market situations.

Secondly, there is no evidence that status alone would motivate individuals to join an industry, nor can increasing it stop them leaving.

Thirdly, the redefinition of organisational roles, will likewise have little impact on the problem without the re-evaluation of the organisation's production, marketing and sales objectives. There is however, evidence of some erosion of traditional boundaries between mechanical and electrical engineering, in addition to some erosion of the distinctions between technicians and engineers in some organisations.

Nonetheless, there appears to be a conflict of interests between professional career orientations, especially in research and development, and the alleged need for generalist engineers who could usefully occupy positions in production, marketing and technical development.

We have identified policy implications at the national level, with respect to state investment priorities, and the education system. However, I believe immediate remedial action can more effectively be implemented at the organisational level.

Many commentators have obscured the clarity of the problem with an array of valid, but not explanatory, grievances. However, through fundamentally reconsidering the issues and thus developing alternative solutions, the electronics industry, and engineering in general, I believe can avoid the currently inevitable and escalating skill shortage, and the consequences of continuing relative decline.

In the light of the continuing labour crisis in the electrical and electronic engineering industries in the U.K., my research was designed to analyse current labour policies and practices at an organisational level. This necessitated determining engineers' own career expectations and self perceptions and the organisations' expectations of the engineers.

Through the following chapters, the issues thus outlined here are seen in sharp focus as they are set in the context of a firm in the consumer electronics industry now encountering this problem. The failure of most research to give us an understanding of the nature and broader significance of the problem is seen, and, through 'first hand' experiences of "life in engineering" in Britain, some more appropriate courses of action are proposed.

CHAPTER TWO.

CHAPTER TWO.

FRAMEWORK OF THE STUDY.

1. THE PROBLEMATIC ROLE OF THE ENGINEER.

What is immediately evident to the researcher in this field is that the discussion of engineers' roles has been widespread both in the United States and Europe. Researchers have approached their analysis at several levels. Zaleznik et al. (1970), for example who studied orientations and conflicts in careers of engineers, scientists and managers in the Development Centre of a large firm in the U.S., applied psychoanalytic psychology to this problem. However, they stressed that the problem " can also be approached with other theories and research methods" (1970:p387)

So what are the issues which have occupied other researchers ? Gerstl and Hutton's work, based on a survey of mechanical engineers conducted in 1962 (`Engineers: The Anatomy of a Profession'), concludes that, "broadly speaking, the primary issues are the **status of the profession, engineers education, recruitment, and the utilisation of skill in practice**" (emphasis mine). They go on to say that "These are all interdependent factors and they cannot be dealt with separately." (1966:p160).

However, insufficient attention appears to have been paid to the issue of utilisation and the demand for skills. It could be argued that the engineer in the Western industrial organisation, occupies a position in many ways very different to that of his colleagues in any other profession.

Leaving aside the supply side of the problem, on the grounds that I believe there is a need to address more attention to the factors contributing to the demand, a limited range of issues have dominated the literature. Basically, the argument can be described as follows.

a) Career structures are poor, therefore engineers are not attracted to work in professional roles and therefore either do not join industrial firms as engineers, or leave after early training, and

b) professional status is low, and therefore individuals either do not go into the industry or they leave. It has been suggested that if engineering was recognised as similar to other more prestigious professions, the problems would be solved.

Unfortunately, little notice appears to have been taken of researchers who have suggested that the solution to the engineers problems lies neither in the trappings of the classical professions, nor even in a metamorphosis into an alternative elite, like a technocracy. The engineer, they claim, is in fact a completely different species and effective policies must be developed from an understanding of this.

"The engineer is the hybrid offspring of a union between science and business. Engineering is a scientific profession, but the test of the engineers' work lies not in the laboratory but in the market place." (Edwin Layton. in Perrucci and Gerstl. 1969 p51) This duality of role, identity and objectives is close to the heart of many of the issues grappled with in the literature reviewed below.

2. THE EDUCATION OF ENGINEERS.

Evan (1969) touched upon what in the literature is seen as one of the clear distinctions between engineering and the classical professions, that is, the period and nature of engineers' education. Numerous writers identify the education system as being close to the root of engineering prestige and social status, being the route by which the working classes can move into the professions, and the distinction with other professions which typify engineering as an occupation subordinate to the goals of an employing organisation.

Gerstl and Hutton (1966) suggest in fact that the shortage and recruitment problems in each country is dependent upon prevailing social conditions, the status of the profession and most important, they claim, the system of school education.

Much of the literature focuses on higher education in connection with the status and the skill shortage, and Gerstl and Hutton point out, as have many, that in comparison with continental Europe, Britain's education system for engineering has historically had several defects. It is interesting to note that a recommendation of the Robbins Committee in 1963 (Ministry of Education) that degree courses should be a year longer, was also to be found among the Finniston recommendations some 17 years later.

Gerstl and Hutton refer also to "The Complete Scientist" (1961) which recommended more time for non-scientific subjects in first degree courses, especially in the area of communication, for example English and Foreign Languages.

"It is recognised, however, that this would be possible only in a four year course and is unlikely to be attempted for the next fifteen years, during which pressure on university places in science and technology will continue to be especially strong." They continue," thus the evidence suggests that British University courses should devote more time not only to humanistic studies, but also to technical writing and the broad problem of communication. If this is to be achieved without sacrificing academic standards in engineering subjects, it is clear that University courses in Britain must be extended." (1966.p.63)

As they predicted, nothing changed for at least fifteen years, and seen in the light of this, the recommendations of Finniston in this area, and the changes that have arisen since can hardly be seen as revolutionary.

Many of the submissions to the Finniston Inquiry focused on the teaching of Maths and Physics at Secondary school level, and the importance of attracting girls into engineering courses in higher education. To attract students generally to engineering courses, Finniston recommended that "all students who are accepted onto accredited engineering degree courses should be assured of bursaries of at least £250 a year over and above the mandatory Local Education Authority Awards". Avoidance of early specialisation on degree courses is emphasised, and provision of degree courses for would-be technician engineers suggested, along with a lengthening and a broadening of all engineering degree course syllabii.

Gerstl and Hutton describe the Education system for engineering in several other continental European countries as being strictly two tier, where a clear distinction is drawn between the `professional' and the `technician'. The British system, on the other hand, has for decades been more flexible.

Evan (1969) discusses the situation in France and suggests that the recruitment of engineering graduates from the Ecole Polytechnique and several other Grandes Ecoles to commanding positions in industry and the civil service, is an example of engineers performing a technocratic role (Granick 1962 pp60-72) However, it could be argued that this is not a technocratic role at all, rather, the French society being relatively more meritocratic than Britain or the U.S., engineers are seen as "professionals" irrespective of the discipline they have studied, simply because they have had such an education.

In "Engineering and the Class Structure", (1969. Perrucci and Gerstl eds.) Carolyn Cummings Perrucci suggests that " engineering can be viewed as the prototype of the career open to talent (p.280). It is argued by some authors that the education system therefore, in engineering, opens an opportunity in the U.K. for a professional career to those who otherwise would not enter into a `profession' as such.

3. THE CAREER PROBLEM.

Approaches to the study of career selection and development are varied, and considerable research has been conducted looking at the problem of engineering skill shortages from several of these perspectives. In the next section of this chapter, the close relationship between career development, professional socialisation, and organisational socialisation is shown. What this suggests is, that we need to know more about the influences bearing on individual's career growth if we are to understand the turnover and shortage problem.

However, certain assumptions are inherent in each of the approaches. In "Orientation and Conflict", Zaleznik et al. provide a helpful review of the major approaches to the process of career selection and development which can be subdivided into three main categories of studies,as follows:

" 1) Those focusing on the direct relationship between environment and career patterns;

2) Those focusing on the individual as an active, rational decision-maker;

3) Those focusing on the unconscious intrapsychic determinants of career choice and performance." (1970:p431)

Essentially they suggest career can be seen from either a sociological standpoint or a psychological one.

(a) The Sociological Approach.

Here, it is maintained that occupations are viewed in terms of their status in the social structure, and of " the occupational role expected of a person in a given status." (1976:p431) This approach maintains that the key determinant of an individual's career pattern is the social class into which he or she was born, as measured primarily by the father's occupational status, and an explanation of how individuals are thus prepared for certain occupations, is attempted in the concept of "Socialisation".

A major work in the area of the "social adjustment of the worker" was that of Miller and Form (1951), two sociologists who were among the first to describe careers in terms of `life stages'. They viewed career patterns as a series of social adjustments carried out through the life stages, and which are imposed upon the worker by his culture. The five periods they identified are as follows:

" 1) Preparatory work period characterised by socialisation of the child at home and at school into the work patterns of society;

2) Initial period when the young worker is initiated into the work-world through part-time employment;

3) Trial period beginning with the first full-time job and continuing to a more or less permanent work position;

4) Stable work period, the period of job permanence;

5) Retirement period." (1976:432)

First, it is necessary to determine the meaning of the term `socialisation'. In "Sociology of Occupations and Professions", Pavalko (1974) quotes three definitions of socialisation from Elkin, Child and Merton. It is described by Elkin as;

> " the process by which someone learns the ways of a given society or social group well enough so that he can function within it", (Elkin "The Child and Society" 1960:p4).

This definition carries no reference to the extent to which the individual identifies with the "ways" of the group within which he goes on to "function". However, Child, in a paper in "The Handbook of Social Psychology" describes socialisation as

> "the whole process by which an individual born with behaviour potentialities of enormously wide range is led to develop actual behaviour which is confined within a much narrower range - the range of what is customary and acceptable for him according to the standards of his group". (Lindsey ed. 1954:p655)

Finally, in "The Student Physician", Merton et al define it as;

> "the process by which people selectively acquire the values and attitudes, the interests skills and knowledge- in short the culture- current in the groups to which they are, or seek to become, a member. It refers to the learning of social roles." (1957:p287)

Miller and Form, themselves, review several studies which suggest a relationship between the occupational status of the father and the son (Sorokin,1927. Taussig and Joslyn,1932. Visher,1955. Davidson and Anderson,1938. Centers,1948.) and later cite studies, again by Davidson and Anderson (1938), and themselves (1947), which suggest an individual's occupational level remains static at that where he began.

Perrucci gives evidence that suggests the choice of engineering is a characteristic of male students of relatively lower class origins as measured by the level of fathers education (Werts, 1966; Davis, 1964).

Zaleznik et al. however, suggest that despite the undoubted value of Miller and Form's review of the empirical research in this area, their own findings present "rather crude social variables as causal factors of career patterns." (1970.p433) . They suggest that even Blau's later examination of the interaction of inter-generation flow, lifetime career flow, and economic conditions (1965), "fail to account for the heterogeneity of each classification and individual styles in selecting only particular segments of an occupation."(1976.p433).

They describe the work of Caplow in `Sociology of Work' (1954), which focuses on occupations more than careers but nonetheless clarifies aspects of status and mobility used in Miller and Form's theory. Caplow's description of society portrays career paths as ambiguous and random. Concerning social mobility, Caplow discusses two types; interoccupational and intraoccupational, the latter he suggests is on the increase. He claims that the primary upward mobility routes are establishment in a professional career and working up the promotional ladder in a large organisation. A certain level of formal education is a prerequisite to both mobility paths and he maintains is related to a third type of intergenerational mobility.

Zaleznik et al. infer from Caplow's work that the pressure for higher education has lengthened the period of indecisiveness to the extent that students are discouraged from committing themselves to either advancement route during their education. Most significantly, because professional work is increasingly performed in the context of large organisations, taking an occupation in such an organisation does not, therefore, preclude the possibility of either career route. Such lengthy periods of time prior to commitment to either career path, is a characteristic of the highly trained individual's career, and is recorded, in much of the literature, as typical of the career path of engineers.

(b) The Psychological Approach.

A more psychological approach to career choice and development is taken by Zaleznik et al. in their own work, and they review studies conducted by others on this approach to the issue. Two of the studies they describe are those of Ginzberg (1951) and Super (1953). Looking more from the perspective of the individual, Ginzberg developed a theory of occupational choice which can be summarised in three basic generalisations:

" a) it is a developmental process,

b) the process is largely irreversible, and

c) the process ends in a compromise."

In these generalisations, which Ginzberg drew from his own findings, he suggests, essentially that occupational choice is not a single decision but rather a developmental process, and is not limited to a narrow time span. He suggests that the process is irreversible as successive decisions narrow career alternatives, and finally, that the individual's values capacities and interests may be in conflict, and the individual is forced to compromise among them in his selection of a career.

Super, like Ginzberg, focused on the individual, and the process described as `reality testing', which the individual goes through in his career development. Zaleznik et al. emphasise that the salient difference between the two theories "lies in Ginzberg's focus on occupational choice and Super's emphasis on personal development as the means of understanding career development." (1970.456) Super defined occupational development as "implementing a self-concept and testing this self-concept against reality, through successive stages in an individual's life". Clearly this implies that career success is dependent upon the individuals ability to gather and interpret the relevant information about his environment. It is argued by Dill, Hilton and Reitman (1962) that it must also be explained to some extent, by several personal attributes and qualities found in individuals. The key attributes they see, are reported by Zaleznik et al. as follows;

"

a) sensitivity to the environment,

b) competence in handling a variety of difficult tasks,

c) ability to learn and adapt to change,

d) ability to maintain sufficient detachment from the environment to maintain active control over their own career progress, and ,

e) willingness to take risks." (1970.p459)

Both the psychological approach and the sociological approach contribute to our understanding of career development, and the engineer's experience of it. However, in the research of Zaleznik et al., which I have discussed in more detail below, they develop a subtle distinction in the hypothesis that " the <u>indicators</u> of career function are in the individuals encounter with the organisation while the <u>explanation</u> lies in his personal history." (1970.p38) [The underlining is mine]. Their research is particularly relevant here, as they studied approximately 170 professional scientists and engineers in a large firm's development centre. The centre linked the basic research unit and the firm's product divisions.

In their study, Zaleznik et al used two measures to place subjects into four basic career types. The first measure was the subject's own statement about his values and aspirations (`Self declared') and the second was the Allport-Vernon-Lindzey study of values. The latter measured theoretical and economic values, theoretical, they alleged, being consistent with a technical career declaration, whereas high economic scores were associated with a managerial career choice. The two measures were ascribed values and the career types which emerged in a matrix, were labelled as follows;

a) Oriented specialists (OS)
b) Oriented Managers (OM)
c) Conflicted Specialists (CS)
d) Conflicted Managers. (CM)

The scoring which produced these types was as follows;

a) & b) High score and self declared,
c) Self declared Specialists but high economic score,
d) Self declared Managers but high Specialist score.

The rationale behind their approach was that individuals whose self-declarations and interests are consistent, will utilise their capacities more fully and gain reward and gratification from their work, compared to individuals who are inconsistent in their self-declarations and interest. Clearly there is an assumption here regarding the individuals opportunity to utilise his capacities, and the organisations' capacity to reward him. However, there is considerable evidence to suggest that dissatisfaction arises out of these conflicts between aspirations and the reality of an individual's work, which is the focus of this thesis.

The inconsistency between aspirations and present work and subsequent dissatisfaction highlights the fact that individuals have identity invested in both their employing organisation and their profession. This spread of identity investment is at the heart of the engineers problem as shall be made clearer as we look at "professions".

Considerable research has been conducted into the relative levels of socialisation of engineers and scientists to their profession and to their employing organisations. This dual identity is another characteristic of engineers careers.

4. THE PROFESSIONAL CONCEPT.

Several contributors to the debate since the Finniston inquiry have suggested , as did many contributors to the inquiry , that, engineering as a profession does not in Britain have sufficiently high status to attract students to the profession. It is widely suggested that improving the status of the engineering profession would be the solution to the shortage problem. It is therefore, now necessary to look at the nature of the engineering profession, and to find out where any differences lie between engineering and other professions, and between engineers in Britain and their colleagues in other countries.

So what is meant by "profession" and "professional" in the literature?

In "The Sociology of Occupations and Professions" (1974) Ronald Pavalko suggested that the terms "Profession " and "Professional" refer more often to data about the aspirations and self-concepts of occupational groups than data about the structural and behavioural realities of work (p.17).

As Gerstl and Hutton point out in their study of mechanical engineers,(1966), "critical evaluations have, on the one extreme, suggested that the only agreed characteristic of professions is a eulogistic terminology, or even more strongly that "profession " is not a sociological category (Habenstein, 1963) and, on the other, found that various commonly cited definitions and criteria indicate a commendable unanimity (Goode 1960)." (1966.p.3)

In "The Rise of Professionalism: A Sociological Analysis" (1977), Larson describes three key components of the professional ideology. The first is a work ethic related to craftsmanship and intrinsic value in the work, which is seen as a vocation or "calling". The second concurs the notion of a " universal service" and "protection of the social fabric against the subversive effects of the market". The third she describes as "noblesse oblige", that is an ideological aversion to commercial pursuits, and the belief held here is that "high rank imposes duties as well as conferring rights."

Pavalko (1974), in turn, suggests 8 characteristics amongst others, which place work along a continuum from `occupations' to `professions'. These are as follows.

(a) Theory or intellectual technique.

This refers to a knowledge which is largely theoretical, is often based in scientific research, and is the basis of a claim to "cognitive exclusiveness".

(b) Relevance to basic social values.

Professions claim that their work is designed to maximise the realisation of such values.

(c) The training period.

It is suggested that the greater the amount of training, the closer the work is to the `professional' end of the continuum.

(d) Motivation.

The extent to which work groups emphasise service to the public or a client as their **primary** goal again places them towards the professional end of **the** continuum. The opposite,he suggests, is business where aggressively seeking and retaining customers is important.

He claims that " the contrast between services and self-interest norms is nicely illustrated in the notion that the professional does not work in order to be paid, as much as he is paid in order that he may work".(1974.p21)

(e) Autonomy

This is seen as characteristic of work at the professional end of the continuum, where the norms are seen to be self-control and self-regulation.

(f) Sense of commitment.

Individuals are assumed to have a certain sentiment towards their work eg. a vocation or "calling".

(g) Sense of community.

The extent to which work groups exhibit characteristics of community and shared values; seldom does anyone leave. The community has power over it's members.

(h) Code of ethics.

This refers to a normative system of control which is found more at the professional end of the continuum. (1974.pp18-25)

From such research, it is evident that there are many definitions of "profession", and as William Evan suggested in "The Engineering Profession: A Cross Cultural Analysis" (Perrucci and Gerstl ed.s 1969) "although there is no consensus as to the definition of a profession, there is a growing awareness that professionalism is a multidimensional phenomenon and that occupations differ in their degree of professionalism (See Carr-Saunders 1955 p.280; Greenwood, 1957; Barber, 1963.pp 669-688; Wilensky, 1964.pp137-158;)".

It seems that there are few **pure** professions and that the degree of professionalism depends upon many factors. Consequently the level of professional status accorded to a profession is similarly determined. Larson (1977) reports Freidson's argument that "the status of a profession is relative to that of other occupations and inseparable from their subordination to professional dominance in a structured work setting." (1973.p.37)

5. PROFESSIONAL IDENTITY OF ENGINEERS IN INDUSTRIAL ORGANISATIONS.

Several authors describe heterogeneous development, even within the same profession (Bucher.1962., Smith.1958). According to Zaleznik et al., viewing a profession "as the sum of differential segments has an important impact on understanding career" (1970.p446). They maintain that it enables us to appreciate more fully an individual's commitment to a particular career line. They suggest that this heterogeneity within occupational groups makes available a wide range of career possibilities and thus helps the profession suit the demands of various work structures.

Similarly, Barber (1965) argues that the purity of social standards within a profession, vary from the classical professions like medicine to the `semiprofessions' like business, and that within these professions, the individual is obliged to select a balance between superordinate control from within the organisation, and colleague control from within his profession, in the choice of his career path. He further suggests that often organisations provide mechanisms for coping with this problem for example through differentiated promotion ladders. Wilensky (1964) also concludes that there is a trend towards semiprofessionalisation, where individuals have a mixed dedication to professional standards and organisational goals and policies .

Zaleznik et al. refer to the studies of Becker and Carper (1957, 1956, 1956) which suggest that certain professions have in fact, a higher propensity than others to prepare for a shift from professional to organisational or even individualistic orientations. They also emphasise how well illustrated the problem is by the case of scientists in industry. They refer to the work of Kornhauser (1962) who defines the problem as;

> an "external conflict between scientists' personal contentment at work and their effectiveness in promoting their own viewpoints, and an internal dilemma between an orientation toward professional standards and personal aspirations". (1970.p447)

Kornhauser describes some of the mechanisms by which the organisations in which scientists work, contribute to the modification of their career patterns and their self-concepts. He notes that professional identification may be loose, as he suggests it is with engineers, and further suggests that "the developmental transaction between the scientist and the organisational structure focuses on the following:

1) the scientists' dilemmas as mentioned above and
2) "the organisations' need for an orderly co-ordination

which is simultaneous with the need for technical creativity, production and communication." (1976.p447)

Clearly the working out of this balance in the organisation largely determines the incentives and rewards offered to scientists, which , in turn, greatly affects their career patterns.

In the functionalist model, professions are self-regulating and individuals learn through socialisation to value their professional status highly and be less amenable to outside influences from non-professionals, which might lead them to neglect their professional ethics (Perrucci and Gerstl 1969. p.86). There will inevitably, therefore, be some conflict between professional and organisational values.

William Rothstein in "The Engineer and The Social System" (Perrucci and Gerstl (ed.s) 1969) suggests that engineers do not in fact conform to the functionalist model of professions. They are members of formal organisations, and are subject to organisational rules, probably not devised by engineers. The adherence to organisational rules or the violation of them, will be rewarded by non-engineers or punished by non-engineers respectively. " It must be concluded, therefore, that the greatest part of the engineers work behaviour must conform to rules and norms and values not under the control of the engineering profession" (1969. p.87)

In "Orientation and Conflict in Career", Zaleznik et al. look at modes of adaptation employed by professionals in order to progress in their employing organisations. They present a model of how the individual evaluates his environment and behaves according to the indicators he receives concerning behaviour which will be rewarded and which punished. In their model, they refer to "role-tasks", "role-issues", and "role-conceptions".

The first refers to the link between an individuals assessment of his personality and his assessment of the requirements of his position in the organisation. In their own words, the individual seeks to "synthesise the organisational requirements of his position with his own individual needs, interests and aspirations". (1970.p.14)

Role-issues they describe as related to the structure and purpose of the organisation; the system of values which determine what behaviours will be rewarded and which punished.

They describe role-conception as "a guide constructed by the individual to orient his action in the organisation." (1970,p.16). The outcome of the interaction of these three, they describe as "Staging",- the way in which the individual actually does what he has thought necessary as a result of his role-conception.

As we have seen above, to an extent, career success depends on the effectiveness of the individual's assessment of his environment and consequent behaviour. We have also seen that there are many orientations within the same profession, and many researchers have attempted to identify where engineers' primary allegiances lie. Gerstl and Hutton (1966) identified from their findings many sources of motivation which focused on craftsmanship. They were told by their sample that " seeing a job completed and working" was important, as was "solving problems", "producing original ideas" and " accuracy and quality". However, for others, they found their allegiance and commitment was primarily to the organisation and human relations. They concluded by saying that " for all categories of respondents in industry, whatever their background, attainment, or type of work, the vast majority found the job of engineering itself to be their major reward".

From the evidence presented in the literature, the heterogeneity of the engineering profession, of engineers' aspirations, and organisational reward structures are obvious. It is clear that a major problem experienced by engineers is role-conflict and the dissatisfaction associated with it. This conflict is manifested in the individual but arises, I would suggest, from an organisation's inability to match the potential of their engineers to the requirements of the firm.

Turning to the actual experiences of engineers in their employing organisations, however, we read from Gerstl and Hutton (1966) that "the evidence suggests, then, that demands of organisations do not appear to be in harmony with the orientations of their professional employees, and that there is a need to create possible lines of promotion along professional rather than managerial hierarchies. (See Kornhauser 1962. p143 ff; Gerstl and Hutton, 1966. p123)

Larson further emphasises the distinction between the professional employed in the organisation and outside when she suggests that what organisational based professionals exchange for income, " on specific labour markets, is their labour power and the skills inherent in their persons." She goes on to point out that " the products of their activity, however, remain within the purchasing organisation, where they are used directly by employers or by clients of the organisation". (1977.p.215)

She suggests that where occupations are encapsulated within or dependent upon large heterogeneous organisations, the ideological appeal of the professional model may represent an attempt to establish a last-ditch defence against subordination.

6. CAUSES OF ROLE CONFLICT FOR ENGINEERS.

Many researchers have written regarding the "professional" versus "organisational" conflict for engineers. Lansbury (1978) refers to the work of Merton (1957) and of Gouldner (1957, 1958) on "Cosmopolitans and Locals", the identification of the individual with his profession or his employing organisation, and he goes on to point out that Drucker (1952) saw the integration of the professional into the business organisation as potentially one of the greatest problems of the age. Drucker outlined six major friction points between the professional and his employing organisation. These are helpful in our understanding of the behaviour of the engineer although his work was with staff specialists, e.g. lawyers and accountants. They are as follows;

1) work assignment,
2) administration,
3) career progression,
4) status within the organisation,
5) participation in policy formulation, and
6) participation in professional activities.

Blau and Scott (1969) also note a number of points of divergence between bureaucratic discipline and professional expertise. These relate first to the organising principles, the professional being bound to the interests of the client, the bureaucrat to his employing organisation. Secondly, they relate to the source of authority, the professional's being rooted in his technical expertise, the bureaucrat's in his status within the organisation. The third difference relates to the means by which decisions are sanctioned. For the professional it is the ruling of his professional society, for the bureaucrat a directive from his employing organisation. Finally Blau and Scott consider the resolution of disputes, where again the final court of appeal for the professional is his professional body, yet for the bureaucrat it is his employing organisation.

Strauss (1963) sees it not as mutually exclusive, but suggests that professionals vary in the extent to which they are compatible with bureaucracies. We can see also from the literature that individuals in the same situation have for personal reasons varying degrees of organisational or professional commitment and identity.

Likewise, Evan (1969) sees that it is not quite so clear as an either/or situation but rather that "the type of function he performs as an engineer, affects his role conception as well as the length of his career in engineering." (1969, p.119). For example, if he works in production he performs a personnel function too, working with technicians, and managers, whereas in R&D his work is bounded by task demands.

Evan argues that due to removal of accountability in a social sense (due to his employment by a company) the engineer needs no social code of ethics. This is not an argument which would hold in the case of engineers in West Germany for example where social accountability is perceived as being of notable significance to the engineer. However his accountability is clear economically. Evan also suggests that industrialisation has led to the proliferation of engineering associations and that they are more concerned with continuing education, and educational standards than economic factors.

A second shortcoming of the model, which Rothstein notes, is that it fails to "deal with the content and nature of the body of knowledge used in engineering". Concerning engineers organisational roles, he suggests " it is necessary to realise that there are no "engineers" as such, "there are only engineers working in specific occupational positions in specific organisations- for example, an assistant projects engineer in a large plant of an electronics firm." (1969.p.96). He suggests that the professional role only exists within the context of the broader occupational role. "To understand the behaviour of an engineer, we must understand all aspects of his occupational role and their interrelationships" (1969, p.96).

From this discussion, it is evident that the engineering career does not conform simply to a classic professional model, nor is the engineer only an organisation member, but that his career, and functioning within his profession and his organisation depend upon close interrelationships between that organisation and it's structure and values, his own values and aspirations, and the extent to which he identifies with his profession. More will be discussed later concerning the profession of engineering and it's differences from other professions, but it is necessary to look further at some of the research on conflicts which stem from conflict of norms between professional and organisational identity.

7. CONFLICTS OF ORIENTATION.

Buchard (1954) described the conflict experienced by military Chaplains, who could not decide whether to identify themselves as ministers or officers, and McCormick (1956) similarly reported the dilemma of pharmacists with a conflicting image of themselves as either retail businessmen, or laboratory technical men. Raylesberg (1949) also found that among engineering students, there were some who viewed engineering as scientific, and some as a materialistic occupation.

Zaleznik et al. looked at adaptation between the professional employee and the organisation, and uses psychoanalytic theory to explain the adaptation. This was facilitated through the identification of Role Tasks, Role Issues, Role Conception and Staging, which have been discussed above.

Their data revealed conflict of interests, and differing expectations of rewards between groups in their sample as can be seen in the tables below.

Table 2.1

Type of orientation.	TASKS ARE SEEN AS IMPORTANT; IN MAKING A "CONTRIBUTION TO KNOWLEDGE"	FOR EARNING A GREAT DEAL OF MONEY.
	Percentage believing this to be true.	
	%	%
Oriented Specialists	51	14
Oriented Managers	11	42
Conflicted Specialists	32	47
Conflicted Managers	21	24

Source: Zaleznik et al. (1970.p.53)

From this we can see that the "conflicted specialists" were fairly pragmatic about the importance of money. "Conflicted Specialists" were more likely to see their work of little contribution to knowledge and of little value to the firm's overall goals.

Regarding organisational rewards, they found that the "conflicted specialists" seemed reluctant to expect too much from rewards they preferred. Concerning subordinancy, "oriented specialists" showed a preference for independence, i.e. " a preference for controls operating primarily from within rather than without" (1970.p101). "Conflicted specialists" on the other hand tended to withdraw in their relationship to superiors and to abdicate control.

Both "oriented" and "conflicted managers" however, tended to feel a stronger sense of belonging to the company, and their work group. "Oriented" and "conflicted specialists", however, were similar in their detachment from others. They declared no strong sense of belonging to the company, or to their work group.

In Gerstl and Hutton's study of mechanical engineers (1966) they suggested that commitment to the organisation increased with age, perhaps as the possibility of an alternative career becomes more remote.

However, their measure of commitment found those in operations highest at 82%, management 78%, and only 74% in R&D. Kornhauser (1962.p128-130) suggests that despite length of service, some engineers move in mid-career because of technical obsolescence and the accompanying flattening in salary.

As we saw in the lists of features which characterise organisational socialisation of engineers, presented by Zaleznik et al., research centres are often recruitment centres for potential executives. Training often exists for engineers to become managers, and upward mobility through the organisation is not a reward immediately available for the employee working as an engineer or scientist per se.

The engineer must face, it would appear, one of two career types, managerial or engineering. He must also determine where he will invest the greater part of his identity, in his profession or his employing organisation.

8. ENGINEERS' ROLES, CAPITALISM AND THE GROWTH OF INDUSTRIALISATION.

Larson (1977) maintains that ". . . insofar as most professionals sell their labor power to an employer, they represent but a special case within the general pattern of labor organisation in capitalist societies". She continues, "professional aspirants pass into their profession through the education system so where this model exists, the education system is the principal legitimator of social inequality in advanced industrial capitalism". She suggests "this intimate connection disguises the stark characteristics of wage labor by covering it with all the structural and ideological advantages derived from status stratification and from the specific ideology of professionalism" (1977 pp210-211)

In her conclusion, Carolyn Cummings Perrucci (1969) suggests there is a trend away from professional aspirations and the traditional social status structure, and there is an accompanying trend towards " a truly organisational society, where the earlier tensions between ascriptive and achievement factors are being replaced by academic credentials and organisational membership as important criteria for success." (1969.p.308)

There are clearly several differences between engineers employed in industry and many other professions, which relate to the fact that the engineer is primarily employed under a contract in which his skills and labour are bought by an organisation, not for their intrinsic value, but in order that with them, that organisation may make a commercially viable product for the sake of profit.

Gerstl and Hutton (1966) suggest that a great difference between engineering and many other professions is that basic creativity is directed towards economic wealth for an organisation or nation. They suggest that doctors and lawyers are expected to have some kind of higher altruistic goal such as `health' or `justice'. However, engineers are not the only `professionals' whose activities are directed towards commercial ends. It could be argued that health care professionals in private practice strive towards financial as well as more altruistic goals. As Larson points out (1977) the key difference is that engineers are subordinated to the `market'. Their service is to the buyers of labour more than to clients, the buyers of services. Larson further suggests that " the essential features of these professions' products"' i.e. medicine and law," is that it tends to be immediately used or consumed (as advice or ministration) by the client or consumer. This means that the realisation of use-value (it's consumption) is immediate- that is, independent of capitalist relations of production". (1977.p.213)

She maintains, therefore, that engineers emerged typically " as salaried employees of either capitalist firms or public corporations in charge of building the infrastructure for economic growth". (1977.p214)

A similar theme emerges in Evan's paper (1969.p125) where he claims that very few professional associations in engineering have codes of ethics which cover anything other than the engineer's relationship with his employer and his fellow engineers, in other words, not his relationship to the public or society as a whole. He suggests that this is true for the majority of engineers, and that the reason is that they typically work in production, or development or research, where the norms governing their conduct are neither service as would be typical of the professional-client relationship, nor autonomy, which is typical of the scientist-employer, or scientist-patron relationship, but rather, obedience, typical of the employee in an employer-employee relationship (Evan 1962. p.352). He further argues, that since management decide whether to produce or not to produce a particular engineering product or service, the salaried engineer 'probably feels he has no occasion for ethical decision making concerning possible adverse effects of a technological innovation.

Larson (1977) suggests that this `model' of the engineering profession was also followed by many more of the modern professions, clearly distinguishing them from the traditional ones like medicine. She draws the point further, by arguing that " the subordination of a professional market minimises the effects of cognitive exclusiveness" (1977.P.30). In other words, "where everyone can claim to be an expert, there is no expertise" (1977. p31). Larson carefully argues that the engineers client is more knowledgeable than the `lay' client of the doctor or dentist for example.

Perhaps the software engineer's expertise is redressing the balance somewhat and is seen as having a legitimate claim to `cognitive exclusiveness'. The growing development and use of software skills has presented a recent exception to the norm for engineering, and illustrated the difference with other professions by moving the engineers closer to a monopoly of technical knowledge. The client of the software designer or engineer employs him because the client himself has no knowledge of the field. Thus the engineer's claim to higher status and pay is reinforced by his "cognitive exclusiveness".

Rothstein (1969) maintains that it is largely due to the heterogeneity of engineering, and the development of specialisations, that engineers associate themselves with other engineers in the same specialisation, and dissasociate themselves from those who are not. He argues that this is a key reason for the multiplication of engineering associations as the body of knowledge has expanded. This he sees as related to the "poor cohesiveness" of the engineering profession and the subsequent fragmentation which is partly to blame for low social status.

His argument is questionable as clearly, many examples of diversification and specialisation are available, most notably in medicine and nursing, one of which enjoys higher status than the other despite countless specialisations.

Again, other writers see this as symptomatic of `marginal professions', amongst which Pavalko (1974) sees engineering and pharnacy. As the engineer is in conflict between his profession and the organisation to whose goals he is subordinated, so the pharnacist, he claims is in conflict between social values and business orientation.

Larson (1977) makes a comparative evaluation of the professions of engineering and of medicine. The achievements of an engineer can be tested and standards passed on the goods. This is not quite the same in the case of medicine, where standards govern more the individuals behaviour. To a certain extent, a similar situation obtains with accountants who have to prepare accounts according to legal requirements, and pharmacists who have to dispense according to tight statutory control.

For the engineer, she suggests that this means that he can not control his professional market because essentially his market is subordinated. Consequently, expansion in industry does not give engineers a monopoly or controls, only stronger bargaining power.

Again, making a comparison with the pharmacist, in the U.K. they can claim cognitive exclusiveness and their behaviour is controlled both by law and the sanctions which can be imposed by their profession. However, there are situations in which the pharmacist is still of relatively low status, like the engineer. When the pharmacist is employed in a hospital, he or she is subordinated to the goals of the doctors, their work is defined by the prescriptions they are given and their exercise of ethical judgement is denied as the role is reduced to little more than a dispenser. Accompanying this is low pay and low prestige within the hospital structure. The client is expert (the doctor), and the consumer of his services is not the patient but the doctor. Thus, many of the features which have been described above as characteristic of the position of the engineer obtain here also.

However, in private practice, many of these are reversed, as are the accompanying benefits. As patients increasingly turn to their pharmacist rather than their G.P. for medical guidance, more often the client is inexpert, the pharmacist has a monopoly of competence, and the client is the ultimate consumer.

It might be expected, however, that the pharmacist, like the engineer, would be subordinated to the profit making goals of the organisation for which he works. The contrast , however, lies in the fact that the pharmacist is also the manager, so is not subordinated, and his too are the profit making goals. It is interesting to note that even in an organisation which has for many years had an effective monopoly of national retail pharmacies in the U.K., the individual branch pharmacist is not in a subordinate position to the goals of non-pharmacist managers, as appears to be the experience of many engineers, who are employed on projects, and under conditions devised by non-engineers. All the key managerial functions are occupied by pharmacists, and the seniority ladder in all aspects of management throughout the organisation to board level is through pharmacy.

This comparison to pharmacy is helpful simply in illustrating that beyond professionalisation and cognitive exclusiveness is the importance of the organisational structure in which the individual's labour is sold, and the market position of the firm.

Many authors see the problem of the roles and status of engineers, as rooted in the experience of industrialisation in each country. While in the U.K. and the U.S. apprenticeships were the main plank of the structure of engineering development, in Germany and France the industry arose from colleges, such as the military academies in France.

Lansbury (1978), identifies the growth of organisational professions e.g. accountancy and engineering with economic concentration in the developed world, particularly over the last 30 years.

Evan (1969) goes further in relating the status and prestige of engineering to a model of industrial growth measured by G.N.P. per capita. He suggests that the "higher ranking of a country in G.N.P. per capita, the more likely it is to rank higher on the size of it's engineering profession and the number of patents issued, and on the percentage of G.N.P. expended for research and development" (P.104). As industrialisation increases, he argues, so does differentiation in engineering and specialisation (Carr-Saunders and Wilson 1933. pp 155-164).

He argues from his research, that as the division of labour becomes more specialised, in more industrialised societies, the proportion of professions in the labour force increases, and the competition for rewards, monetary or otherwise, increases. He argues that there is an inverse relationship between industrialisation measured in G.N.P. per capita and engineering prestige ranking, which he sees related to the heterogeneity which arises with industrialisation.

This appears to be at the least not the whole answer, for as we have seen, there are both very heterogeneous and specialised professions, which still enjoy of high status e.g. medicine, and countries which are highly industrialised where the prestige of engineering is greater than in those relatively less industrialised, e.g. Sweden and West Germany.

Larson also quotes an eminent Columbian professor who candidly defined engineering as the "science of making money for capital" (Calvert 1967). Thus engineers have been and still are subordinated to the commercial goals of their employers, which minimises the effects of cognitive exclusiveness (Larson 1977 p30), and, has made the engineers' professionalisation project into "an obsessive concern for social status" (Layton 1971). Larson suggests that it was marked "by specific ideological attempts which exalted the expertise of this dependent professional and made it the base of a grandiose social role" (1977.p30).

Layton, (1969) suggests that the issue is for the engineer, whether to accept the junior position implied by his niche in the business hierarchy, or to escape that position "by assuming an independent political role".

With role, status, and prestige distinctions in organisations where engineers feel subordinated there will obviously emerge various coping strategies some of which are described by Pettigrew (1973). Lansbury (1978) describes the part of Pettigrew's work where he outlines the approach taken in a mail order firm by computer programmers to systems analysts who were a newly emergent group with superior technological expertise and who were enlarging their sphere of influence.

The programmers reacted in four ways;

1) They denied the analysts competence in the field of computer technology.

2) They generated "fictions" about the special qualities necessary to do programming.

3) They withheld information from the analysts to prevent them from becoming more independent.

4) They resisted any attempts to set up in a joint training and recruitment scheme which would further erode the differences between the groups.

Pettigrew observed that the analysts emerged as the dominant specialism while the prestige of the programmers decreased. i.e. changes in the technological environment and shifts in the balance of power and authority relationships go together in interactive relationships.

9. THE PERCEIVED MIS-UTILISATION OF ENGINEERING SKILLS.

Some writers try to deal directly with the utilisation issue. From the evidence so far, this seems crucial to the engineers perception of his role, his career, and for the benefit of the firm. However, Gerstl and Hutton (1966) point out " it is surprising ... how little serious research has been done on the important question of training and utilising engineers". (p.9) This situation appears to have changed very little since 1966.

From their own findings they commented however, that "under-utilisation of professional skills is apparently felt less keenly among engineers than other studies reported (Kornhauser 1962. p140) even though when specifically asked, over half of the sample agree that aspects of their work should be handled by someone with less training." (1966.p121).

This under- or mis-utilisation, clearly can lead to alienation from work roles. Wallman (1979) suggests that degrees of alienation are greatest "where the worker has negligible control over the value and disposition of his product, least where he initiates the work effort, arranges time, place, person,- all the elements of the work process, and can identify with the product and the values of the product." (1979 p.17). Such alienation would appear, from these arguments, to be almost inevitable for the engineer in many modern industrial organisations.

10. THE TECHNICAL OBSOLESCENCE ISSUE.

Compared to `utilisation', `obsolescence' is discussed more widely in the literature. Perrucci and Rothman (1969 Perrucci and Gerstl eds.) discuss in detail the nature of and issues surrounding obsolescence of the engineers skills. Various authors define obsolescence according to how they perceive it's cause. For instance, Malmros (1963) defines it as the "loss of once-held knowledge and the failure to become familiar and knowledgeable about new knowledge in one's field." (1969.p.254) The individual engineer who is obsolescent, he argues, is of limited effectiveness because he uses out of date problem solving methodologies, although Malmros doesn't relate this primarily to the employing organisation, as does Ferdinand (1966) for example.

Perrucci and Rothman in their argument refer to Boehm (1963) and suggest that the problem of obsolescence will be greatest for engineers who have been promoted into management. This, they suggest in turn causes the manager to become `out of touch' with what his young subordinate engineers are talking about.

However, some authors claim that the ageing process is the very cause of obsolescence, that by 45-50 an engineer has become obsolete and must therefore move into management (Gerstl and Hutton 1966). Evan (1969) argues that this termination of the engineering career and the move into management is brought about by rapid technological change and is almost inevitable. Evan (1963) also suggested that career shifts to applied research, administrative posts and teaching were adaptations to obsolescence, and means by which the individual copes with the fact.

Perrucci and Rothman discuss the view that obsolescence " may be traced to the nature of one's educational experience; the particular setting in which professional practice is carried out; and the individual's motivation to pursue his career in a manner that focuses close attention upon keeping up-to -date in one's field." (1969 .p254)

They further quote Evan who suggests that sheer volume of knowledge is responsible for obsolescence in technical and scientific professions.

There would appear to be major flaws in many of these suggested causes when the experience, training, body of knowledge and changing technology of engineers is compared with that of the doctor and surgeon, many of whom practice as surgeons with ever changing methods up to retirement age. However, their skills too are known to become out of date, and entrance to the profession is strictly guarded.

It is however, helpful to consider the five hypotheses Perrucci and Rothman present.

The first holds that obsolescence of knowledge is directly associated with the length of work experience. They suggest that it is not only associated with the length of time out of college, but where that time has been spent. Equally, they suggest that the degree of obsolescence will in turn reflect the nature of the individual's education.

The second hypothesis holds that obsolescence of knowledge is indirectly associated with the extent of education. The argument here is that the engineer with the higher degree will have both more exposure to various academic areas, and will have a self-educating ethic which will necessitate him continually up-dating his knowledge.

The third claims that obsolescence is **indirectly associated with the extent of exposure to colleagues.** In other words, the greater the exposure to new ideas, the less will be the obsolescence, and also as the engineer in turn helps less experienced colleagues.

The fourth suggests that it is **indirectly associated with the engineer's level of technical responsibility** and finally the fifth, that obsolescence is **directly associated with the level of supervisory responsibility**. In this hypothesis it is assumed that if the engineer is in a supervisory position, it is because he has chosen to leave his technical career and follow a supervisory one.

In their summary of the five arguments, they claimed that three were supported by their data. They suggested that the attainment of higher degrees does have a dual function of imparting knowledge and increasing motivation for maintaining knowledge. Further, they suggest that positions of high technical responsibility appear perhaps to selectively recruit engineers with superior knowledge and, in addition, reinforce the engineer's knowledge through the activity of his position.

Finally they suggest that time itself also naturally affects the character of an engineer's scientific and technical knowledge, and they felt that there was therefore a need to determine whether further degrees or greater technical responsibilities were sufficient in themselves to offset obsolescence due solely to the passage of time.

They conclude that "process variables" (as compared with static variables like contact with colleagues), such as the type of response to new problems, regarding obsolescence, suggest that further understanding of this problem means that it will be necessary to make longitudinal studies of the stages in careers of professionals and the choices of action at each stage.

11. THE UNIONISATION OF ENGINEERS.

Not surprisingly many writers focus on the compatibility of professionalism and trade unionism and their conclusions vary. Some claim that the two are mutually exclusive, others that they are essentially complimentary.

In "Engineering Unionism" Joel Seidman (Perrucci and Gerstl eds.1969 p235) suggests that "the basic problem of engineering unionism is that of reconciling the professionalism of it's members, with the ideology and practices of a labour organisation."

He further alleges that engineers' unions lack economic power, and secure membership by services provided, not by great wealth of strength. Writing in the 1960s he concluded that there was no reason to expect any significant growth in union membership over the coming few years.

However, this was rapidly refuted by events in U.K. labour relations. Manual union membership increased in density between 1968 and 1978 from 49.8% to 62%. Over the same period there was a similar increase in white collar unionism, which includes scientists, technologists and technicians. The most striking statistic is the change in the ratio of white collar union density to manual union density over this period. This steadily increased from 65.5% in 1968 to 70.8% in 1978. Furthermore, in manufacturing in 1968 the manual union density was reported as 62% while white collar union density was around 15.4% . By 1979 this had risen to 80.3% for manual and 43.7% for white collar unionism (Price and Bain,1983; tables 4 & 5). However, despite these increases, union membership was far from universal amongst technical and engineering grades.

Lansbury (1978) discusses the issue and refers to Kleingartner (1967) who notes views varying from "complete incompatibility" to those who claim that salaried professionals cannot become truly professional without the protection of a union. It could be argued that in the successful and prestigious professions such as medicine and law, the BMA and the Law Society fulfil many functions of a trade union including maintaining an effective closed shop.

Lansbury's own study, in fact showed that " a considerable proportion of specialisations see dual membership of professional bodies and trade unions as fundamental to the maintenance of their status and the enhancement of their power " (1978.p152)

Despite this apparently optimistic outlook for the dual role of professional organisations and trade unions, there is still evidence that suggests professional engineers are fundamentally reluctant to become involved in a trade union. Larson quotes Dahrendorf in "The Service Class" who maintains that "unions are, in fact, an instrument of power of the working class, and as such are symbolic of a loss of general social status; for analogous reasons, even when there are unions, professionals are more reluctant than other workers to engage in militant tactics." Dahrendorf continues, by referring to what he calls the "Diensklassa" or the "Service Class". "The members of the service class, however, are in Crozier's words, a "Classe sans conscience". Instead of feeling cohesive , they all stand in a relation of individual competition to each other. Of course" he adds, "not every bureaucrat competes with every other one... But for the bureaucrat, advancing his status is essentially an individual achievement. (Ralf Dahrendorf. "The Service Class, in

Industrial man. Tom Burns ed. Baltimore: Penguin 1969 p.146).

However, it is worthy of note that despite the present governments trade union legislation, and the evidence of declining membership among some manual unions, there is evidence to suggest that white collar unionism is still slowly on the increase.

12. CONCLUSIONS.

In view of this, the trends over the last ten years in Britain, and the situation described by Dahrendorf, Larson could be right, that individuals compete more intra-organisationally and merit is awarded according to the goals of the capitalist enterprise.(c/f the City and the East End barrow-boy risk takers)

Gerstl and Hutton in their study of mechanical engineers appeared defeated by what they saw as a vicious circle, and the problem of knowing where to break into it. Their practical suggestions included setting up one body to govern the various engineering institutions and embrace all their concerns, from examination standards to pensions and salaries, and to integrate practical and academic training, vacation work and industrial release.

In their concluding paragraph they suggest that "modern society is largely dependent upon the engineering industry for the provision of the services and consumer and capital goods that have become essential to the twentieth century way of life. The pressures of automation are already being exerted; old methods of engineering practice and education must give way to new; and a new and vigorous management must arise, equipped to meet the challenge of complex technical and scientific problems thrown up in an age of rapid technological change." (1966)

So, in the light of the Finniston report, which came after Gerstl and Hutton's research, methods of training and education have changed, the Engineering Council has been established, but many problems still remain.

Evan (1969 Perrucci and Gerstl eds) spells out a less than optimistic future involving society as a whole and describes the connection between international conflict and technological development. He maintains that "if international conflict in the next decades come under effective international regulation - thus reducing the chances of nuclear war - technology and in turn the engineering profession, will be able to continue it's development largely independent of international political and military conflict". He continues, "Such an international political environment would be conducive to the institutionalisation of the role of the `professional technologist', particularly in industrialised societies, and to the growth of a technological community, both of which would usher in a new level of professionalisation of engineering" (1969.p130).

So where does this leave us ?

We saw in the first chapter that contributors to the Finniston Inquiry, and much of the research since, have failed to arrive at a full understanding of the issues surrounding the problems facing British engineering.

From this summary of research on engineers' roles, career identities and professional orientation, it is clear that - at least in Anglo/American studies - **there is an inherent conflict of role identity for engineers working in commercial R&D, production and sales organisations.** This means that organisational design and personnel policies are crucially important to mediate such conflicts and provide an effective and non-alienative work situation.

My own research has focused on one manufacturing plant within an organisation facing an engineering skill shortage, for I suggest that the first step to resolving the issues of skill shortage, role conflict and mis-utilisation outlined above, must be taken at the plant level.

In the 1950s, Burns and Stalker adopted a similar approach in their own studies in the electronics industry. Tom Burns commented that " I am more than ever impressed with the extraordinary gap that exists between the perceptiveness, intellectual grasp, and technical competence of the people who work in individual concerns, and the cumbrous, primitive and belittling nature of the administrative structures by which they direct their efforts, and the constraints they see fit to impose on their thinking and liberty of action." (xxii Preface to 1966 edition of Management and Innovation).

For this research extensive use was made of interviews and observations. The hypothesis presented here is that **the skill shortage and labour problems within engineering, along with the industry's relative decline, are largely as a result of management's failure to appropriately adapt organisational systems to changing product and labour market circumstances.**

Burns and Stalker interpreted such failures as "an inability to adapt the management systems to the form appropriate to conditions of more rapid technical and commercial change". They found in their study, engineers describing the frustrations arising from a functional division of work in a dynamic consumer electronics area (p161). Similar frustrations and similar systems of work organisation were found in my own research.

I would support Burns and Stalker's claim that there is no "ideal type" of organisational structure. Rather, that if firms are to begin to overcome the problems facing them in engineering, one of which is the skill shortage, then they must look at the appropriateness of their management systems to the product and labour market, as tested by commercial performance and labour shortage. I would argue that no other approach, whether involving career patterns, wage adjustments, education or professionalisation, or any other approaches advocated in the research reviewed above, can alone give a full understanding, nor solution, to the alleged engineering skill shortage.

In the following chapter the methodology used in undertaking this research is described, and the route by which I arrived at the conclusions rejecting many of the above arguments is presented.

CHAPTER THREE.

CHAPTER THREE.

DESIGN OF THE STUDY.

1. THE OBJECTIVES OF THE STUDY.

(a) The focus of this research was the experience of electronics engineers within a large Electronic Consumer Goods Manufacturer facing both tough competition and a perceived technical skill shortage. Such a case study combined the circumstances of a changing product market with an engineering skill shortage. The former according to Burns and Stalker would require a move to organic project teams and away from mechanistic hierarchies of specialist departments.

Within a corporate experience of change, the electronics engineers present a special case due to the rapid technological developments in electronics.

(b) In such a situation, given Burns and Stalker's findings, the following can be hypothesised.

i) Engineers will be dissatisfied with their professional roles, particularly with respect to their careers, role autonomy and utilisation.

ii) Where the type of work allows occupational autonomy engineers will be less dissatisfied.

iii) The degree of dissatisfaction and the full utilisation of talent can be affected by:

- Human resource development policies,
- Organic organisation structure

and therefore

iv) These policies can ameliorate skill shortages by using the capabilities available.

2. METHODOLOGY

The process of the study can now be described, and variations from the original plan noted where they occurred.

(a) The History of the Project.

In the Autumn of 1985 a literature review was made of some of the submissions to the Finniston Inquiry. The findings of this review were the springs from which the study presented here arose.

The company was first approached with reference to this project in January 1986, and the study took place between April and October of the same year. A date was arranged for the final feedback to the company, which by mutual agreement was postponed until March 1987.

The research took the form of a case study in a consumer electronics firm which was reporting difficulty in obtaining the numbers of skilled engineers and technicians that were believed to be required. The skill shortage being reported in the industry in general, was acutely experienced in this company due to recent organisational changes and major upheavals in the structure of the firm and its parent company.

The company was involved in four basic stages of the research the first of which was the pilot of the questionnaire. This was conducted in April 1986 and the amended version was completed by the sample respondents in June 1986. The following two stages, the interviews and the observations, were carried out over the period

September to October 1986.

The original concept of the study, was to investigate the impact of the alleged electronic engineering skill shortage on this firm and to determine ways in which the company might better recruit, train and develop engineers in order to mitigate the effects of the shortage. As the study progressed, it also moved in emphasis to an assessment of existing utilisation of engineering skills, and the relationship between the organisation and it's demands on the engineer, and his attitudes to his work, the company, and his career progress and prospects.

The company chosen, at the time the study was being planned, had undergone considerable reorganisation. This heavily involved the engineering and technical staff, and as a consequence of various aspects of the reorganisation, the numbers had fallen somewhat. Those remaining were thus under increased pressure. The entire consumer electronics manufacturing industry was the sector of engineering believed to be most affected by this problem and suffering most from the recent relative decline in the engineering industry. At the time of the study, the plant investigated was the only remaining British T.V. manufacturing company.

The relationship between the researcher and the firm had been established through a previous international comparative survey, conducted in another plant in the company. This study had been successfully conducted and had provided valuable data for the company.

The project proposals were presented to three senior managers, the Director of Personnel, the Executive Chief Engineer and the Head of Engineering Services Division, and were discussed to arrive at a mutually beneficial "Terms of Reference" (see Appendix I). The methodology was discussed and agreed, and a tentative outline of a questionnaire was presented at that meeting. The groups to be included in the study were discussed, and the emphasis was agreed to be on the engineering and technical staff. It was suggested that those in administration or non-technical work were to be excluded.

Although the study was designed to concentrate on `engineers', it was decided not to exclude from the sample others who would be described as `technicians. The term `engineer' is used broadly throughout this thesis, unless otherwise indicated, to refer to the entire sample of technical employees, whether graduates or not. There are clear instances where `engineer' is distinguished from `technician', the distinction usually arising from the nature of the work, level of supervision and autonomy, or level of qualification. The skill shortage problem applies equally to both, and as their work is inextricably linked,it was believed unnecessary to make a clearer distinction. It was also found that the issues arising from the questionnaire, interviews and observations were not peculiar to either category alone.

As with many studies, there were situations encountered as the project progressed which caused the research to depart to a greater or lesser extent from the original plan. This was most commonly a result of difficulties with the original timescales for various phases of the research. The time schedule was therefore considerably different from the original plan. However, this was considered by neither the company nor the researcher to be of serious detriment to the project.

The first stage of the research, preliminary to any data collection was an exploration phase. This began with a period of familiarisation with the Personnel Department, meticulously going through Personnel records in order to find those with Engineering qualifications of H.N.D. level or above. This was followed by a period in other departments with whom I would be maintaining close contact throughout the study. It was necessary to become familiar with the structure of the company and the most fundamental of the recent changes the firm had undergone. The questionnaire was also developed at this stage and incorporated knowledge of the areas from where the data was to be collected. The sample was designed and the research process for the whole project formulated.

It was decided to focus on the engineering departments related to both the product and the manufacturing process, and to concentrate on the one plant. All those currently employed in engineering positions or those with engineering qualifications were identified from Personnel records and formed the sample for the questionnaire stage of the survey. It was believed that if any measures of career development and related attitudes were to be taken, it was necessary to obtain information not only from those currently employed in a technical capacity in engineering departments, but those who, possessing engineering qualifications, had moved into less directly related areas.

(b) The Investigation.

The investigation broadly divided into four phases each of which are described below in chronological order.

The questionnaire phase of the survey was designed to provide wide ranging background information of a fairly detailed nature on the respondents current work, biographical details, and some indication of attitudes and perceptions on a range of work related issues. A draft questionnaire was discussed at an initial meeting with the heads of the engineering departments to be involved, in order to clarify any ambiguities of language, to amend inappropriate phraseology, and to add company specific details where necessary. It was felt crucial to the success of the study to involve the staff and management at each stage to as great an extent as practicable.

The department heads briefed their subordinates that the survey was being conducted and at this stage and indeed throughout the project, the company gave the utmost co-operation, and exhorted the staff to cooperate by stressing that the project was seen as very important for the company.

The sample for the pilot survey was drawn from most of the areas to be studied, and respondents were invited to attend a group session to complete the questionnaire. They were asked to give comments and suggestions as they completed the questionnaire, in order that any refinements might be made. This exercise generated some necessary revisions, primarily to phraseology. Having incorporated them into the final questionnaire, it was administered in a similar manner.

The supervisors and managers of those in the sample were given a list of the names of people who were to complete the questionnaire. To minimise any misunderstanding arising from the questionnaire, and to ensure a high response rate, it was decided that respondents would complete the questionnaire in a given room, at a set time, and in groups of up to twenty. The Personnel Department co-ordinated the invitation of respondents to the room where the questionnaire was to be completed. At the beginning of each session, a brief explanation was given of the purpose of the study and the outcome for the company, from where they could expect feedback, and the method in which to complete the questionnaire. This stage of the data collection was completed over a period of approximately three weeks, and was followed by a period of preliminary analysis.

While every attempt was taken to avoid bias in the construction of the sample, or the interpretation of the results, inevitably possible sources of bias can be identified. These might include ambiguity of questions in the questionnaire, misinterpretation of comments in the interviews, or of events in the observations. For example, in the interviews, in this instance no sound recording was taken, in order to prevent inhibition of the respondents, and to guarantee the confidentiality of their comments. Only taking notes however, presents the possibility of omission of key information, and the possibility that the researcher will only note what he is listening out for. Also, given only the notes of the interviewer, it would be impossible for a future researcher to verify what was said. He may only repeat the questions in a future study.

The questionnaires were processed by computer, and preliminary results were withdrawn. The composition of the actual sample was immediately seen, and is presented in chapter five. The majority of the questions (See Appendix II) were multi-choice, and therefore were easy to pre-code and analyse. Some broad trends were identified at this stage, and formed the basis of questions for the interviews and observations. After a period of approximately two months, the basic results were fed back to the department heads concerned, for their comments, and to explain to them the purpose and nature of the subsequent phases of the research.

Following this feedback, was a period spent designing the interview stage. Some administrative staff, who were employed in the engineering departments, had completed the questionnaires, and obviously had to be screened out of the interview sample, which included only those who were employed in technical areas and were qualified to H.N.C. level or higher. Forty percent of all those in this qualification band were interviewed, selecting the names at random from a list of those meeting this qualification requirement, and in proportion to the representation of those qualifications in each department being studied.

Again, with the co-operation of the Personnel Department and with a list generated from Personnel records, the interview schedule was prepared and those concerned were invited to attend.

This second phase of the investigation was designed with several purposes in mind. At one level, it was felt necessary to probe beyond the information obtained from the questionnaires, to gain insights into `how' and `why' questions rather than just `what'. It was helpful also in establishing the representativeness of the original sample by re-posing and expanding upon questions similar to those on the questionnaire and investigating more carefully some of the trends which emerged from the preliminary analysis of the questionnaire data.

The interviews were open and semi-structured and were carried out away from the workplace in a very comfortable and `neutral' office. The interviews were `one to one', and no recordings were made as the quality of the information obtained was dependent upon the guarantee of confidentiality.

Several of the questions were put to the respondents in exactly the same way with each individual. These were in several instances taken straight from the questionnaire. Having answered a given question according to the multi-choice responses provided, the individual was asked why he had answered in that way, and was given the opportunity to develop his answer. In this manner, a wide range of information was gathered and, to move into a fresh area of questioning, often the questionnaire would be returned to. Each interview lasted a maximum of one hour and this phase of the investigation took approximately one month to complete.

Having collated all the interview scripts, a **content analysis** was carried out prior to beginning the penultimate investigation phase. All the scripts were carefully read and the comments, quotes and answers to questions analysed and classified according to several categories. There were certain key areas which attracted proportionately more comment than others, and these were then also analysed. This process was undertaken over a period of one to two months and was followed by the design of the `observation' stage.

The design of this stage arose from critical review of the `indicators' being established from the questionnaire and interview data. It became apparent that several departments and sectors markedly differed from one another, not only in end product output but in employee attitudes and perceptions. A number of areas in which observations would be conducted were identified, and the time-scale drawn up, and discussed with the department heads concerned. At a subsequent brief meeting attended in each case by the department head and the researcher, those to be involved were made aware of the forthcoming stage of the project. None of the managers or individuals involved had received any specific indication of the purpose of visiting their area in particular, other than the reasons given for visiting all the areas.

Some time was spent with departments, which, from the company's perspective, had no problems, as well as those clearly seen as experiencing difficulties. This was in order to avoid providing cues to members of the departments concerning the purpose of observing their section.

In each situation, the section leader provided introductions and a brief overview of the area's work and a description of the interface with adjacent areas in the production, or product development process. Each day, and often several times a day and at random intervals, the engineers and technicians were approached by the researcher and asked to explain what they were currently doing. As the day drew to a close, and throughout the period in each area, the engineers were asked about the progress of their current work, what had been the hold-ups, and what was the cause of the successes. As trust developed between the engineers and the researcher, individuals volunteered further relevant information on their career, perceptions of the company, and matters related to their work.

At the end of the observation stage in each area, another informal interview was held with the area head to clarify any points and to provide discrete feedback. Clearly confidence was not broken, but it was seen as very necessary to assure the head that the exercise had been a success and to thank him for the time and co-operation of his subordinates and to answer any questions he wished to raise.

Having gained an overall understanding of the technology used in each area and the frustrations and satisfactions peculiar to that area, the next area was visited and the process repeated. This phase of the investigation lasted approximately one month.

The final phase of the investigation comprised a series of informal interviews with senior managers in departments outside engineering. These included Marketing, a senior accountant and the Managing Director. This was necessary in order to gain their perspective on the recent re-organisation of the company. These interviews were arranged through the secretaries of the individuals concerned and several were conducted over a period of one month.

At the end of this phase some feedback was given to the managers who had been involved at the initiation of the project and it was explained that the investigation was complete and that following further analysis, preliminary results could be presented. It was suggested by the management that this would initially be to a range of managers and the downward dissemination of the results would be organised internally.

(c) <u>The Analysis.</u>

Over the following two months, all of the data collected was analysed thoroughly. Initially a more critical analysis was conducted of the original questionnaire results using a Social

Science package (S.C.S.S.) on a Vax computer. This was followed by a content analysis of both the interview results and the observations.

The study was of a single case, and the problems investigated related to individuals' experiences, perceptions and expectations, and the exigencies of organisational structure and behaviour. As the more anthropological methodology of interviewing and observation had yielded invaluable results, as will be seen from the following chapters, it was considered more appropriate to emphasise the analysis on these two qualitative phases of the investigation, than to derive purely statistical results from a more numerical approach to the analysis.

The results were formally and officially presented at a small seminar of managers four to five months after completing the investigation, although an earlier date had been agreed and then cancelled by the company. The report to the company was completed in the light of their initial request, and the fulfilment of the agreed `Terms of Reference'. Following a brief presentation, through question and answer, the implications of the findings were elucidated. The report can be seen in full at Appendix III.

Although the findings differed from the company's expectations the issues identified were recognised as valid and the company initiated it's own measures to overcome some of the problems raised.

After the presentation to the company, a further review of the literature and further analysis of the data was conducted over a period of approximately six months. As issues had emerged during the survey which were outside the area embraced in the earlier literature review, it was considered essential to investigate other relevant research and integrate and reconcile the findings of this survey, with the theories presented in the literature.

To fully understand the research findings, it is necessary to become familiar with the context in which the research was conducted. The following chapter therefore describes briefly the prevailing environment in the electronics industry world-wide and in U.K. television manufacturing in particular. A description of the changes taking place in the parent firm at the time of the study in this company, is also presented.

CHAPTER FOUR.

CHAPTER FOUR.

THE CONTEXT OF THE STUDY.

In this chapter, relevant aspects of the electronics industry, the T.V. manufacturing industry and the company studied, are described in order to set the context in which the research was carried out.

1. THE U.K. ELECTRONICS INDUSTRY SINCE 1970.

The relative decline of the U.K. engineering industry, in which electronics was no exception, has been described in Chapter one. Briefly, the late 1970s saw an expanding U.K. market for electronic products being supplied increasingly by imports. A considerable trade surplus in the mid 1970s had been turned into an even greater deficit by the end of the decade. Consumer electronics in particular were struggling to keep pace with international competition, while investment tended to be more forthcoming for the defence sector.

Extensive cuts in the labour force accompanied the increased import penetration as output fell dramatically. In some sectors of the industry, the fall in output was mirrored in a fall in employment, both in the region of 25%. In consumer goods, the labour force reduction between 1978 and 1983 was over 40%, although output fell by much less. In the electronics sector, however, while employment overall fell by 16%, output actually increased by 35% over the 1978 to 1983 period and it was accompanied by a 45% increase in the employment of scientists and technologists.

Although an engineering skill shortage had been widely reported for many years, there was evolving a new market atmosphere, technology was developing at an unprecedented rate and there was a shift in skill requirements towards the more technical and scientific. It is therefore important to remember that the change in skill requirements was only one amongst many enormous challenges and developments facing managers in the industry at this time.

2. TELEVISION MANUFACTURE IN THE U.K.

Many of the internal management and financial difficulties facing Thorn EMI, arose through poor judgement, which allowed expansionist ideas to outstrip the means of financing them. However, Thorn EMI were not alone in facing these problems which were common to many firms in the U.K. electronics industry. In a feature on the company in the F.T. `Management' page (March 16th 1989, p.14), the ability of U.K. industry to compete in the high-technology, electronics based industries was questioned: " does Britain have any chance of progress in a sector where companies only succeed through a commitment to growth and long-term investment?"

The situation in the T.V. manufacturing industry, and the comparative position of firms in that market around the time of the research needs to be discussed in some detail.

In the late 1970's and first half of the 1980's, changes were occurring in consumer spending patterns, influenced by the recession, changes in taxation, the development of home computers and video. The behaviour of the consumer during this period caused probably the largest single shift in the behaviour of T.V. manufacturers world-wide, as a period of new dynamism and volatility in the market was entered. Competition between manufacturers heightened and technological developments were accelerated with the incentive of capturing more or holding on to existing shares of the market.

A sample of the U.K. market in 1982, taken by Mintel and involving 928 adults, showed a structure as follows.

Table 4.1

U.K. TELEVISION MARKET.

1982	%
Rent one colour T.V. only.	26
Own one colour T.V. only.	21
Own one black and white T.V. only.	8
Rent one black and white T,V, only.	4
Own two or more colour T.V.s.	3
Own two or more black and white T.V.s.	2
Rent two or more colour T.V.s.	1
Rent two or more black and white T.V.s.	0
Own and rent any number of colour T.V.s.	37
Neither own nor rent any T.V.	2

Source: BRMB Mintel: Video and Television 1984. p.33

The figures do not add up to 100 due to some overlaps. During the years leading to 1982, there was a shift in the balance between demand for black and white, and colour T.V.s, which was accompanied by a rapidly increasing proportion of the market being supplied from overseas. Table 4.2 illustrates this.

Table 4.2

IMPORT PENETRATION OF U.K. TELEVISION MARKETS.

	Colour(m)			Black and white(m)		
	U.K. made	**Imports**	**Total**	**U.K. made**	**Imports**	**Total**
1976	1.3	0.21	1.51	0.42	0.54	0.96
1977	1.39	0.31	1.7	0.6	0.52	1.12
1978	1.46	0.34	1.8	0.7	0.57	1.27
1979	1.42	0.47	1.89	0.74	0.6	1.34
1980	1.47	0.48	1.95	0.55	0.99	1.54
1981	1.81	0.75	2.56	0.32	1.19	1.51
1982	2.01	0.92	2.93	0.22	0.79	1.01

Source: Mintel. Based on BREMA/Business Monitor. Mintel Video and T.V. 1984. p.34.

The table shows that as a percentage of the total, colour T.V. has moved from 61% in 1976 down to 56% in 1980 then up to 74% in 1982. This reflects the shift in the purchasing of second sets from black and white to colour, as the latter became cheaper, particularly in the small screen sector. Also the domestic manufacturing share of the colour T.V. market fell from 86% in 1976 to 68% in 1982. Black and white U.K. manufactured sets have halved from 44% to 22% over the same period.

Between 1979 and 1983, Japan was amongst the major exporters, whose T.V.s were coming onto the British market. After 1980 the share of imports arriving from Japan fell dramatically, as is seen in the table below. However, this must be seen in the context of E.E.C. trade restrictions, and the establishment of factories in the U.K. and around Europe by Japan. This period saw Sony, Matsushita, Toshiba, Hitachi, Mitsubishi and Sanyo all doing this, thus the figures for some of the European countries do not necessarily reflect their own domestic T.V. manufacturing industry.

Table 4.3

PERCENTAGE SHARE OF IMPORTS BY COUNTRY.

COLOUR T.V.s

	1979	1980	1981	1982	1983
Japan	39	41	29	23	15
West Germany	23	10	14	15	29
Singapore	11	12	14	16	14
Finland	7	4	4	5	7
Netherlands	6	11	6	6	7
Austria	4	6	10	18	8
Sweden	4	2	2	2	2
Belgium	3	4	9	3	3
Denmark	1	-	2	2	4
Hongkong	-	-	-	4	4
Italy	-	-	-	3	2
Others	2	10	10	3	5

Source: Mintel. Based on Overseas Trade Statistics. Mintel Video and T.V. 1984. p 35.

As has been mentioned, the most significant change in the T.V. market in the early 1980's, which it is alleged is the snare which Ferguson fell prey to, was the shift in the share of the market going to smaller screens. The table below illustrates this development clearly.

Table 4.4

SHARE OF COLOUR T.V. MARKET BY SCREEN SIZE.

	Large screen %	Small screen %
1978	90	10
1979	80	20
1980	75	25
1981	70	30
1982	69	31

Source: Mintel , based on BREMA. Mintel Video and T.V. 1984 p.36.

The sales of small screen T.V.s was boosted by the purchase of second sets, and the use of small screen sets for video, home computers and electronic games. During this period, in addition to the growth in demand for small screen T.V.s, as we have already seen there was an increasing demand for colour T.V.s and a decline in the purchases of black and white T.V.s. Mintel (p.37.) claim that the trends observed during the 1970's and early 1980's were largely the result of the replacement of 25%

purchase tax with 10% V.A.T. which, coupled with a relaxation of rental and hire purchase restrictions, gave the market a boost in the early 1970's and the reverse with the introduction of 15% V.A.T. in the mid 1970's. They suggest also, that the easing of hire purchase regulations in July 1982, was a factor favourable to the T.V. market. In 1983-1984, their research suggested that around 80% of households owned or rented a colour T.V. and that in 1983 consumer spending on purchasing sets reached £557m and rental payments for the same year £1460m.

It is expected that the demand for second sets, and technological developments like Text and P.I.P. (Picture in picture) will continue to boost volume, as will the fall in real prices. The brokers Philips and Drew claim from their research that the average hours needed to work in order to buy a colour T.V. fell by 30% between 1978 and 1982.

Inevitably, the movements of the market were reflected in the behaviour of manufacturing firms. At this time, the troubles were beginning for Thorn EMI and Ferguson, although they were in fact in quite a strong market position. Table 4.5 shows the market shares of colour T.V.s by volume retail in 1982. One of Ferguson's market advantages was Rumbelows- their sister company, with over 400 retail outlets nation-wide.

Table 4.5

MARKET SHARES BY VOLUME OF COLOUR T.V.

RETAIL 1982

	%
Thorn EMI	25
Philips/Pye	25
Hitachi	8
Grundig	7
ITT	7
National Panasonic	4
Sony	3
Toshiba	3
GEC	3
Granada	3
Redifusion	3
Others	10

Source: Mintel and trade estimates. Mintel Video and T.V. 1984 p.38.

Regarding monochrome, Philips were the leaders with 15% followed by Thorn at 13% and Binatone with 10%. No other manufacturer had more than 2% of sales. Table 4.6 shows the value and volume of retail sales over this period.

Table 4.6

VALUE AND VOLUME OF RETAIL SALES

	COLOUR				BLACK AND WHITE				TOTAL			
	Units m		£m rsp		Units m		£m rsp		Units m		£m rsp	
		Index		Index		Index		Index		Index		Index
1976	**0.77**	100	**220**	100	**0.78**	100	48	100	**1.55**	100	**268**	100
1077	**0.79**	103	**240**	109	**0.84**	108	56	117	**1.63**	105	**296**	110
1978	**0.84**	109	**275**	125	**1.09**	140	81	168	**1.93**	124	**356**	133
1979	**0.94**	122	**309**	140	**1.20**	154	90	187	**2.14**	138	**399**	149
1980	**0.97**	126	**324**	147	**1.35**	173	101	210	**2.32**	150	**425**	159
1981	**1.10**	143	**352**	160	**1.39**	178	105	218	**2.49**	161	**457**	170
1982	**1.35**	175	**435**	198	**0.90**	115	70	146	**2.25**	145	**505**	188
1983	**1.53**	199	**490**	223	**0.95**	122	67	140	**2.48**	160	**557**	208

Source: Mintel and trade estimates. Mintel Video and T.V. 1984 p.39.

The evidence suggests that the market is becoming more competitive. Demand is now high but the edge is held by the firms who can provide quality and technology for a favourable price. This represents a significant shift in the outlook for manufacturers over the last 10 years or so.

The experience of Ferguson was that a move had been made from the industry being "technology led" to being "market led". This demanded alternative strategies to those with which many firms, Ferguson included, were familiar. Expenditure on T.V. retail advertising is an indication of the degree to which manufacturers are competing at a level previously unknown in the industry's history.

Table 4.7

T.V.SET ADVERTISING EXPENDITURE

	£'000
1980	5869
1981	6914
1982	10984
1983	14728

Source: MEAL. Mintel Video and T.V. 1984. p.45.

In 1983 , the largest advertiser in the industry was Ferguson followed by Philips and Grundig, these three alone accounting for 50% of the expenditure. Similarly T.V. rental firms were spending heavily on advertising. The figures below, however, also include expenditure on video recorder rental.

Table 4.8

T.V. RENTAL ADVERTISING.

	£'000
1980	7800
1981	8700
1982	13200
1983	14500

Source: MEAL. Mintel Video and T.V. 1984. p.45.

In 1983 approximately 40% of this figure was spent on advertising which was predominantly for V.C.R.s, the largest single advertiser again being Thorn EMI, under the Radio Rentals name, with an expenditure of £2.75m, followed by DER and Granada.

From the figures, it is clear than considerable change was taking place in the T.V. manufacturing industry, which demanded changes within the firms in that industry.

So what was the position of Ferguson at the time, and what was the background to their situation ?

3. THORN EMI AND FERGUSON.

The personal creation of the late Sir Jules Thorn in 1928, the company was, in the words of a past chairman " a rather patriarchal company". It was founded to import valves from Germany, and built up on lighting, then the rental and manufacture of T.V.s. Sir Jules added to the company activities ranging from domestic appliances manufacture to engineering. In recent years Thorn's development continued to be marked by a sequence of mergers, acquisition bids of varying success, and lately, selling to the market, sectors of the business which were seen to be incompatible with the enterprises at the core of the business.

Sir Jules retired in 1976, and Sir Richard Cave, chairman until 1984, continued to make acquisitions including several in the States. The largest was EMI in 1979. Thorn saw great advantage in the opportunity to merge with EMI, which it acquired with £170m in 1980, though critics foresaw the combined enterprise facing considerable obstacles.

His successor, Peter Laister, continued the acquisitions, but with less success, and the once cash rich company, began to experience a serious cash shortage.In 1984, British Aerospace was identified by Thorn as an a company with strengths in electronics, information technology and defence, and a short lived, £650m bid was made for the company. The subsequent abandonment of the bid dealt a devastating blow to the share value of Thorn EMI, knocking the shares from a high of 705, to end July 1984 at 370. In the same year, Thorn paid £95m for the acquisition of 76% of the government backed micro-chip manufacturer, Inmos, a purchase which caused a further plummet in the share value.

These acquisitions precipitated major changes in the structure of Thorn the effects of which were felt in all sectors of the business. Below, are described some of the key changes which took place throughout the period from 1984 to the time of this research within Ferguson.

Thorn's pre-tax profits had fallen 28% to £40.2 in the six months to September 30th 1984. In the year ended March 31st 1984 the pre-tax profits were £156.8 m on a turnover of £2.82 bn. With the share price of the company at little over half it's level of early 1984, the management had a strong incentive to act quickly in order to avoid take-over bids.

The activities of three branches of the company, Screen Entertainment Division, Inmos and Ferguson, illustrate the experiences and aims of the company over this period.

Thorn clearly recognised that one of the most significant causes of the problems facing the company, was due to 70% of the business being directly related to consumer spending patterns and the U.K. domestic market. However, the company was widely criticised for taking measures which seemed more likely to increase this dependence, than reduce it.

Diverse growth opportunities were pursued in several areas of the business, for example the setting up of a £175m fund to finance new feature films, which was backed by 12 international banks.

In mid 1985 a new chapter in the company's history began with the resignation of the chairman, and his replacement by former non-executive deputy chairman. The then recently appointed Managing Director had begun making structural changes to the company, the impacts of which are still enduring. The new team at the top of the company consisted of Sir Graham Wilkins, Chairman, and Mr Colin Southgate, Managing Director.

Sir Graham , formerly chairman of the Beecham pharmaceutical group, was described in the Financial Times (Terry Dodsworth and David Thomas. March 16th 1987), as having " the affable air of a family physician with the ruthless methods of a company doctor-hard-headed, unsentimental, averse to unnecessary risks and keenly profits oriented." Having been asked about the problems he saw facing Thorn he commented in the article that he believed the firm had been too "broadly based in activities that were loss making, and which we couldn't afford to keep. We had to prune things like cable television and direct broadcast systems which had no immediate profits potential."

This "pruning" put an end to many of the ambitions which had developed during the period when the firm appeared to be trying to move from it's traditional base to an integrated communications and entertainment business. Under the short chairmanship of Peter Laister the business had been moving towards a position in which it would create films and videos, manufacture the T.Vs. and VCRs on which they would be shown and these would be distributed through the firm's own retail outlets and cinemas.

Such was the situation facing the parent company, but what was the `knock-on' to the individual firms within the company ?

(a) Ferguson.

Ferguson had suffered a massive decrease in profits during 1984/85, largely, it was claimed, due to the switch from big screens to small screens in European T.V. retailing. One of the measures taken by the new chairman involved cutting the direct workforce at Ferguson by 490. Combined with a policy of not replacing leavers, and accepting voluntary redundancies, job losses came close to 1,000.

In the late 1970's Thorn EMI had spent some £13m on re-equipping the Ferguson plants at Enfield and Gosport, but the productivity improvements were not maintained, and costs continued to rise sharply. The technical design side became divergent and it was proving impossible to sustain production between the two plants.

On July the second 1985 (F.T. Gary de Jondquieres) it was announced that Ferguson was to reorganise in the next year, 1986. The Enfield plant was to specialise in making sub-assemblies, while assembly work would be carried out at Gosport.

(b) Screen Entertainment Division.

During this time, Screen Entertainments division was still expanding ambitiously with the establishment of the film maker's fund and plans to build a £3.5m cinema complex in Salford. Under the new streamlining of the company, there now seemed reason to sell off Screen Entertainment division, and the management team, in September 1985, after a long struggle raised the finance to exceed the £105m joint bid from Heron and Cannon. The `White Knight' rescuer of the management bid for SE division, Australian entrepeneur Alan Bond, later exercised his option to buy the whole company. Thorn sold the company to him for £125m, and he then sold it a week later to Cannon for £175m.

(c) <u>Inmos.</u>

Compounding the effects being suffered due to the slump in the world semiconductor market, problems were discovered in one of Inmos's U.S. static memory production lines. A third of all the static memories produced had to be sent back. Thorn had invested heavily in new plant at Inmos, and the firm was absorbing about £40m in cash a year. In the 1985 financial year, Inmos had made a loss of £25m before interest. In December 1985 plans were announced to sell 49% of Inmos and buyers were sought and in July 1986, Thorn announced it's plan to make 500 employees at Inmos's Colorado Springs plant redundant as part of a major restructuring costing £45m.

Clearly, the group had to decide the business it was in, and the F.T. management page in January 1986 reported the main areas in which they saw the group's previous problems.

i) Because of weak information systems the margins on a number of important products including T.V. manufacture and lighting were not known.

ii) Products were under-priced because of this and because subsidiaries were not charged interest- it was carried as a central overhead. Ferguson small colour T.V.s were one prime example of this.

iii) Insufficient market research across the company.

iv) The complexity of keeping control over all of the 450 trading subsidiaries, of which 350 were in the U.K. These were part of 37 operating companies within Thorn.

v) The company had 2000 brand names which meant that many were not supported and were ineffective.

vi) In the overseas subsidiaries there were no holding companies, thus profitable subsidiaries could not offset losses in other subsidiaries, against tax.

(d) Other Sister Companies.

Against this gloomy background, however, new products were emerging from lighting and domestic appliances division. The launch of the Manhattan record label in the States aimed to boost the company's share of the U.S. market from 8% to 12% (Andrew Cornelius, FT. 10.1.86) and Ferguson was reported to be trading profitably in the third quarter.

In April 1986, Ferguson signed a long term contract with JVC to manufacture between 150,000 and 170,000 sets a year at the Gosport factory from January 1987, a deal which would be worth about £25m a year. By July 1986, Ferguson had gone back into profit to the tune of £10m, and this was expected to continue with the JVC project at Gosport.

December 1986, saw Thorn pushing the pre-tax figure up from the previous year's £11.4m to £41.5m. , for the first half of the year. This was despite a drop of almost £46m in sales. The board had set itself the long-term aim of achieving 7.5% on sales. By far the biggest profit contribution was made by the firm's rental and retail outlets: £54m on a turnover of £458.8m, compared to £42.2m on £402.2 the previous year.

In the same month, the plans for the recovery of Thorn EMI, were reported in the Financial Times (Andrew Cornelius). Thorn planned to sell part of it's 46% share in Thames T.V. Negotiations were underway to raise £50m by the sale of 14 other subsidiaries of the company. One third of Thorn's 150 top managers were replaced and £11m cut from operating costs, reducing head office staffing and overheads.

(e) <u>The source of the problems.</u>

In an article in the Financial Times, titled "The great fightback", Terry Dodsworth and David Thomas looked at some of the factors which had contributed to Thorn's difficulties, and how they had to some extent begun to be resolved. The domestic products, namely Tricity, Parkinson Cowan, Bendix and Moffat, make 3% or less on sales, and even lighting, which is the groups stronghold in the U.K. and internationally was performing below group targets. There were weaknesses in the defence sector, and both Inmos and the North American division of EMI music were making losses. It's estimated that in acquisition costs, losses and loans, Inmos has cost Thorn around £300m, which is approximately half the net worth of the entire Thorn group.

It has been alleged that at least part of the problem was insufficient investment over many years. For example, lighting and domestic appliances, at the heart of the group, suffered in the late 1970's due to high inflation and growing foreign competition. When these divisions needed strengthening, cash was being diverted into acquisitions such as that of EMI in 1979.

The present top management team at Thorn, lays considerable blame for the past situation on poor management systems, which were too weak to cope with the stress of rapid expansion. These allegations are backed by others, of "fuzzy lines of accountability, unclear targets, inadequate information systems, poor marketing and too many layers of bureaucracy". (F.T. March 16th 1989, p.14). Such difficulties are discussed in the Results chapter, under

"Observations".

(f) The way back ?

Over the period since mid 1985 to the time of this research, the group had raised approximately £230m from asset sales, much of which was used for essential investment, propping up Inmos and clearing borrowings, which were halved from over 60% of shareholders' funds to approximately 30%.

Inevitably the cash injection from the disposal of assets had to end and the firm found itself in a situation in which the funds to plough back into the business had to come from operating profits but the businesses needed in some cases considerable investment to start achieving the desired profitability. For example, Ferguson's capacity of about 700,000 sets, raised doubts in the city as to whether the firm would be able to stay profitable at such a relatively small size, considering the cost of keeping up with changing manufacturing and component technology.

Although Thorn had injected £28m into Ferguson in order to enable the business to move up to producing 1m units per year, profit margins were very slender. Commenting on this, the chairman said that "Ferguson will finance it's own capital, but I am not so sure that it will be a cash generator. A five per cent trading margin on sales would be a pretty good performance." (F.T. March 16th 1987. p.14). In the year to the end of that month, March 1987, Ferguson had lost £12m, including £8m `rationalisation costs'.

Only three months after that, in mid June 1987, a contract was agreed with the French nationalised electronics and defence group, Thompson, for the sale of Ferguson. The sale was completed on the 17th July 1987, when Thompson paid Thorn £90m in cash for Ferguson, £9m more than the company's net asset value of £81m.

Ferguson had for many years been what has been described as "technology led". This meant that, operating in a fairly predictable and slow moving market, product runs were long and the key determinant of the type of products to reach the market, was the manufacturers choice and the technology available. Up to shortly before this research was commenced, Ferguson did not even have a marketing department.

Recognising the need to make dramatic changes to the structure, and "thinking" of the business, plans were developed and put into effect which aimed at moving Ferguson into the position of being "market led", and, as the slogan added, "employee driven". The changes were far reaching and few sectors of the company were left unaffected. The Personnel department was widely involved in the changes and itself had experienced radical restructuring.

Over the previous two years many managerial and structural changes had been made within the parent company, Thorn EMI. As we have seen, the main changes in Thorn brought about a decentralisation of managerial and financial responsibility to the individual companies. Managerial structures changed and accountability was strengthened to improve marketing and information systems. Also, in addition to reducing the range of product diversity by cutting costly enterprises, the group sought to capture an increased share of foreign markets.

Within Ferguson a "Task Force" was established in 1985 and charged with analysing operations and prescribing changes. The most notable adaptations within Ferguson included the introduction of plant specialisations and thus the removal of duplication, the merging of foreman and supervisor roles into a new line manager function with broader responsibility, and the loss of approximately 40% of the indirect workforce through redundancies. Dramatic changes were made to the manufacturing process to the extent that 80% of production was by machine, and 20% was by hand, figures which would have been the reverse ten years previously. A degree of diversification was sought by Ferguson through the manufacture of P.C.B.s for IBM and a joint venture with JVC for the manufacture of VCRs.

Looking more closely at the Personnel department, the changes there were equally radical. A 50% departmental staffing reduction accompanied a fundamental reorganisation of responsibilities. Appendix 5 contains the organisation chart of the Personnel department. Amongst recent changes in the department was the removal of the post of Personnel Assistant between Clerk and Personnel Officer and a shift in the emphasis of the Personnel Officers' work from specialist to generalist. This was to overcome what was perceived as ineffectiveness in the "specialist" system. The Personnel Officers, therefore dealt with day to day issues, leaving the Personnel Managers to be involved in long term planning and the organisational changes facing the Enfield site as a whole.

Perhaps the greatest changes, and the focus of this research, occurred in the engineering departments. The company reorganised the entire engineering and manufacturing process around one central location. Anything regarded as unnecessary duplication of effort or resources was removed by establishing a centre for all the engineering research and development functions, at the Enfield Plant.

Some advanced, and more purely scientific, research was still conducted at the plant in the North of England. The manufacturing of the PCBs would be completed at Enfield, but all assembly work would be carried out at the Gosport plant.

The Enfield site was the focus of this study, and the research sought to investigate a problem, initially identified as technical skill shortage, through an analysis of the attitudes and perceptions of the engineers regarding themselves, their work and the company.

In the following chapter, the results of the key stages of the research are presented; the questionnaire, which provided indicators of areas for further investigation, the in-depth interviews with the engineers and the observations, which enabled the researcher to gain a detailed understanding of the nature of the work and the source of the problems which arose.

From these results, questions were raised, which are discussed in the conclusion, regarding the effectiveness of the changes made, the organisational structure and the management systems which were being deployed in order to achieve the goals towards which the company was attempting to move.

CHAPTER FIVE.

CHAPTER FIVE.

RESULTS OF THE STUDY AT THE PLANT.

The plant studied was in the consumer electronics industry predominantly manufacturing T.V.s, Video Cassette Recorders (VCRs), and Printed Circuit Boards for third party contracts.

Over the months preceding this study, which took place between April and October 1986, the firm had moved the engineering staff from three locations to one, in the South East of England. At this site was concentrated virtually all of the Research and Development capacity of the company, with the exception of a very small number of research engineers at a laboratory in the North of England.

In addition, a new engineering department (E.S.D.) had been established to provide all the engineering functions not under the control of Product Research and Development. This department largely had responsibility for the manufacturing technology and the production systems. (See Organisation chart at Appendix 4)

It was hypothesised in Chapter three that there often arises at the organisational level inappropriate skill utilisation with consequent dissatisfaction for individuals, skill shortage in the internal labour market and poor performance of the organisation. In this chapter, the engineers' perceptions of themselves and their career, their work and the company are presented from their written and verbal responses. Their satisfactions, dissatisfactions, criticisms and suggestions underline the existence of the perceived `mismatch' between the skill utilisation and skill requirements of the company.

QUESTIONNAIRE AND INTERVIEW RESULTS.

1. **THE SAMPLE.**

The research was fairly successful in reaching the target sample, in both the questionnaire and interview phases. The figures given are percentages rounded up or down to the nearest whole unit, hence they do not always add up to 100. **The total sample size was 163.** However where `N' is less than 163, this is because it was decided to exclude `missing' responses from percentage calculations.

It was decided to take as the target population for the interview sample only those qualified with H.N.C., H.N.D. or a degree. Although the sample from each of the departments was generated with great care,inevitably, due to operational requirements not all of those selected were able to attend for interview. However, as Table 5.1 shows, the sample closely reflected the percentage of the population in each department with these qualifications.

Table 5.1

COMPOSITION OF THE INTERVIEW SAMPLE BY QUALIFICATION.

	Advanced Development		Product Development		Engineering Services Division	
HNC	**N**	**%**	**N**	**%**	**N**	**%**
Actual	12	43	6	43	19	57
Interviewed	4	44	3	50	9	60
HND						
Actual	5	18	1	7	2	6
Interviewed	2	22	0	0	0	0
BSc						
Actual	11	39	7	50	12	36
Interviewed	3	33	3	50	6	40
TOTAL						
Actual	28	100	14	100	33	99
Interviewed	9	99	6	100	15	100

Table 5.2 shows how the entire questionnaire sample described themselves according to various occupational categories.

Table 5.2

OCCUPATIONAL CATEGORIES IN THE SAMPLE

	%
Engineers.	46
Technicians.	13
Draughtsmen.	7
Section and Group Leaders.	16
Designers.	2
Other technical.	14
Administrative.	1
Missing.	2

N = 163

The total sample was spread between the departments studied in the proportions shown in Table 5.3 .

Table 5.3

PROPORTION OF TECHNICAL STAFF REPRESENTED IN THE SAMPLE, BY DEPARTMENTS.

Department	%
Advanced Development	22
Product Development	17
Other R & D	13
Research and Development total	52
Engineering Services Division total	45

N = 163

Although the female engineers and technicians were included in the sample, 93% of the respondents were male. This accurately reflected the composition of the workforce.

Table 5.4 shows the age spread of the sample which was found to closely reflect that for the total departmental population.

Table 5.4

AGE OF SAMPLE.

	%
Under 20.	3
21-25.	31
26-30.	14
31-35.	8
36-40.	15
41-45.	6
46-50.	8
51-55.	6
56-60.	7
Over 60.	2

N = 163

Table 5.5 shows the length of service of the total sample both within the company and in their present position.

Table 5.5

LENGTH OF SERVICE WITH THE COMPANY.

	%
Less than a year.	17
Between 1 and 5 years.	23
Between 5 and 10 years.	17
Between 10 and 20 years.	25
Over 20 years.	18

N = 163

Table 5.6.

LENGTH OF SERVICE IN PRESENT POSITION.

	%
Less than a year.	41
Between 1 and 5 years.	38
Between 5 and 10 years.	9
Between 10 and 20 years.	9
Over 20 years.	4

N = 163

By `highest academic qualification', the sample comprised the following.

Table 5.7

QUALIFICATIONS REPORTED.

	%
Master's Degree.	1
Bachelor's Degree.	18
H.N.C and H.N.D.	33
O.N.C and O.N.D.	17
Sixth Form.	2
Secondary Education.	11
Non, or elementary.	7
Other.	8
Missing.	4

N = 163

In the total sample, 19% were graduates. Cross-tabulating `education' with `length of service' confirmed that the graduates were mostly recent entrants to the company's graduate recruitment programme, which began in it's present form only about two years prior to this study. Of those with a Bachelor's degree, 67% had been with the firm less than 2 years, whereas 42% of the H.N.C.'s had over 10 years' service.

Table 5.8 shows the percentage of the total population in each of the engineering departments who were graduates.

Table 5.8

PERCENTAGE OF GRADUATE POPULATION IN EACH DEPARTMENT.

	N	%	Total sample size.
Advanced development.	11	31	36
Product development.	7	29	24
Engineering Services division.	12	16	73

The table shows that the two `development' departments had nearly twice the proportion of graduates as ESD. The uneven distribution of graduates was partly a function of the firms recently developed graduate recruitment programme, and reflected the concerted effort being put into the `product'.

Sorted by the subjects studied, there were some distinctions between the departments. In AD, 75% had gained their qualification in Electronic Engineering, and a further 11% in Radio and T.V. Engineering.

A higher proportion of the ESD respondents were qualified in Radio and T.V.. Engineering (17%), with a smaller percentage than in AD, qualified in Electronic Engineering (32%), and 17% in Mechanical Engineering. No department other than ESD had individuals whose main qualification was in either Production Engineering, or Industrial Engineering (9% and 6% respectively.)

In PD, more were qualified in Mechanical Engineering (39%) than in anything else and this was also a higher proportion than for the other departments. Only 26% were qualified in Electronic Engineering and 13% were Radio and T.V. engineers by qualification.

Professional Associations.

Less than one in four (23%) gave the name of any professional organisation to which they belonged.

2. THE ENGINEERS' PERCEPTIONS ABOUT THEMSELVES.

(a) Their job.

In the responses to many of the questions there were differences between the departments which reflected the nature of the work and workforce involved and the position in the product cycle. In all the figures quoted below, those who did not answer the question have been omitted from percentage calculations.

In AD, the work mainly consisted of "design", with some preliminary "development", and technical management. On the other hand, PD conducted the majority of the "development" . Finally, ESD were the department responsible for engineering work associated with the production process, maintenance and technical services, test and inspection.

In the questionnaire, the engineers were asked the reason they believed they were initially offered their job with the company. In AD and PD, 53% and 54%, respectively, believed it was for their specific skills and 25% said they were offered a training post. In ESD, however, only 44% believed they were offered their position for their skills, whilst 15% were offered apprenticeship positions and 26% a training post.

Table 5.8 shows that this department had the lowest proportion of graduates, relative to the other two, and the highest proportion with ONC and "None, or elementary" qualifications. The development engineers clearly believed, therefore, that they had something of value to offer the firm.

Asked the main reason why they had accepted the position they had been offered, the engineers responses again revealed some distinctions between the departments. In AD, more gave `technical opportunities' than any other reason for accepting (32%), and a further 20% said it was because they enjoy the kind of work they believed was available. Many saw the recent reorganisation as involving a limited choice of either `accept it' or `lose your job'. This is confirmed by the high proportion in AD and PD who said `Lack of alternative' was the reason (26% and 22% respectively). In PD more said `Salary' (25%) than any other of the choices. `Technical Opportunity' and `enjoying the sort of work', was given as the reason by 14% in each case.

In ESD, the two most common reasons were `technical opportunity' (26%) and enjoyment of the work (24%). In this department, a further 15% suggested that the main reason they accepted the position was the salary. These responses show that, while technical opportunity was foremost in the minds of some of the engineers when accepting, particularly in AD, more instrumental motivations were also involved, especially in ESD where the engineers were in general lower qualified.

(b) Strengths and weaknesses.

In the questionnaire, several questions were designed to investigate any mismatch between the engineers' perceptions of the value of their skills and the use made of them by the company.

In AD, not surprisingly, 73% stated that `product technical knowledge' was their main strength. In Product Development, however, 32% claimed that `product technical knowledge was their main strength while 39% claimed to be stronger on `process technical knowledge'.

In ESD , those who claimed that `Product technical knowledge' and `Process technical knowledge' were their main strengths were equally divided, with 37% in each. A further 10% claimed their main strength was `management ability'.

The engineers were asked to identify additional skill requirements which they experienced in their present job. From each department the specific "additional skill requirements" identified by the highest proportion of engineers were as follows.

Table 5.9

ADDITIONAL SKILL REQUIREMENTS.

	AD	PD	ESD
Skill Requirement.	%	%	%
Technical	17	21	43
Managerial	26	21	16
Design	23	-	-
Production	-	18	-
Practical experience	-	14	10
N=	35	28	73

Respondents were then asked to specify in the light of this, which additional skills they had been trained in. The answer to this question was revealing. A high proportion in each department stated `none'. In AD this was as high as 53% , although 17% had received `development' training and 13% `general technical skills'. In PD 67% claimed to have received no training in the areas mentioned, 13% claimed to have gained `general practical experience', and another 15% in `design'. Although `production' was identified by a fair proportion as an area of training need, only one person in PD claimed to have received training in this field. `General technical skills' training had also been given to 30% of the ESD respondents, 14% claimed to have gained `general practical experience', but still 42% claimed to have received no training at all in the categories listed.

(c) <u>Graduate recruitment and utilisation.</u>

Large scale graduate recruitment, as mentioned earlier, was a recent development in the company's recruitment practices and for two years there had been a significant graduate intake. This had been met with mixed reactions from the graduates, their colleagues and their superiors. However, while allowance was made for some expected negative reaction to the change, it is important to study the nature of the complaints about the graduate programme.

To the firm, the new graduate recruitment programme was an important achievement. However, many of the graduates believed that for the work they were doing, a degree was not necessary. Given the opportunity at the end of the interview to add relevant comments, one graduate in AD made the complaint that

> "a degree is too over qualified for this company. There's very little design work, it's all application and modification."

Another AD graduate, complaining that promises and expectations regarding the work and career paths had been defeated, alleged that

> "the firm were fairly dishonest with graduates to start with. We found out what it was like after a while".

Another graduate, this time in PD, also in the unstructured `additional comments' section of the interview, said that,

> "the firm seems never to have had too many graduates before, and now they're learning by their mistakes."

Inevitably, the new emphasis on graduates was interpreted negatively by some of the engineers without degrees.

An industrial engineer in ESD without a degree, for instance, alleged, with some bitterness, that,

> "If you haven't a degree you are treated like a moron"

and went on to say that,

> "Having a degree means that your parents pointed you in the right direction at the right time and no more !"

It is clear from these comments that in the departments with both high and low concentrations of graduates dissatisfactions and frustrations are experienced.

3. ENGINEERS' PERCEPTIONS OF THEIR WORK.

In both the questionnaire and the interviews, respondents were questioned about their career choice, the nature of their first job, their career goals as they were, and how, if at all, they have changed, and finally, to suggest in what way, given the opportunity, they would like to change jobs.

(a) Engineers' first occupation.

Asked about their first job, in AD 94% stated that their first position was engineering related, and only one individual described it as `non-engineering but industrial' and one claimed it was `non-industrial'. In PD 64% indicated that their first position was `engineering related', though 25% said it was `non-engineering but industrial'. Although 75% of those in ESD said that their first position was `engineering related' 11% said `non-engineering but industrial', and 14%, the highest in all the departments, began their careers in a `non-industrial' position.

Therefore, the greatest proportion going straight into an engineering career were found in AD.

The respondents were asked in the questionnaire the main determinant of their first engineering job. Not surprisingly, for those in AD, who tended to be higher qualified and more technical career oriented, the main determinant chosen by more respondents than chose any other option was `technical opportunity' (47%), the second most popular choice being `reputation of the company' (14%).

In PD the situation was slightly different. Here the two most common determinants were `location' (22%) and `lack of alternative' (22%) with `technical opportunity' being given as the reason by only 19% and reputation of the company by 15%. The `lack of alternative' score was high due to the number of engineers in the department who had moved down from the Bradford site in the re-organisation.

In the case of ESD the most common determinants were `technical opportunity (29%), `lack of alternative' (19%) and `salary (14%).

(b) Career and promotion.

It was found in all departments, that a technical career in a large company was the initial career plan of the majority of the engineers. This aspiration has since been supplanted by others. In AD, although many still wanted a technical career, 20% saw their career moving into `management in a large organisation'. In PD, a large proportion suggested that they would now prefer a career which enabled them to move into management, become a self-employed engineer, or leave engineering completely. Similarly, management was seen by many in ESD as the path for their future career. In this department, however, those wishing to leave engineering completely, had risen from 1% in their initial career choice to 15%.

This shift reflected not just dissatisfaction with technical career prospects but a change of expectations from when the engineers' careers began.

The engineers were also asked , given the chance to change their job, what they would like to do ?. Relatively few in each department opted to continue with their present job. In AD the figure was 14%, in PD 11%, and in ESD only 10%.

In AD and PD the most popular of the options was to be promoted to a job with added responsibilities (31% and 32% , respectively).

The second most common choice in both AD and PD was `a job within the company which enabled me to use more of my technical expertise' (23% and 25%, respectively) the third choice in both areas being supervisory or managerial jobs (17% and 18% respectively).

In ESD, the opportunity to use more technical expertise was first choice with 26%, and `supervisory or managerial' second (22%). Unlike the other areas, 19% would like to be self-employed and only 16% said they "would like a job with added responsibilities".

This result again highlighted a desire among the engineers for greater responsibility and more demanding work. The implication was that the work was not currently meeting this need.

So what were the sources of this apparent dissatisfaction ?

In the interviews, some of these questions were asked again in order to establish the reasons behind the career aspirations. Many comments were made regarding career, the opportunities to use skills and promotion, which appeared to be a key source of dissatisfaction among a wide proportion of those interviewed.

Several individuals made comments about the need to "push" or "stretch" themselves. Most comments were fairly negative, like those of the graduate engineer, with over a year's service in AD who said,

> "I was told on induction that it would be 2 years to middle management- no chance. 10 years to Section Leader"

and similarly from a colleague in the same department who said,

> "It seems a joke doing management training already. There are so few jobs for so many graduates, it's `dead men's shoes' ".

In ESD, a graduate with 6 years' service expressed similar but more resentful sentiments regarding promotion and technical expertise.

> "People aren't promoted because of technical expertise. You have to be a manager to get on. Engineers get promoted when they say they are leaving and managers realise they can't cope without them."

Another graduate engineer from the same department, with only 2 years service, encapsulated the frustration by saying that while he "would like to give his best efforts to the company's success",

> "the only way to get on is to leave the company."

Does this add up to any mismatch or is it simply a reflection of the frustrated enthusiasm of fresh graduates ?

One respondent from PD who had over 14 years service with the company and is now over 60, showed considerable insight into the problem when he said,

> "Personality rather than ability tends to cloud the issue and you end up with square pegs in round holes. The guy promoted then feels insecure and makes a bad job"

From these results there is evidence, therefore, that engineers' from all departments had experienced dissatisfaction with their career prospects and the extent to which their technical expertise had been used.

(c) <u>Utilisation and recognition.</u>

Many engineers commented more specifically about the nature of the work and the use made of their technical expertise.

Particularly among recent graduates, there was considerable dissatisfaction expressed regarding the nature of their work. In PD the sentiments of several engineers were reflected in the comments of one who alleged one problem was that, after doing one piece of work, a similar one is allocated, so if the first job was very dull " you're given one menial job then another follows that".

An older engineer in the same department with long service recognised the problem and suggested that the firm had to realise that

> "People are better educated today than they ever were but it needs holding in . It's like it's all on the table and overflowing, it needs holding in."

The engineers were asked about any rewarding aspects of their work and their comments indicated that they appreciated working hard and determinedly towards a target and being accredited with praise when it is achieved. However, many of the engineers complained that they received no credit. An engineer in ESD with just under 2 years' service suggested that the satisfaction and rewards were all derived from personal satisfaction, rather than allocated credit. Some resentment was evident in comments like those of the ESD engineer who complained that, "even when you give your best, it goes unnoticed" and added "so what's the point ? ".

The consequences of this were noted by another ESD engineer who said that

"If you don't get any rewards or recognition, your efforts tend to decline and you have no concern for the company."

Yet another engineer from one particular area in ESD where a considerable mis-utilisation of skills was reported, when asked what was particularly good about his work and what was particularly bad, said that the bad thing was working as hard as he could and " really putting yourself out" and getting no recognition. He was questioned further about this recognition and added,

"I'm not looking for a pat on the back, I'm just trying to avoid being kicked in the teeth."

Having themselves identified a utilisation and motivation problem, the engineers were questioned about any suggestions they had to overcome these problems. Suggestions ranged from `greater mobility between departments' to `greater involvement with projects'. One line manager suggested that it was necessary to

"get engineers involved from beginning to end of a project" and another ESD engineer stressed that engineers

> "must be able to finish projects and carry them through to see them worthwhile."

(d) <u>Training.</u>

The comments in the interviews suggested again some mismatch between the training available and what engineers believed they needed. Those who expressed dissatisfaction regarding training, were asked to explain the reasons. One ESD engineer said that there is in fact quite a lot of training available but, while

> "some's very valuable, . . . a lot's a waste of time because you never use it again".

Few others believed there was much training available. The comments of one graduate were typical of many, when he said,

> "They say people are our greatest asset and training our greatest investment, but in reality it doesn't happen that way."

Many believed the training wasn't specific enough, and that the need was for more technical training. As one components engineer said,

" We want more technical training; you get left to your own devices too much."

Some believed the root of the training problem was actually financial. One engineer in AD with 13 years' service with the company alleged,

"you have to push for anything."

He referred to `surface mount technology' (SMT. See `Observations' later in this chapter.) training, which, he said was greatly needed,

" but it's like asking for gold".

An ESD engineer with 4 years' service commented, regarding the difficulty of getting his `boss' to provide for training, that,

"it's like he's spending his own money."

In the questionnaire, respondents were asked whether they had received any job related training since joining the company. In

ESD, 43% said `no', 64% of AD said `no', and 82% of PD said `no'. Those who answered `no' were asked to suggest `why ?'. In AD, 28% stated that the main reason was they `had only just joined the company'. However, a further 28% said they were not given the opportunity and another 24% claimed that none was available in their field. The most common response in PD was `not given the opportunity' (55%), and `none available in my field' (35%).

In ESD 30% claimed not to have been given the opportunity, while 21% alleged none was available and a further 21% that they had only just joined the company.

Asked if they believed they would benefit from training in the future, in PD 100% replied `yes', in AD 91% and in ESD 90%.

Asked how satisfied they were with training, in PD 78% said they were fairly or very dissatisfied. In AD this figure was 63% and in ESD 57%.

From these results, in addition to utilisation, career paths, recognition and motivation, training is amongst the factors with which there appears to be considerable dissatisfaction.
The extent of this dissatisfaction is clarified by reference to the questionnaire data.

4. SATISFACTION AND DISSATISFACTION WITH WORK.

From the questionnaire figures and the interview comments, indicators of mismatch between skills and their use, training and training needs were identified. On a 1-5 scale from very dissatisfied to very satisfied, engineers were asked to rank how they felt about a range of issues.

(a) Intrinsic factors.

Two issues with which there was found to be a high degree of dissatisfaction were promotion opportunities and training. Regarding general promotion opportunities, 42% overall were fairly or very dissatisfied, 28% indifferent and 30% fairly or very satisfied. Taking technical promotion opportunities first, the proportionate satisfaction levels by department, were as follows.

Table 5.10

SATISFACTION WITH TECHNICAL PROMOTION OPPORTUNITIES

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	31	19	23
Indifferent	17	42	31
Fairly or very dissatisfied	53	39	46
N =	36	26	70

Table 5.11

SATISFACTION WITH MANAGEMENT PROMOTION OPPORTUNITIES.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	11	18	13
Indifferent.	31	43	33
Fairly or very dissatisfied.	57	39	54
N=	35	28	69

In AD there was found to be dissatisfaction with both technical and managerial promotion opportunities, whereas in ESD it was particularly with managerial opportunities. In PD, there was lower dissatisfaction than in either AD or ESD.

Training was similarly a source of dissatisfaction to 63% in AD, 78% of PD respondents and 57% in ESD, yet regarding the extent to which they found their work interesting, 67% of AD were fairly or very satisfied, as were 61% of PD and 69% of ESD.

Although it was stated that the work was interesting, the proportion, who were satisfied with the extent to which they could use their technical expertise in their work, was not high.

Table 5.12

SATISFACTION WITH USE OF TECHNICAL EXPERTISE.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	53	39	49
Indifferent.	28	21	27
Fairly or very dissatisfied.	19	39	24
N=	36	28	71

Table 5.13 shows that `professional recognition' at work was found not to be a strong source of either satisfaction or dissatisfaction except in the case of ESD where 50% were fairly or very dissatisfied.

Table 5.13

SATISFACTION WITH PROFESSIONAL RECOGNITION AT WORK.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied	19	19	18
Indifferent.	42	44	32
Fairly or very dissatisfied.	39	37	50
N=	36	27	72

There was little to suggest that `Status in the company' was a major concern of the engineers in general, although 51% of AD were fairly or very dissatisfied.

Table 5.14

SATISFACTION WITH STATUS WITHIN THE COMPANY.

	AD	**PD**	**ESD**
	%	%	%
Fairly or very satisfied.	23	25	23
Indifferent.	26	50	30
Fairly or very dissatisfied.	51	25	46
N=	35	28	73

From these results, it was suggested that greater dissatisfaction was experienced in connection with opportunities for promotion, both managerial and technical, than with the engineers opportunities to use their technical expertise in their current post.

It would appear that `status' and `professional recognition' in the literature are, therefore, ascribed greater importance than would seem justified from this case.

(b) Extrinsic factors.

From the literature, `pay' also was expected to be a major source of dissatisfaction. Some dissatisfaction was found but not of the magnitude expected. It was found that dissatisfaction was highest and satisfaction lowest in AD.

Table 5.15

SATISFACTION WITH PAY

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	14	25	30
Indifferent.	39	32	25
Fairly or very dissatisfied.	47	43	45
N=	36	28	73

During the interviews the dissatisfaction with pay was found to be associated with a general perception of value to the company.

For example, a PD engineer with 14 years service said,

> "A lot of people are on the edge of leaving. A little pay boost or just knowing that they're needed would be enough to stop them."

Fringe benefits were seen by a greater proportion as a source of dissatisfaction. This appeared to be linked to the belief among engineers that company cars, for example, would be available to them for doing similar work in other companies.

Table 5.16

SATISFACTION WITH FRINGE BENEFITS.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	8	30	12
Indifferent.	33	15	17
Fairly or very dissatisfied.	58	56	71
N=	36	27	69

The hours of work were found to be an issue mainly in AD and PD where the dissatisfaction was found, in the interviews, to reflect dissatisfaction with the manner in which management had recently changed the engineers' hours.

Table 5.17

SATISFACTION WITH HOURS OF WORK.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	31	21	36
Indifferent.	28	32	32
Fairly or very dissatisfied.	42	46	32
N=	36	28	72

In all departments more were satisfied than dissatisfied regarding holidays.

Table 5.18

SATISFACTION WITH HOLIDAY ENTITLEMENT.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	61	46	45
Indifferent.	19	36	29
Fairly or very dissatisfied.	19	18	26
N=	36	28	73

The reorganisation on the site necessitated many of the engineers in the sample working in very poor conditions and in temporary accommodation. Consequently many saw their present environment as a major source of dissatisfaction. However, the majority were satisfied with their proposed environment.

Table 5.19

SATISFACTION WITH THE PRESENT ENVIRONMENT.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	44	21	44
Indifferent.	8	14	21
Fairly or very dissatisfied.	47	64	35
N=	36	28	72

Table 5.20

SATISFACTION WITH THE PROPOSED ENVIRONMENT.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	47	82	63
Indifferent.	33	14	11
Fairly or very dissatisfied.	19	4	26
N=	36	28	72

The relatively high proportion in PD who were dissatisfied with their present environment and satisfied with their proposed environment, reflected the poor accommodation in which they were situated during the reorganisation and refurbishment of the plant. It also reflected their high expectations of their new work accommodation.

In summary, the results on the extrinsic factors clearly suggest them to be relatively less fundamental to the satisfaction of the engineers than intrinsic factors. Pay and fringe benefits appear to give rise to some dissatisfaction but it was found from the comments in the interviews that this dissatisfaction was indicative of the esteem and value in which engineers believed they were held by the company. The dissatisfaction stemmed also from comparisons with engineers in similar positions in other companies or in alternative work.

As one PD engineer with 13 years in the firm said,

> "Pay is very low. I could get another £5,000 and a car in a technical sales job."

An AD engineer, with 18 years overall service suggested that pay was neither a source of satisfaction nor dissatisfaction, but something which is tolerated.

"the engineer pays for his satisfaction; he's satisfied but under-paid."

5. ENGINEERS' PERCEPTIONS OF THE COMPANY.

From the engineers' perceptions about their work it was apparent that, although they believed they were underutilised to a certain extent it was not the all-consuming issue, it would have been expected to be. From previous research, a lot of dissatisfaction would be expected to be found in connection with pay and with professional recognition and status. Again, although these were sources of dissatisfaction relative to other factors, they were peripheral.

In the questionnaire, several questions focused on the individuals' perception of the company in respect to certain issues. The interviews yielded considerably more information on this area and more still was obtained from the observations.

In view of the physical circumstances, as already described, under which some of the engineers were working and the recent upheaval in the firm, which involved considerable redundancies, it was at first surprising to find such a positive response in answer to the question of engineers' feelings in general towards the company. However there were marked differences between the departments.

Table 5.21

WHAT ARE YOUR FEELINGS TOWARDS THE COMPANY ?

	AD	PD	ESD
	%	%	%
I would like to give my best efforts to the company's success.	89	64	37
I will give as much effort as the company gives in reward.	11	29	50
I do not have much feeling for the company.	0	4	11
I am completely indifferent on all matters concerning the company.	0	4	3
N =	36	28	74

From this measure, those in the AD department appeared to have the strongest commitment to the company's success, PD next and ESD the least. In ESD the principal feature of the relationship appeared to be `effort for reward', a far more instrumental approach, and here there was a higher proportion claiming to have "not much feeling for the company".

The question was repeated in the interviews and the respondents were asked to explain their feelings. Comments from those who wanted to give their best efforts to the company's success included the following. Concerning the company;

> "When you see the firm changing for the better it wins your loyalty."

and

> "There's a charisma about the firm."

Some explanations focused more on the actual products.

> "Because people know the product and the outside world knows the name."

and

> "You can see your product in the real world."

In addition to the comments expressing commitment, were many which revealed disillusionment and indifference.

Of those claiming their relationship with the firm is on an `effort for reward' basis, the majority of the comments explaining this alluded not to pay nor to the nature of the work nor professional status but to recognition for effort and involvement in the direction in which the department or a particular project was going. The sentiments expressed reflected a general indifferent attitude towards the company.

> "You don't sweat your guts out and get nothing for it...If I'm not getting rewarded in Ferguson in a year or two I'll have to leave".

This was stated by a graduate in ESD with three and a half years service. One respondent who claimed to be indifferent on any matters concerning the company said

> "People are fed a lot but nothing happens."

Yet another ESD engineer commented;

> "If you don't get any rewards or recognition, your efforts tend to decline and you have no concern for the company."

Yet another, who chose the `instrumental' answer said,

> "Even if you give everything, you get nothing for it."

From the questionnaire, feelings towards the company were also reflected in the responses to the question ` Do you ever think of leaving the company ?'. In AD only 14% frequently or very frequently thought of leaving, 61% sometimes did and 25% seldom or never did. In the case of PD, 36% seldom or never thought of leaving and another 36% said they sometimes did, while 29% frequently did. However, in ESD 33% frequently or very frequently thought of leaving, 48% sometimes did and only 19% seldom or never did.

The engineers were asked in the questionnaire a range of questions about satisfaction and about the importance they attached to certain issues and the importance they believed the firm gives them in view of the rewards associated with them.

They were asked how satisfied they were with participation in management decision-making. The highest level of dissatisfaction with this involvement was found in ESD where 72% were fairly or very dissatisfied. In AD it was 57% and in PD 52%, while those who said they were fairly or very satisfied was only 13% in ESD , 11% in AD and 22% in PD.

Another question tested their satisfaction with their relationship with their immediate boss. In AD, where the greatest company commitment was found, 78% were fairly or very satisfied and in both PD and ESD it was over half (57% and 59% respectively). Perhaps more revealing was the proportion in each area who were very dissatisfied. In PD this was 21% and in ESD 32%, while in AD only 3% were.

It is interesting to note that, despite the reorganisation and redundancies, a similar proportion in each department were satisfied with `security of employment' to those who were dissatisfied.

Table 5.22

SATISFACTION WITH SECURITY OF EMPLOYMENT.

	AD	PD	ESD
	%	%	%
Fairly or very satisfied.	35	36	35
Indifferent.	25	25	29
Fairly or very dissatisfied.	39	39	36
N=	36	28	72

7) IMPORTANCE AND REWARD.

On the questionnaire the engineers were given a range of behaviours about which they were asked to state whether they believed them to be important and whether the firm rewarded the behaviour. In response to this section of the questionnaire, few engineers saw any one of the features itemised as being any more "rewarded" by the company than the rest . However some features were considered by the engineers to be more "important" than others. These included the following.

Table 5.23

FLEXIBILITY AND ADAPTABILITY IN YOUR APPROACH TO TASKS AND THE USE OF YOUR SKILLS.

	AD	PD	ESD
	%	%	%
Important.	97	92	87
Neither important nor unimportant.	3	8	7
Unimportant.	0	0	4
N=	34	25	70

Table 5.24

EFFECTIVE AND EFFICIENT COMMUNICATION.

	AD	PD	ESD
	%	%	%
Important.	89	96	87
Neither important nor unimportant.	6	4	7
Unimportant.	6	0	6
N=	36	23	70

Table 5.25

PROBLEM SOLVING.

		AD	PD	ESD
		%	%	%
Important.		89	92	90
Neither important nor unimportant		11	8	10
Unimportant.		0	0	0
	N=	36	24	69

SUMMARY OF QUESTIONNAIRE AND INTERVIEW RESULTS.

The engineers believed a flexible approach to the use of their skills to be important, as did the plant management. Therefore their dissatisfactions and frustrations cannot be explained in terms of inflexible professionalism. The engineers placed great importance on communication and problem solving and it was clear that the origins of any instrumental or indifferent feelings towards the company arose not only out of their work, but were to a greater extent concerned with lack of involvement, lack of recognition for effort, and consequently a lack of motivation.

There is clearly a sharp difference between the `product' and `production' departments in terms of graduate concentration. What is equally clear is that both graduate and non-graduate engineers in all departments reported various frustrations and dissatisfactions, although their perception of the issues and the consequences of those issues varied. Inevitably values, aspirations and expectations will vary on account of level of education, but the results revealed a range of different responses to a common problem, namely the management strategies adopted by the firm, or rather, those neglected in the pursuit of new business goals.

If we are to accept that generally the engineers experienced greater dissatisfaction with intrinsic work factors than extrinsic, it is necessary to understand the nature of the work carried out in each area, in order to substantiate or refute this hypothesis. Achieving this understanding was one of the objectives of the observational phase of the research.

THE RESULTS OF THE OBSERVATIONAL STUDY ON ENGINEERS' ROLES.

The `observation' phase of the research was a detailed process, which took several weeks, learning from the engineers and carefully watching where work came from and went to and what caused particular problems. A lot of time was free for engineers to engage in unstructured conversations with the researcher about their work or career. Interestingly, although the engineers knew the study was being conducted on skill shortage, none suggested that they were numerically short-staffed. Although several were worked to their limit, the work was well beneath their capabilities.

During a period of four weeks, several groups within each department were visited. This enabled the researcher to gain some understanding of the technology involved in each area and to understand the nature of the work. The types of problems faced and the sources of those problems are discussed below.

In each area evidence was found to suggest that the problems originated in a failure to appropriately adapt working systems to organisational objectives and the product market environment. These I have referred to as 'mismatches'.

The results of the observations in each area are presented in turn. First, the type of work the area is expected to perform is described and also where relevant, how this differs from what is actually being undertaken by the group. Secondly, the type of problems which were evident during the period of observation are outlined. Finally, the source of the problem and the nature of the mismatch is discussed.

The observations presented below thus represent small case studies within each department. In some areas, a period of only one to three days' observation was undertaken with a limited number of engineers. Priority areas for observation were identified and these are reported below. For an understanding of how these departments fitted into the engineering organisational structure see Appendix 4.

1. ADVANCED DEVELOPMENT.

(a) Digital Group.

(i) The type of work.

As the name suggests, Digital Group work on anything digital for future models. This includes not only software but also the design of other digital features such as digital stereo, Teletext, and Picture in Picture (PIP) for example. The work went from here to Development Group in Product Development department but on account of the overload in that department and the lack of experience of the engineers, work assignments tended to stay in Advanced Development for longer than planned.

The work being undertaken was largely as had been planned, except as stated above, that a greater degree of development was being put into the products before they were "handed over".

An example of the type of work was that of the engineer designing Programmable Read Only Memory (PROM) for Video Cassette Recorders (VCR). With the exception of the mechanical functions, such as the `eject' mechanism, the functions of the VCR are controlled by microprocessor.

The work involved starting with a `blank' machine which doesn't "understand " anything and building up the programmes so that the machine performs all the correct functions. For example, with pre-set capacity for recording programmes, it is usual to `instruct' the microprocessor to give start time priority. In other words, if two programmes the user is `asking' the VCR to record overlap, then it will begin the second before the first has finished, rather than waiting for the end of the first and losing the first few minutes of the next. However, these instructions had to be contained in the PROM, in addition to the instructions to provide the user with a display, informing him of what the VCR is doing. A careful iterative process was involved to ensure that, in addition to performing the functions it should, the VCR will not "do something stupid" if the user presses a sequence of "wrong" buttons.

The PROMs eventually went to an outside manufacturer to be made into microprocessors, then returned to the factory where, after development, they were built into the VCRs.

Much of the work for this area comes from the marketing department. Some was market-led and some technology-led. For example, Marketing may have found that a particular feature is demanded on new models, then Advanced Development have to find a way of producing that feature. However, an outside supplier or the firm's own research group may design a feature, as was the case with PIP, and then ask Marketing whether the feature is desirable. If it is, then again it is the work of this group to design it.

(ii) **Type of problem.**

The problems experienced were associated with time pressures. The engineers felt very much "in the driving seat" of the firm. Projects were usually defined by time limits and the work was broken down by the group leader into sections that individual engineers could work on. The leader tried to allocate work according to engineers' ability and experience so none were "out of their depth", yet they were "stretched" and working to capacity. Problems arose as a variety of factors contributed to the time scales being over-run. Having to send `art-work' out to a contractor, for example, meant that jobs which were previously done `in-house' in a day, were taking one to two weeks.

Another technical problem was that the group felt that work left the section in top quality but poor work later in the process rendered their efforts redundant. The Group Leader saw the problem as one of poor motivation in other departments, which was having a severe effect on his own department. For example, Prototype build apparently were taking up to five weeks to `turn a model round' and for this he blamed lack of awareness of the firms goals, for which, in turn, he laid the blame with middle and senior management and poor communication.

(iii)**The** source of the problem.

The source of the problem was described as a failure by middle management to make people aware of the overall goals of the firm. The consequences, according to the Group Leader were that people were unaware, so had no incentive to work towards them. They consequently felt they were held in low trust, so had poor motivation. It was also suggested that autocratic and "authoritarian" managers **telling** employees what to do, did not win their support and motivation. The consequences he saw for the firm were serious.

The engineers in his department, he believed, were highly motivated due to being aware of the competition Ferguson were facing and, if not through loyalty to the firm, through a sense of personal challenge, there was a strong incentive to `beat' the competition. He admitted that the engineers were beginning to lose this, as they saw their hardest efforts being defeated by the rest of the system. He saw a need for middle management and top management to communicate more effectively.

(iv) **The nature of the mismatch.**

In this situation, the mismatch was not between the skills of the engineers and the nature of their work. Rather it was between the goals of the organisation and the nature of the systems which were actually hindering the progress towards those goals. The consequences as we have seen, were falling motivation in what was otherwise one of the most committed and highly motivated departments in the company and for the company itself, not meeting the goals it had set in view of the new product market competition.

2. PRODUCT DEVELOPMENT

(a) Development Group.

(i) **Type of work.**

Essentially this group of engineers transformed what came from Advanced Development into a product, which could be manufactured and which was ready for the market. The work involved numerous, and diverse tests on the product, such as heat tests, and interference and reception tests. The heat test involved leaving sets at 50 degrees Celsius and 80% relative humidity for a week at a time. The reception test involved taking sets to places outside mainland Britain to test the reception of the signal. The group had a set of "Standing Orders": procedures which were followed with all the sets in order to put many of the components through rigorous testing.

The actual nature of much of the work being carried out during the period of the observations was "fault-finding". Much of the work arrived in the department from a group called "Prototype Build" who made up prototypes of models for the development engineers to work on. However, often the circuit boards or whole sets, arrived in Development Group for the tests, with many faults. This sometimes took days to rectify. In addition to this problem , the process was described as being very lengthy and time consuming.

One graduate engineer was observed as he wrote up a "mod sheet". This was a document generated after a modification had been made, which it was necessary to implement as part of the development of the product. The time, from when the sheet `went in' to when he got back a corrected circuit board, was four to six weeks. The drawing office received his typed "mod sheet" and they drew up a new design. This then had to go to an outside firm for the "art work" to be done on the board. It then comes back to the plant, and the board can be made at the factory, after which it is returned to Prototype build to be made into a model, from whence it returns to this engineer to continue the development. Having corrected the fault and conducted the tests, the amended boards often returned from Prototype build with still other faults which were not there initially.

(ii) **The type of problem.**

Under-Utilisation was the main problem facing the engineers. In-efficiency and poor output were the problems facing the group as a whole. The graduate engineers expressed dissatisfaction at not being involved in development work but only fault finding and an engineer, who had served a five-year apprenticeship claimed he was doing the same work now as when he began his apprenticeship.

For the group, the problem was that time schedules overran, or work left the group incomplete. This caused duplication of effort and whilst not using the skills of the tool room effectively or efficiently it meant that the engineers in turn were being mis-utilised.

(iii)**The source of the problem.**

Differing suggestions as to the source of the problem were put forward by the engineers and the group leader but they were, in fact, only differing facets of the same problem. The engineers claimed that work arrives in the group without complete documentation and Prototype Build made up the boards with incorrect components. They identified the source of these problems, as the nature of the organisation since the restructuring. They suggested that, if Development Group were involved more with the whole project from the beginning, then there would no longer be "handover problems". This would reduce time-wastage and component wastage. Also they believed it would provide them with more interesting work, which would enable them to cope more adequately with the "boring" work they were otherwise doing. It was stated that the firm had not previously employed many graduates in this area and that the work, as it stood, was not graduate work.

The Group Leader saw the source of the problem as the "Management

Systems". He alleged that "no-one seems to know any of the systems and there are tons of them". Form filling and notifying all the appropriate people at the correct times of "all you are doing", was suggested to be the source of the problem and the subsequent inefficiency. He described a simple task of obtaining some components for the engineers to continue with their work which took half a day, due to the bureaucracy attached to the process. The geographical spread of the site did not help, though this was largely due to the structural alterations being carried out.

On a later visit to this area, the engineers were angry and frustrated at having found that the signature of the manager of Product Development, was no longer valid for the requisition of components. This was evidently not even appreciated by the manager himself, as the appropriate notification had not been received from the commercial department, who had initiated the change, in an attempt to reduce component costs. The instruction was that requisitions had to be signed by the Executive Chief Engineer, the head of the entire R&D area. In the Development Group, one engineer's response was to follow the instruction carefully and thereby get it revoked. He repeatedly visited the Executive Chief Engineer with single orders, wasting his time and his own, as a long wait was required on each occasion. Attempts were soon made to find from whence the change had originated in order to get it reversed.

(iv) Nature of the mismatch.

Clearly, in this group there was a mismatch between the company's organisational systems and the nature of the work which they were expected to accomplish. The consequences at the individual level were that many of the engineers feel underutilised, several felt underpaid and many were regularly looking for alternative work outside the company. At the level of the firm, there appeared to be a severe mismatch between the direction in which the company was attempting to move in view of increased product market competition and the systems being adopted to effect that move.

(b) Mechanical Design Group

(i) **The type of work.**

Still within the Product Development Department, this group was expected to design and develop the mechanical features of the product. This included the layout and structure of the cabinet, Printed Circuit Board (PCB) design, and the functioning of any mechanical features such as the positioning of controls, etc.

During the observations, all areas of the group were visited. The work being undertaken in the cabinet design section was largely as it was planned to be. The difficulties they experienced were related only to the complexity of the work. One example was the advent of rounded corners on T.V. cabinets. A way had to be devised of producing non-moulded cabinets in such a way that they could be transported in flat component sections to the assembly plant. Another problem arose with a temporary change in the suppliers of the Cathode Ray Tubes (CRT). The new ones had slightly more rounded screens which necessitated setting the entire `workings' of the set back a few centimetres. Such mechanical alterations were the work of this group.

In the printed circuit board design group, some of the engineers were working with Racal Cadet machines (C.A.D.) which enabled them, through the computer and light pen, to design the layout of the components on the PCB. Others were using drawing boards. Again, in both areas the work carried out was largely that which had been intended.

(ii) **Type of problem.**

The main problem faced by the PCB designers was administrative. A recent instruction to them had been that drawings must now all show costings. Tooling for modifications or manufacture was expensive. Tooling for a modified plastic moulding, for example, generated from the cabinet design engineers could cost between £8,000 and £20,000. For the printed circuit board designers this presented a problem that had not previously been faced. They had a system of modification codes to work to and had to consult whoever could help them, in order to arrive at a costing for the design they had drafted. Components had to be costed, as did the tooling, the figure for which was obtained from employees working in the tool room. The engineers expressed the fear that they were being given by the toolroom "vague guess" figures, and they themselves showed little commitment to the new idea. They believed it was the "bright idea of someone in Finance to have some figure or other on the drawings".

Another problem was that some of the engineers did not use the tool room for modifications but did their own, as the tool room "took too long". This caused duplication of effort and this failure to use the skills of the tool room appropriately meant that engineers in turn were being mis-utilised.

(iii)**The source of the problem.**

Again the source of the problem was within the system. The engineers felt that their design work was subordinate to the financial goals of another department. The organisational structure did not facilitate the adequate functioning of the change that had arisen from the reorganisation of the firm and the move towards being "market led, employee driven".

(iv) The nature of the mismatch.

As in the case of the development group, there was a mismatch between the organisational systems and the priority for product excellence.

3. ENGINEERING SERVICES DIVISION.

(a) Advanced manufacturing department.

(i) The type of work.

The department was responsible for the R&D aspect of manufacturing, looking at future manufacturing techniques and alternative production equipment.

For example, one of the engineers in the group was investigating Surface Mount Technologies (SMT), with a view to making cost savings in manufacturing and improving product quality. Essentially, the principle was to reduce the space occupied by PCBs. Normally the components are mounted on the boards with their `legs' going through holes, to be "clinched" before soldering takes place. With SMT the components are mounted directly into the circuitry.

Two of the techniques come under the heading of "Reflow Techniques". In both, a metal paste is used to fix the components in position, which is then either heated by infrared radiation, which liquefies the paste and bonds the components in the solder, or they are heated by a vapour. The two techniques are called "Infrared" or "Vapour Phase". An alternative method of SMT uses a conventional Wave Solder machine, where literally a wave of molten solder splashes over the base of the board. Using this technique, the components are first held in place by an epoxy resin which then dissolves away in the heat of the solder process.

(ii) **The type of problem.**

Much of the work being undertaken by the engineers was as it was planned to be. However, there were many problems with the conventional machines already operating on the production lines, few of which were operating above 40% efficiency. Thus, the manager of this department was shifting attention temporarily away from the future to the present. However, the engineers expressed concern that they didn't know "where the company was going" or even how ESD all fitted together.

(iii) **The source of the problem.**

This was seen as a lack of knowledge in the system. The machines on the lines required maintenance by a variety of skilled technicians and that resource was not available.

(iv) **Nature of the mismatch.**

The mismatch was not with the engineers skills and the work of the department, so much as a disproportionate amount of time being spent on existing problems on the lines, rather than being able to focus on the firm's future requirements. Moving into the type of productivity being demanded by the new "market led" goal, required more effort to be dedicated to future needs.

The manager of this department had, at the time of the observations, been given the additional responsibility for a `sister' department, which was experiencing considerable difficulties, the Robotics group.

(b) Robotics group.

(i) **The type of work.**

The work of this department involved developing and maintaining Robot systems for the line. The department grew from the machine tools department, which was responsible for making, modifying and maintaining much of the plant on the lines. The firm bought three Japanese robots which went into service, it is alleged, without the necessary assessment. Consequently, there were problems, which remained at the time of this study. In fact, when the researcher was taken to see the Robots they were in a redundant branch of the production line and standing idle.

The majority of the engineers and technicians in the department were therefore not working on anything directly related to the robots.

(ii) **The type of problems.**

Almost every engineer expressed considerable frustration due to under-utilisation, and accompanying disillusionment about the department, which gave rise to concern about the company. The workshop, which was part of this department, used to make and repair much of the plant on the lines. As new technologies had been introduced, the role of the workshop had declined but the decision had not been made to close the workshop nor were the staff given new work. The department had suffered considerable redundancies under the re-organisation and those remaining were led to believe that, in future, they would be working as robotics technicians and engineers.

Any work that had been done on robot feeders and other equipment had been "shelved" and the group were consequently very disillusioned. One of the draftsmen observed, had heard that he was now to be working for another "boss" but his "new boss" was not clear about it. As no robotics work was available, he had been given work to do, using the CAD for designing floor layouts for the new department. He had also been asked to design various forms and even calendars. He was disillusioned at using such a powerful machine for "Mickey Mouse projects."

(iii)The source of the problem.

The source of the problem was identified by the new manager as poor communication and poor management. The employees had been "living on hope" and without direction. He had decided to shut the robot line and return the engineers and technicians to repairing and maintaining the existing lines, in order to increase the lines' productivity.

The two managers who had been involved in the establishing of ESD had been promoted and the department was now described as "running around like a headless chicken". The manager identified many areas of unnecessary duplication of effort in the department, which were compounding the inefficiencies. One such inefficiency occurred in one of the Carbon Tracks in `Print and Etch' department which was producing between 80 and 100% failures.

(iv) **The nature of the mismatch.**

There was clearly a mismatch between the skills available, and the type of work available. The consequence for the engineers was that they were being underutilised leading to severe loss of motivation. At a department level, expensive robots were not in use, and other plant was in need of maintenance. The manager of ESD claimed that while labour costs were only 5%, there was in fact "no mileage" in using the robots to reduce labour costs at all.

(c) Test Gear.

(i) **The type of work.**

The work involved building test gear for new products and maintaining existing test gear on the lines. The department was originally part of R&D but in the reorganisation had been taken into ESD.

As R&D developed a new model, working to times prescribed on a Network, Test Gear were involved in the design and production of the equipment necessary to go on the lines in order to test the product. Before full production began, the product and the test gear went to "Zero Series", a group responsible for making limited pre-production trial runs.

The firm used to make 100% dedicated testgear and replace it completely at the end of a model, whereas at the time of this study, in order to reduce costs, more flexible `gear' was being bought in, and modifications made in order to allow re-use on other products. However, one engineer having seen the gear produced and used by a competitor, suggested that it would require too much adjustment to be used by Ferguson. This was because of other deficiencies in Ferguson's manufacturing process. He suggested "it seems crazy to have to modify the test gear just to let more boards pass." Asked about his feelings towards the company he stated that he would like to give his best efforts to the company's success.

(ii) **The type of problems.**

On account of delays in the system, equipment went onto the lines before it should. As production deadlines were unswerving, the development time for test gear became drastically reduced as delays in the development of the product in R&D department over-ran the time schedule.

Considerable amounts of time were spent by engineers in the department out on the line "fire fighting", in order to prevent production losses.

(iii)**The source of the problems.**

These were seen by those in the department and by the manager, as the design of the organisation, poor communication and poor `hand-over' from R&D, as well as mechanical breakdowns on the line.

(iv) **The nature of the mismatch.**

Here, well qualified and highly committed engineers were unable to provide the type of service and quality of work they would like, because of the severe limitations imposed on them by the inadequacies of the system. The manifestation of the mismatch at an individual level was frustration among the engineers and, at a company level, time schedules overran and inadequately developed test gear was on the lines, needing frequent breakdown maintenance.

SUMMARY OF THE RESULTS.

In this chapter, the perceptions and attitudes of the engineers have been explored as they were revealed through the questionnaires, the interviews and the observations. The causes of particular dissatisfactions and frustrations are identified and, through the description of the mismatches experienced in a variety of areas, a picture has been built up, in which weaknesses in the operating systems can clearly be seen to have made considerable impact on the work of individual engineers and given rise to considerable dissatisfactions. The appropriate use of engineers' particular skills has been at the heart of this research, particularly looking at the implications for the performance and profitability of the company as a whole.

In the following chapter, relevant evidence from other companies, and other contemporary studies is discussed, as we seek to determine whether this case study was in any way representative and whether it is possible for any principles to be established or policies formulated from the conclusions drawn here.

CHAPTER SIX.

CHAPTER SIX.

DISCUSSION.

It is necessary at this point to recall the general hypotheses made at the beginning of Chapter three. It was suggested that;

a) engineers are likely to be dissatisfied with their professional roles, particularly with respect to their careers, role autonomy and utilisation,

b) where the type of work allows occupational autonomy, engineers will be less dissatisfied,

c) the degree of dissatisfaction and the full utilisation of talents can be affected by

    i) human resource development policies,

    ii) Organic organisation structure,

and therefore

d) these policies can ameliorate skill shortages by retaining labour and by using the capabilities available.

The "status", "pay" and "professionalism" arguments presented in Chapter two, might then in turn be supported by evidence to suggest the following.

a) Engineers in U.K. engineering firms are not being attracted to companies due to the low pay offered, and those employed, experience considerable dissatisfaction with pay levels.

b) The firm's inability to recruit the appropriate calibre engineers is largely due to the external candidates' perception of low professional autonomy within the firm and, dissatisfaction found internally regarding engineers professional recognition.

Some evidence of mis-utilisation and under utilisation might also be expected according to the literature reviewed.

Finally, if the alleged skill shortage of engineers was strongly related to the issues studied by Burns and Stalker, it might be expected to find evidence of the following.

a) Engineers in the firm of appropriate calibre experiencing dissatisfaction with the nature of the management systems under which they are expected to exercise their talents.

and

b) evidence that a change in the management systems and organisational structures would reduce the dissatisfaction experienced by the engineers, improve the performance of the organisation and by reducing turnover ameliorate any skill shortage experienced by the firm.

The results presented in the previous chapter certainly seem in conflict with some of the arguments put forward in the literature on engineers.

While pay was found to be a source of dissatisfaction, it was not to the extent expected. Pay was believed by the engineers to be less than they could earn elsewhere, although little evidence was available to suggest that on account of this they would leave the firm. Any intention to leave was expressed more commonly in association with the nature of the work.

The issue of `professional autonomy' appeared from the interviews and observations to be of little relevance to the engineers. Very little evidence was found to suggest that the engineers sought recognition for themselves as an autonomous professional body selling their acquired knowledge for the advancement of the organisation.

What was evident, however, was a considerable commitment to the firm, it's products and it's future. Evidence was found, during the observations in particular, to support the argument that the engineers' dissatisfaction was related to their utilisation, their careers and their role in the organisation. There was evidence to suggest that where the level of `task autonomy' and `task creativity' were greater the role dissatisfaction was lower, and yet considerable frustration was expressed by the engineers in these areas regarding the management systems. Such `task autonomy' refers to freedom to use initiative in solving work problems and was not identified particularly as a characteristic of a `professional' role.

It would therefore appear that the findings of this research are largely consistent with Burns and Stalker's findings in the 1950s.

One of the implications of these results is that the attention paid in much of the literature on engineers to the causes of imbalance in the external labour market, such as deficiencies in the tertiary education system and relative levels of pay and status, appear to be preoccupations unworthy of such attention.

It is necessary now to establish the extent to which this case study is representative of the situation in which the whole of the U.K. electronics industry and engineering in general finds itself.

The case study of the Enfield plant of Ferguson (Thorn EMI) was made during a period (1986) when unemployment was at a level of 8.7 % in the South East of England (Regional Trends 22. p110 Table 8.21 1987) and when the economic recovery of 1986/8 was just beginning. The business strategy of the firm (see Chapter 4, page 71-72) had led to large scale redundancies, de-manning and rationalisation policies. The engineering departments studied had been concentrated on the Enfield site and there was a clear strategy to develop a high quality engineering labour force who would enable the technical quality of Ferguson's T.V. and other products to be greatly improved in order to compete with the Japanese and others. In these circumstances, it could be expected that there would be a strong drive by the company to develop an effective Human Resource Development policy for engineers, one reason for this expectation being their acceptance of this research project.

If the findings of this case study support the argument that, changing the management systems and organisational structure to forms more appropriate to the product and labour market will have an impact on engineers' satisfaction, turnover and therefore, ameliorate the firm's experience of skill shortage, an important question remains. What should the strategic response and policy making for companies in similar situations include ? This is discussed in the final chapter.

Let us now compare the results here to other contemporary studies.

A TELECOMMUNICATIONS COMPANY STUDY.

For a period during this research, a parallel investigation was being carried out in a division of a large electronics firm manufacturing telecommunications equipment for private systems, defence contracts and commercial telephone switching gear. A questionnaire, which was virtually identical, was used and the study then proceeded to an interview phase. Time limitations prevented the researchers undertaking any observations or developing the same degree of "inside experience" reported in the previous chapter. Below, some comparisons are made between the data from the two studies.

Though the products, the geographical location, size of plant, and the culture of both companies differed enormously, several similarities were evident in the experiences and subsequent attitudes of the engineers involved. Both companies were experiencing an engineering skill shortage, though to a large extent both displayed differing symptomatic problems. The telecommunications company was suffering considerable technical labour turnover problems, whereas the TV firm had no such difficulty. Broadly, it was found that in the telecommunications firm, major dissatisfactions were expressed regarding a variety of employment issues. Company loyalty seemed less developed than in the TV firm, where, although faced with similar dissatisfactions, leaving the company appeared not to be considered as the only option available to the engineers.

One unexpected result in the case of the telecommunications firm, was that those engineers, who during their undergraduate studies spent industrial release periods at the company, appeared to feel even less company loyalty than those who had not. Similarly, with regard to career goals, 62% overall expressed dissatisfaction with general promotion opportunities. This average disguises the fact that among those engineers who had spent their industrial release with the company, this figure was 74%, while among those who had not it was only 48%. For the whole sample, it was found that 69% had changed their career goals since joining this company.

As with the TV factory, issues of particular priority to the engineers, were identified through their satisfaction or dissatisfaction with them. In both companies the issues were similar. In the telecommunications firm, 79% stated that they believed that effective and efficient communication was `important', while only

17% saw it as `rewarded'. `Effectively managing manpower' was believed to be `important' by 78%, yet only 19% saw this as `rewarded'. Regarding their relationship with their `immediate boss', as with the TV factory, satisfaction in this firm was high, 64%.

In the interviews, the researchers were able to further their understanding of these apparent sources of dissatisfaction. The findings suggested that **overall, company communication was poor.** Respondents were dissatisfied with the fact that they had no clear understanding of the company or how it operates. Engineers complained that little information was available about future projects, an allegation which, when presented to middle management, was explained by their own lack of information about future projects. This situation was not, as might have been expected, found to be most serious in the defence division where a certain level of secrecy was unavoidable, but in the private systems division. Engineers expressed a particular interest in having available more commercial and marketing information.

As with the TV company, **`pay' was not a major source of dissatisfaction**; it ranged from 35% to 46% according to length of service.

The researchers' results implied that **technical aspects of the work were the most important in ensuring job satisfaction**, 42% of the respondents having chosen their present position on technical grounds. Satisfaction with the extent to which the work was interesting was found again to be similar to that found in the TV company. **Among the engineers involved in design work 55% were satisfied, whereas among those engaged in development work it was only 23%.** This was believed by the researchers to partly explain other departmental differences. The implications of these results can only be appreciated when crosstabulated with `frequent thoughts of leaving the company'. It was found that 80% of those dissatisfied with `work interest' thought of leaving the company frequently.

Further investigation of the desire to leave the company revealed that it appeared to increase with length of service. The researchers pursued the issue in the interviews and found that many of the engineers expressed a preference to work for a smaller company. Many engineers believed that their career paths were `blocked' within the firm and a considerable number expressed a desire to move into employment abroad, where opportunities for engineers were perceived as being "better"; quite an indictment on the deployment of technical skills within British engineering.

In neither case did the engineers complain that they were overworked because of the shortage of graduates as would have been expected. Rather, more frequently the complaint was the direct opposite. **The work was not as demanding as many engineers would** like, they were doing work far beneath their capabilities, and lack of opportunity was forcing them to regularly look for alternative work.

FURTHER RELATED STUDIES

At the present time, a study, which has essentially developed from this research, is being undertaken, co-ordinating the work of researchers investigating similar issues in four European countries and Japan. A study of graduate engineers' careers and attitudes has also been conducted by researchers at The Imperial College of Science and Technology involving a cohort of graduates from the college. Both pieces of research seek to gain an understanding of the comparative issues surrounding the development and utilisation of engineers and the relative implications for the industries in which the engineers are employed.

Many writers have suggested, more by way of complaint than of an opportunity, that engineering today is, by nature, a commercial activity; that engineers are employed in profit making enterprises and that they practice their `craft' not in any professional isolation but in a fiercely competitive environment. It appears from the results, that the case study firm was perhaps most in error in the selection and implementation of business strategies appropriate to the product and labour market, in which they were operating. These were manifest in the experiences and attitudes of the engineers studied.

It has long been perceived and widely discussed, that one of the many determinants of the success of Japanese electronics companies is related to the integration of business strategies, organisational structure and personnel practices, particularly Human Resource Development. While it is widely agreed that `wholesale' adoption of Japanese practices is not possible, even if it was at all desirable, the U.K. engineering industry could benefit from understanding the origins of competitor nations relative success with regard to the development and utilisation of technical skills.

One aspect of the manufacturing process, which is a key determinant in the success of the firm, is the management of the design process. From the results, it was seen that in the case study firm, the design and development process was, to a large extent, functionally divided as a consequence of which the engineers involved expressed lack of understanding of "the whole project". Communication between interacting departments was perceived to be less than optimal. In discussion with one of the departmental managers, he described the flow of work between the areas up to that time as characterised by the philosophy that "when your bit's done you chuck it over the wall" to the next department and "then it's their problem."

This imagery was also picked up by a research team at the Imperial College investigating the management of the design process. They identified three broad types of design process which they described as the "relay race" , "volleyball", and "rugby team" approaches. (Francis and Winstanley, 1988 and 1989.)

In the TV firm, the approach to design described in the previous chapters can be seen to be somewhere between the "relay race" and the "volleyball" approach. The first approach is described by the Imperial team as characterised by a sequential design process, in which there is an isolated design function, which, on completion of designs, passes them on for development and to be "productionised". Any barriers between the functions may include geographical separation, poor design procedures and poor communication systems or an aversion to effective inter-functional communication.

The second type, the "volleyball" approach, represents an iterative design process in which the "ball" is passed from design, to draftspeople, to development, to test and production and then to and fro between them until final production and, eventually, to the market. This, they claim, is said to be one of the most typical of British design methods.

Ferguson were making attempts to overcome geographical fragmentation of the design process by moving all the R&D functions to the one site. They were further attempting to integrate the other engineering functions by providing, through the re-furbishment, an "Engineering Centre", a building in which AD, PD and much of ESD would all work. The management systems and the provision for inter-function communication was, however, identified by the engineers as one of the major sources of their frustration and work dissatisfaction. Inadequate documentation and poor "handover" of work was given on many occasions as the source of a group's problems.

In the third analogy, the "rugby team", designers and production staff are all seen to be "on the same side", working together towards a common goal. This approach is also described as iterative, although as the "ball" is passed between them, they are moving forward, gathering speed until a "try" is scored when the product reaches the market.

Clearly, there are advantages and disadvantages in all the processes. Inevitably, the "relay race" approach carries high design and production costs, and at the end, as one Ferguson AD engineer commented, the product will leave the factory "looking like it needs another six months development". The disadvantage of the "volleyball" approach is again high costs and long lead times, a problem which can be seen to be reduced in the "rugby team" approach, although here there may be an added risk of losing intra-discipline communication.

Some attempts were being made within the T.V. company to move towards "project management" but the idea appeared to be functioning only on a limited basis.

Some of the managers interviewed in the first stage of the Imperial College "design management" study, alleged that one of the typically British design practices which result in long lead times stems from being "research led " rather than "application lead". In the case of the TV firm, during the re-organisation, the emphasis in the company had actually been switched from being "technology lead" to being "market lead, employee driven." This, as has been illustrated, placed considerable demands on the organisation and individuals within it. The flexibility and "organic" structure which would have been be advantageous to to the firm operating in a market led environment would have required considerable shared responsibility.

Struggling to operate within an inappropriate organisation structure, was however, found not only to be a problem facing Ferguson. From the Imperial College research, it was found that a number of companies in their sample were also struggling with inappropriate and outdated organisational hierarchies which were proving impossible to use effectively.

In addition to the development of more "organic" organisation structures, the development of product teams of engineers has often been advocated. The conception is that the functional boundaries will be blurred. This may be achieved in several ways. One would be by the cultivation of multi-functional engineers, who would not claim to belong to any of the existing specialisations such as design, development or production, but whose work would comprise aspects of that held previously to be the territory of more than one engineer. An alternative would be to create teams of multi-disciplinary engineers, who although being specialised in one discipline, for example electronics or production, would have a knowledge and understanding of other disciplines and perhaps of management and business. The thinking behind many of the modifications to the engineering degree structure over recent years, much of which arose from Finniston, has reflected this approach.

Clearly, for industry, it is a matter of selecting an approach which is again, appropriate to both the product market and the internal and external labour market and deciding at which point on the continuum from "specialist" to "generalist" the teams will operate.

From the interviews and observations, in the T.V. company, considerable frustration was found regarding the time pressures towards the tail end of development, immediately prior to production, caused by delays earlier in the system. Criticisms were also made that products consequently reached the market having had incomplete development or having been produced on less than optimal equipment and tested on gear that was developed in a fraction of the time originally scheduled, with all the ensuing product quality consequences. It was suggested to the Imperial team by some of the companies involved in the initial stage of their research, that this problem is a common one and that a possible strategy for overcoming it would involve planning the peak of the work load early in the project, with greater analysis at that stage. The obvious disadvantage of mis-managing such a strategy is the danger of long and costly lead times and designs failing to be converted to marketable products within the time and cost constraints imposed.

In the TV plant, the manufacturing technology was on the whole very advanced, with maximum use made of auto-insertion equipment. In fact, at the time of the research , the factory boasted the most extensive use of auto-insertion equipment in their field in Europe. Computer controlled video test gear was also being introduced and CAD was used widely in both product and process design and development. Despite the hardware being available, the engineers still alleged that the organisational systems prevented the optimum co-ordination of functions and thus reduced the realisation of the advantages to be gained from the equipment. While many companies introduce shift-work in order to make fuller, more cost effective use of CAD, in the T.V.firm one of the the engineers experienced disillusionment as a result of being asked to use the CAD equipment to lay-out the department's new floorplan, for designing forms and even calendars, due to the absence of other purposeful work.

Much of the discussion above has focused on circumstances within the internal labour market. At the same time, in addition to experiencing changes in the product market and the internal labour market, companies in the electronics industry and engineering in general are facing considerable changes in the structure of the external labour market. As was illustrated in the introductory chapter, employment across all levels in engineering is declining but this hides the fact that the numbers of professional engineers, scientists and technologists, are increasing. According to the EITB, between 1978 and 1985 there had been an increase in this sector of the workforce, of 46.5% (EITB Occupational Profile: Trends in Employment and training of Professional Engineers, Scientists and Technologists in the Engineering Industry. Geoff Mason. June 1986).

As was found in Ferguson, the educational make-up of the workforce is also rapidly changing. It has been shown that the numbers of graduates in the external labour market has increased and the number of those qualifying only to the level of HNC or HND or their BEC/TEC equivalents is decreasing. The reasons for this include greater availability of University education to those who for financial reasons would have in past decades found it impossible, and a higher proportion who delayed entering the labour market during periods of high unemployment.

It is widely alleged that there is a gap between the demand for, and the supply of qualified technical staff, particularly graduate engineers. Yet, as has been described, there is considerable evidence from a wide variety of sources to suggest that there is a `lag' in companies adaptations to the skill requirements and skill availability which they face. When asked by the Imperial College "design management" research team, why their company was moving into the employment of graduates in design, a common explanation was a "skills gap". It was alleged by the companies that with the huge expansion of tertiary education, technicians and technician apprentices were hard to find and the individuals, who would previously have entered industry at this level, were now going to university. Consequently, the graduates left university with high career expectations and with knowledge which the company was unable to use, but without some of the operational skills the firms required. This reduction in the numbers of school leavers going straight into industry will also increase in the future with the predicted fall in that age sector of the population.

Complaints have been made by engineers, in the Ferguson research, of poorly structured career ladders, poor allocation of tasks, poor rewards and under- or mis-utilisation of their skills. This suggests that a problem has arisen related to firm's management of the graduates and non-graduates they employ. In a situation of skill shortage, it could be argued that promotion opportunities might be at their best and career paths would be characterised by rapid promotion and progressively increased responsibility, depending on where in the hierarchy the shortage was perceived to be.

This raises questions about the "skills gap", regarding the development of the human resources available to companies in the industry, in view of the general dissatisfaction of engineers with the training they receive. As the discussion above suggests, questions must also be asked regarding the match between the product market situation of the firm, and the organisational structure and internal labour market.

From this, it appears therefore, that the blame for the alleged skill shortage cannot be laid solely at the feet of the Universities. Nor can the problem be resolved simply by increasing pay, the image of the industry or the professional recognition and social status of engineers. Resolution of all these issues may accompany the solution to the skill shortage problem but are more symptomatic than causal. The problem to be overcome is the relative decline and poor performance of much of the U.K. electronics industry or, in the case of this research, the U.K. TV manufacturing industry. It is a poignant reminder of the severity of the problem, that since beginning the research, the sale of Ferguson to the Thomson Corporation of France marked the end of the British TV manufacturing industry.

It is therefore concluded, from this research that the engineering skill shortage problem is actually only symptomatic of the wide variety of managerial problems and opportunities currently facing the U.K. engineering industry. Few of the problems are `new', but have been brought to greater prominence by the changes described, in technology, in education, and the nature of the external labour market.

Therefore, it is believed that for the successful resolution of these problems, attention must not focus only on the skill issue. Rather, attention must be given to re-shaping management systems, moving to a more project based organisation and developing an effective Human Resource Development programmes for engineers, which would then contribute to the increased performance of the industry against growing international competition. It is believed that accompanying this, and as a result, firms will face less of a shortage, engineers will have fewer complaints about mis-utilisation and career structures can be developed to the mutual benefit of the individual and the company for whom he works.

In the following chapter, the conclusions which can be drawn from this study are presented and some implications for the future, particularly policy options for companies facing problems of this nature are proposed.

CHAPTER SEVEN.

CHAPTER SEVEN.

CONCLUSION.

1. INTRODUCTION.

This research was designed to explore the shortage of engineering skills in a firm manufacturing Televisions, Video Cassette Recorders, and producing Printed Circuit Boards for third party companies. Starting from the findings of the Finniston Inquiry, the hypotheses was developed on the engineering skill shortage debated since that Inquiry.

The key arguments presented by previous researchers can be seen to operate on three levels and from three different perspectives.

First, at the level of the state, allegations have been made that the British secondary and higher education systems are inadequately meeting the requirements of the engineering industry both quantitatively and qualitatively. In addition, it has been declared necessary to re-assess Government investment policies regarding manufacturing, and the U.K. electronics industry in particular.

Second, amongst the professional associations, it is believed that it is necessary to increase the status of engineers, both within industry, and in British society.

Finally, within manufacturing companies, claims have been made that comparative pay levels are unsatisfactory, that career lines for engineers are unfavourable, and that their skills are often not fully utilised, due to the nature of their roles within industry.

Extensive desk research showed that while some of the above arguments could contribute to a raft of policies designed to reduce the extent of the shortage, neither alone, nor together do they either satisfactorily isolate the causes of the shortage or lead to totally satisfactory solutions.

Several questions clearly remain unanswered. At the level of the state, how successful can measures aimed at reducing the skill shortage in the consumer electronics industry be, while national defence procurement policies favour investment in specialised 'leading edge' technical systems? Such projects have attracted much of the highest skilled scientific and technical manpower, but their uncertain nature has often led to cancellations and failure to utilise knowledge gained for 'civilian' or general usage. The current situation in consumer electronics has evolved during the post-war period as U.K. companies have found themselves unable to compete with foreign manufacturers and have increasingly withdrawn from this sector only to see Japanese and other competitors set up perfectly viable plants in the U.K. but with research and development facilities overseas.

Facing the professional associations is the question of their role over the coming years in the engineering industry. Will the distinction between them and the trade unions serving the industry become more blurred ? In view of the nature of the work carried out by engineers in their employing organisations, how valid is it to pursue any kind of traditional professional model as a route to improving the social status of the profession and thereby reducing the skill shortage?

In this final chapter we consider again the argument in my hypothesis that changing the management systems and organisational structures to those more appropriate to changing product and labour markets will have an impact on engineers' satisfaction, turnover and thereby reduce the alleged engineering skill shortage. We look at the strategic response and policy making implications for other organisations in similar situations, particularly from a Personnel Management perspective and consider the implications for future research.

In the light of the weaknesses evident in existing arguments, the aims and strategies of this research were re-assessed and, in this study, it was decided to focus on the level of the firm; that is, the perceptions engineers held regarding themselves, their work and the company, and whether the firm's business and personnel policies were appropriate to the product market and the external labour market environment.

An important finding of this research was that the engineering skill shortage facing the firm was not a simple matter of a lag in supply catching up with demand, but was also dependent upon the firms general business and personnel strategies, and their adaptation to the demands of the product market. The firm had committed itself to a new market orientation, and acknowledged that the T.V. market was no longer a predictable and relatively static one. Televisions had become fashion products, and the market volatile, demanding rapid response if products were to remain competitive.

Under the re-organisation, however, the product design and development process, had been subdivided functionally, and work was passed from department to department until the product left the factory for final assembly. The most common grievances expressed by engineers in all departments related to the workings of this functional division.

In the previous chapter we saw the hypothesis confirmed that engineers were dissatisfied with their professional roles, their careers, autonomy and utilisation. The dissatisfaction was found to increase in the product development and engineering modifications sections where engineers were instructed to solve many small technical problems. Similarly the converse hypothesis was confirmed that where work allowed professional or occupational autonomy, the employees were less dissatisfied, for example in the A.D. department.

Many of the dissatisfactions the engineers expressed regarding their work were therefore found to be largely rooted in the nature of organisational systems. Similar experiences were reported by engineers in another sector of the electronics industry and such organisational problems were found to be fairly common to other engineering companies, as was seen from the preliminary findings of the Imperial College study.

We must consider now the third and fourth hypotheses made at the beginning of Chapter three. There it was suggested that the degree of dissatisfaction and utilisation of talents can be affected by H.R.D. policies and a change in organisational structure. It has been hypothesised that these policies can reduce the impact of any perceived skill shortage by facilitating the optimum use of capabilities and reducing labour turnover. First we look at the specifics of the Ferguson case, then the remainder of the chapter is devoted to a presentation of the general principles from which organisations facing the same pressures might learn.

2. FACTORS FACING THE CASE STUDY PLANT.

(a) Amongst a complex set of business environment changes, the most notable can be the arrival of new forms of product competition which call for changes from the firm in order to maintain or increase it's market share. The organisation will inevitably experience some period of lag during which the internal labour market adjustments are made. The length of the `lag' and the nature of the adjustments made, however, are the key to either restoring equilibrium, or risking further deterioration in performance. It was seen that Ferguson's existing engineering organisational systems including a hierarchy of skills, functional division of tasks, ineffective routes of communication especially in design and development and ambiguous career net-works were becoming inappropriate to the needs of the plant. Thus amongst the most pressing challenges facing the firm was the need to move towards organic, flexibly working, dynamic teams, capable of turning designs, whether originating in AD or marketing, rapidly into quality saleable products, and in a manner which fulfilled more of the engineers' work expectations.

It was evident from the case study that the success of Ferguson in meeting such demands depended on their ability to undertake further internal reorganisation and cultural change. Although the impetus for change was external the basis of the solution lay in effective Human Resources Development (H.R.D.) and Human Resources Management (H.R.M.) policies.

Ferguson did not employ anyone whose function was specifically to undertake H.R.D., although some awareness of appropriate H.R.D. policies was evident. The firm was primarily concerned to recruit engineers of the right calibre and this had increasingly meant graduate recruitment. Graduates represented a broad and regular supply of generalists who were relatively cheap to replace. However the high expectations of the graduate engineers, where they were not met, were the source of considerable dissatisfactions.

(b) Technological advances with regard to the product and the manufacturing process was also forcing the firm to restructure the organisation of it's engineering and design services. New operating structures and systems, new skills and knowledge were required, including Marketing, which was an activity in which until recently, the firm had not been greatly involved.

External factors which contributed to low technical skill supply included a limited local labour market in the northern suburbs of London, and an inability to attract engineers to the plant partly on account of local housing costs. Internal supply problems were exacerbated by staff turnover, limiting Ferguson's ability to develop new skills quickly.

(c) In this plant, the Personnel department itself had undergone considerable restructuring to cope with new pressures facing the workforce and the company as a whole. What appeared to be lacking was evidence of their ability to act as developers and change agents. The specific knowledge and competences required to build on the technical and conceptual changes already taking place were underdeveloped.

However, within the plant, there was a fairly well established management development role which, with some room for improvement provided various management education programmes. It would be here that programmes aimed at providing new organisational concepts and systems of management might originate.

(d) As part of the company's approach to new market pressures, quality assurance had become a central feature of their strategy. The quality drive was understood across the plant and was evident in the work of A.D. on improved product features, and the research into new production processes. However the inadequacies of the production lines and the poor management of the design and development system thwarted many of the best intentions.

(e) The central constraint which was at the heart of the problems reported by the engineers was the lack of plant managerial capacity both to reshape the engineering workforce into effective product teams and to plan for a comprehensive development programme to upgrade the skills and knowledge of technical specialists on a long term and continuous basis. Although the study showed a high level of company identification and loyalty among engineers, this advantage was not being utilised and was in fact being dissipated in engineer dissatisfaction.

3. GENERAL FACTORS AND CONCLUSIONS TO BE DRAWN.

In a climate of change in the U.K. electronics industry, and with increasing numbers of firms reporting an escalating skill shortage problem, there are several policy options open to the firm, for the reduction of the impact of any technical skill shortage in the external labour market. Several fundamental measures can thus be identified which firms in similar situations might consider valuable.

Conceptually, a viable approach would include the following elements:

a) Clarify business strategies. Quality product development and marketing objectives are key here.

b) Translate such business strategies into technical manpower requirements.

c) Define the **key** technical manpower requirements.

d) Examine **why** there are shortages of such key skills. This will involve an examination of the development of skills, labour turnover, and difficulties in attracting talent to the company. Also the firm must examine it's organisational framework, and whether any move is required away from former skill specialisations.

e) Develop organisational systems to provide these skills, for example Human Resource Development programmes, improved recruitment, and rewards for learning. Also Organisational Development may be required, as will examination of the existing career hierarchies and existing systems of communication.

f) Develop operational systems and personnel responsible for constantly assessing skill needs, section by section and re-allocating personnel or teams.

g) Develop a change strategy to provide the above.

Taking each of the above in turn, **clarifying the business strategy** will enable the firm to understand fully the implications of the product market in which it is operating. It will be necessary to determine the duration of product runs, the time and cost involved in 're-tooling', the product unit costs, and to establish an investment strategy for both capital and manpower.

Translating the strategy into technical man-power requirements, demands establishing, through detailed long-term man-power planning, the needs of the firm. For example with a high-technology product, but with long product runs it may not be necessary to employ the same proportion of graduate development engineers as would be required in a firm producing a slightly lower-tech product but with short product runs, and in a volatile market and with high volume, low unit value output. In a technology centred firm it is vital to balance this strategic product management with effective `people management'.

Defining the key technical manpower requirements will enable the firm to develop appropriate personnel, and particularly recruitment and training, policies to ensure that those requirements are met. The Personnel Management function therefore becomes increasingly one of H.R.M. and H.R.D. in that it is essential that a strategic view is taken of the whole range of personnel practices in relation to business activity as a whole.

The acquisition of skills is a serious concern of any firm facing change or growth. **Examination of why there are shortages of key skills** in the internal labour market is essential and will enable the firm to reveal any mis-, or under-utilisation of technical manpower which has contributed to turnover. An examination of the external labour market will enable the firm to identify training and development requirements, and to establish effective ways of providing necessary skills, or other ways of overcoming the shortage.

Developing the organisational systems to provide these skills will require careful examination of the most appropriate strategy or combination of strategies. In reality, it may be necessary to simultaneously embark on new training and development initiatives, revise recruitment policies, restructure existing career patterns, and improve communication networks. It is also vital to develop new operational systems to allow skilled technical specialists to be re-allocated to new tasks, either individually or through teams moving to new projects.

4. SPECIFIC PERSONNEL AND HUMAN RESOURCE MANAGEMENT POLICY IMPLICATIONS.

Several Personnel strategies exist for overcoming the internal skill shortage. The development of such strategies will, however, necessitate careful determination of priorities, according to the shortage of key technical skills, financial and other resources, and any factors influencing the product market and labour market which might influence the timing of changes.

(a) The manipulation of recruitment criteria.

Two strategies exist, raising or lowering recruitment standards, both in turn heavily reliant on training and development. Raising them would provide the firm with a more flexible skill base, but would require skilful management in terms of career opportunities, training and employment conditions. The shortage in the external labour market, combined with additional external factors makes this a less practicable option than the second.

Here, relaxing the standards would have the effect of broadening the recruitment net but would impose a pressure on training to bridge the gap between job skill requirements and entry standards. Training policies, including a new approach to OJT and the use of external educational facilities for `mid-career' education would have to be redefined.

(b) Greater pay flexibility

This also would facilitate internal skill retention. It would be assisted by a change to skill structures and the integration of job categories, with the primary effect of increasing flexibility. This requires further careful personnel management.

(c) The appraisal system

This would become crucial for assessing performance and promotion readiness, to link cultural changes to rewards and to identify training needs.

(d) Training

Training is fundamental to skill supply, but can also be used as an internal communication tool. Increased investment would be required as broader general training might be necessary at entry points where lower skill standards were evident. Similarly, re-training activities of a project-based nature could be increased, being triggered by changes in product design, production processes or management systems. This clearly must be linked to an organisation's drive for increased competitiveness.

(e) Human Resources Management.

Finally, I would suggest that it is necessary for any firm facing the same skill shortages and external pressures as the case study firm, to have within the Personnel function the skills to link together business, technical and H.R.M. requirements. This should not simply be the role of one specialist but, I would suggest should be a skill distributed throughout the organisation including director level. This would be greatly facilitated by increasingly involving senior line management in H.R.M., and conversely, Human Resource Managers in line management. This allows for the constant individual attention to development and utilisation of capacity, which is at the heart of the engineering role issue.

5. IMPLICATIONS FOR FUTURE RESEARCH.

It appears beyond doubt that within the British engineering industry, and in Electronics in particular, there are skill imbalances. This research has addressed the problem of the alleged engineering skill shortage from the perspective of one firm experiencing the problem and also facing pressures from a changing environment.

I would suggest that future research must address the methods by which organisations adapt to external pressures impinging on the internal technical skill supply. It is necessary to examine the measures firms take to overcome technical labour turnover, and by what means and with what objectives they train and develop engineering talent within the organisation.

I believe it is important to gain an international perspective on the issue, for which it would be valuable to compare the experiences of British engineers and their employing organisations with those employed in firms throughout the rest of Western Europe and the Far East. There is some evidence to suggest that in some Western European countries and in Japan the technical skill shortage problem is less acute and is overcome with greater success in terms of company profitability and the career satisfaction of the engineers employed.

In the U.K. greater demands will inevitably be made of the Personnel and Human Resource Management functions, demands which will be compounded by demographic factors including a relative decline in the number of school leavers and fewer graduates.

As attention is increasingly focused on recruitment policies, career structures, payment systems and H.R.D. generally, a proactive function must arise within organisations which will manage the interaction of product, and the internal and external labour markets more effectively than has been reported throughout much of this thesis.

This research sought to challenge some of the commonly propounded solutions to the engineering skill shortage by drawing on a deeper understanding of the technology and organisation of one sector of the industry, TV manufacture. Ways have been suggested in which the problem can be alleviated. It has also been shown that this research does not depict an isolated exception but that the findings are corroborated by other contemporary studies.

It is however, only too clear that there is yet much to be learned and still more to be achieved in order to overcome not only this symptomatic problem of engineering skill shortage, but to prevent British Electronics, Engineering, and perhaps the U.K. manufacturing industry in general, falling further behind the growing overseas competition.

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APPENDICES

APPENDIX I

APPENDIX I

TERMS OF REFERENCE

FOR THE FERGUSON, L.S.E ENGINEERS PROJECT.

1. To describe and analyse ;

   a) the individual characteristics, education, training and experience and careers of the engineers employed by Thorn EMI Ferguson,

   b) the present and emerging work organisation of the engineers concerned, through observation and informal interviews,

   c) the attitudes, expectations and perceptions of the engineers to their work, future careers, identity etc. This is to be studied through briefing groups and a self-administered questionnaire.

2. To check the validity of the data collected and interpretations of this information by small group feedback and discussion, first with a few of the engineers involved, and after this , with a group of management staff, engineers, and union and professional representatives if relevant.

3. To report back to the steering committee with the analysis of these results and as suggested plan for the next stage of the research.

APPENDIX II

APPENDIX II

THE QUESTIONNAIRE

The questionnaire is to be found in the pocket on the back cover of the thesis.

THE INTERVIEW STRUCTURE

The interviews were structured around the following guidelines.

BACKGROUND

Age:

Position:

Length of service,

with the company:

in present position:

Do you supervise anyone ?

How many ?

EDUCATION

Apprenticeship, degree or other qualifications ?

Why did you choose to take that course ?

Are you studying for any further qualifications at the moment ?

What has the route been from your first qualification to where you are now ?

The relevance of your course to your work:

Is that as a result of the work or the course ?

REASONS FOR JOINING THE COMPANY

What attracted you to the company/ your present position ?

Do you feel you have been able to contribute as much as you would have liked to ?

PRESENT POSITION

(Question 8 on the Questionnaire.)

What are your feelings towards the company ?

Why ?

(Question 11 on the Questionnaire.)

Given the opportunity to change jobs . . . .?

Why ?

TRAINING

In what ?

How useful was it ?

CAREER

(Question 51 on the Questionnaire.)

What were and are your career aspirations ?

Why ?

ATTITUDES AND SATISFACTIONS

(Question 53 on the Questionnaire.)

On a 1-5 scale (Very dissatisfied to very satisfied) ;

Satisfaction with general promotion opportunities:

" " technical " " :

" " managerial " " :

" " relationship with your boss :

" " opportunity to participate in managerial decision making :

" " training and re-training :

" " extent to which you find your work interesting:

" " extent to which you can use your technical expertise at work :

" " pay and conditions :

" " hours :

" " holidays and leave :

" " present working environment :

" " proposed working environment :

" " status (both personal and professional) :

A "GOOD" AND A "BAD" EXPERIENCE AT WORK ?

Describe!

ANY OTHER COMMENTS ?

ANY SUGGESTIONS ?

APPENDIX III

THE REPORT PRESENTED TO THE FIRM

The report presented to the firm is to be found in the pocket on the back cover of the thesis.

APPENDIX IV

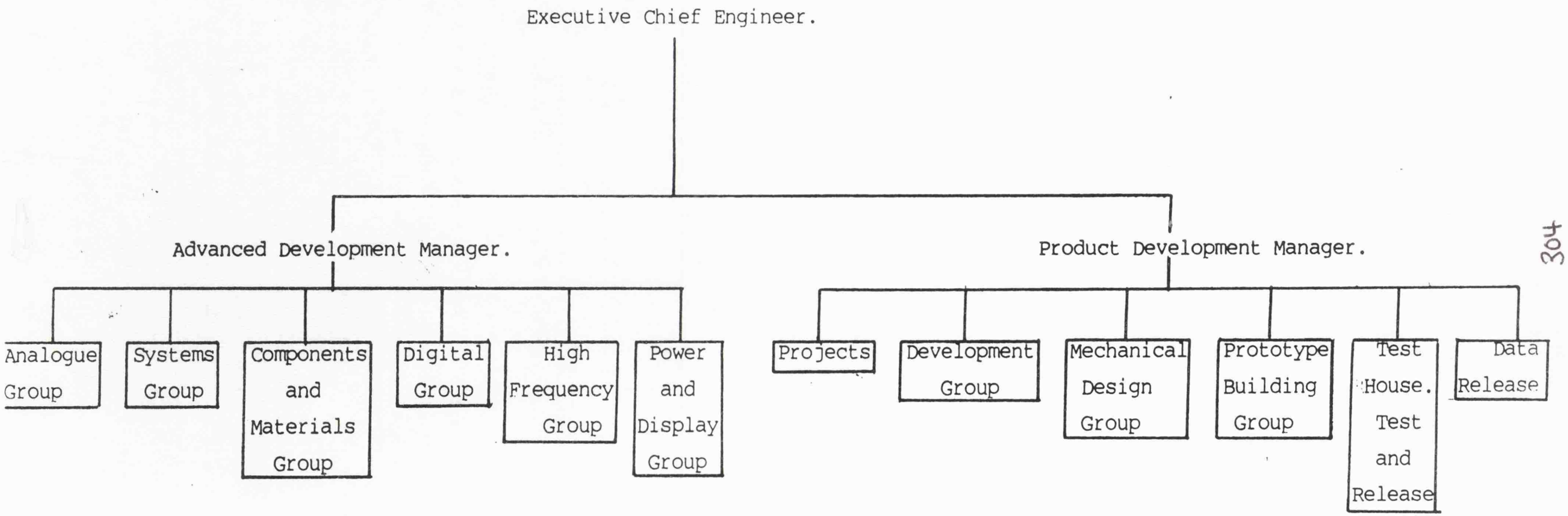
APPENDIX IV

ORGANISATION CHARTS OF THE ENGINEERING DEPARTMENTS.

The organisation chart of Engineering Services Division is to be found in the pocket on the back cover of the thesis. The organisation chart of the Product Development Centre is overleaf.

Appendix IV

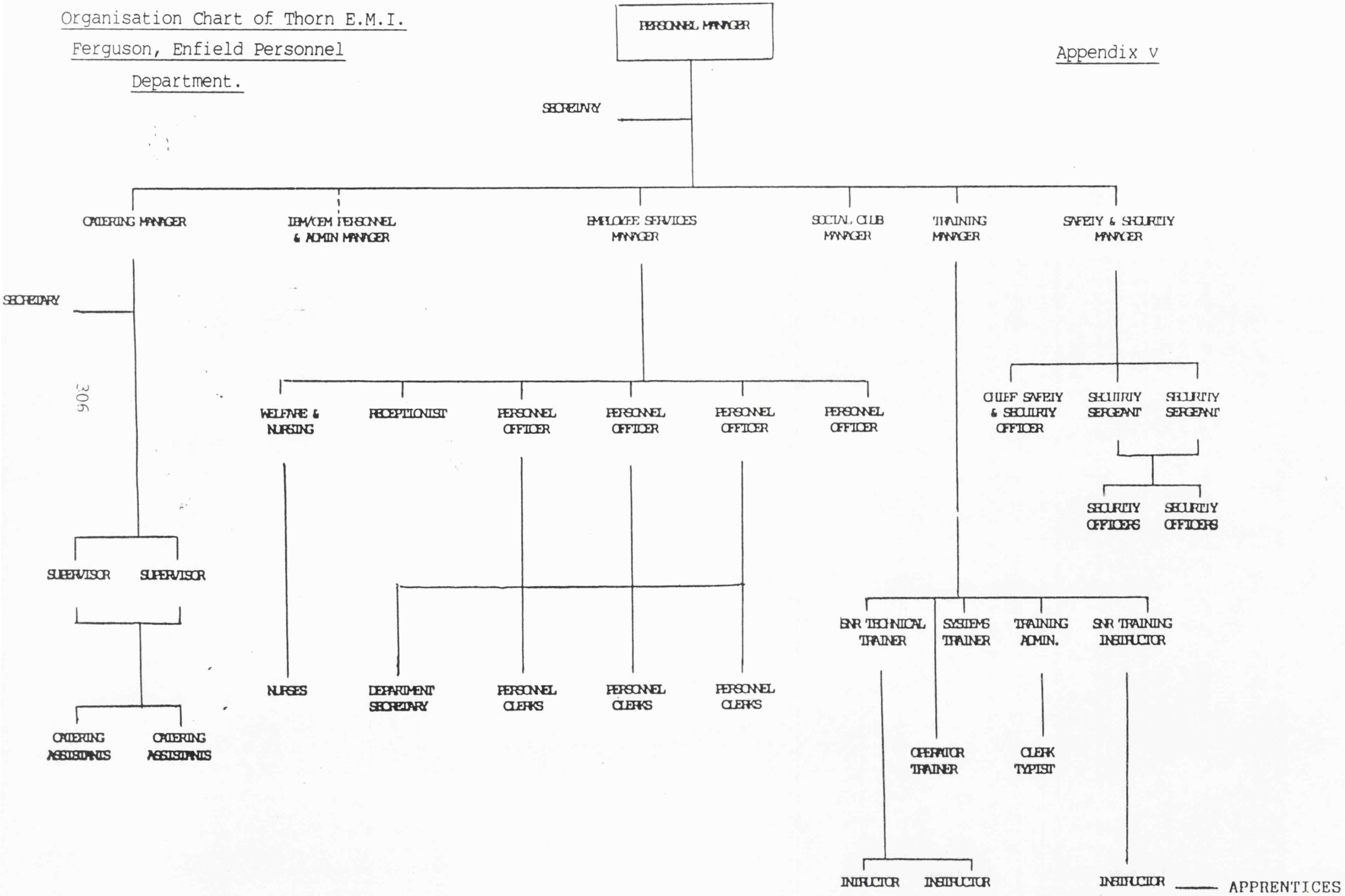
Organisation Chart of Thorn E.M.I. Ferguson Product Development Centre.



APPENDIX V

Organisation Chart of Thorn E.M.I.
Ferguson, Enfield Personnel
Department.

Appendix V



Appendix II

FERGUSON ENGINEERS QUESTIONNAIRE

01	02	03	04	05	06
1	1	1			

PRESENT POSITION

1. What is your job title as given in your job description ?

   Title ______________________________ (07)

2. Which one of the following would you say you are engaged in for most of your work time ?

   Research 01 Design 02 Development 03 Production 04 Test and Inspection 05

   Sales 06 Purchasing 07 Teaching and Training 08 Marketing 09 (08-09)

   Non-technical management 10 Technical management 11 Administration 12

   Quality assurance 13 Planning 14 Other (Please specify) 15 ______________

3. Are there any employees under your supervision ? YES 1 NO 2 (10)

   If "NO", please now move to Question 6.

4. If YES to Question 3. , how many ? (11)

   Up to 5 1 6-10 2 11-15 3 16-20 4 21-30 5 31-50 6 Over 50 7

5. Please give the lowest, and the highest grades of those under your supervision.

Highest grade.	T1	T2	T3	T4	P1	P2	P3	P4	P5	(12)
	1	2	3	4	5	6	7	8	9	
Lowest grade.	T1	T2	T3	T4	P1	P2	P3	P4	P5	(13)
	1	2	3	4	5	6	7	8	9	

6. How long have you worked for Ferguson ? (14-15)

Less than a year 01

Between:

1 and 2 years	02	2 and 3 years	03	3 and 4 years	04
4 and 5 years	05	5 and 6 years	06	6 and 7 years	07
7 and 8 years	08	8 and 9 years	09	9 and 10 years	10
10 and 20 years	11	Over 20 years	12		

7. Why do you think you were initially offered a position by Ferguson ? (16)

Ferguson needed your specific skills and knowledge. 1

Recommendation from your college. 2

Recommendation from previous employers. 3

To complete apprenticeship. 4

Ferguson recognised your potential and offered you a training position. 5

Other. (Please specify) ______________________ 6

8. What are your feelings towards Ferguson ? (17)

I would like to put my best efforts to the company's success 1

I would like to give as much effort to the company as the company gives in reward. 2

I do not have much feeling towards the company. 3

I am indifferent to any matters concerning the company. 4

9. How long have you held your present position ? (18-19)

Less than a year 01

Between:

1 and 2 years	02	2 and 3 years	03	3 and 4 years	04
4 and 5 years	05	5 and 6 years	06	6 and 7 years	07
7 and 8 years	08	8 and 9 years	09	9 and 10 years	10
10 and 20 years	11	Over 20 years	12		

10. Which of the following best characterizes your main reason for accepting your present position ?

Please indicate the number coresponding to the main reason in the left hand two boxes below, and, if you wish to choose more than one, the second reason in the right hand two.

Location 01 Salary 02 Status of the position 03

Reputation of the company 04 Management opportunity 05

Research opportunity 06 Technical opportunity 07

Lack of alternative 08 Because you enjoy the kind of work 09

To continue to benefit the company by your skills 10

Other (Please specify) 11 (20-21) (22-23)

____

1. Given the opportunity to change your job, which one of the following would you most like to do ?

I would like to stay in my present job.	1	(24
I would like to be promoted to a job with added responsibilities.	2	
I would like a job within the company which enabled me to use more of my technical expertise.	3	
I would like to reach a supervisory or management position.	4	
I would like to join one of the commercial departments.	5	
I would like to be self-employed	6	
I would like to join a consultancy.	7	
Other (Please specify) ________________________________	8	

12. When you accepted your present position, which one of the following did you think was the main strength you could bring to the job ?

Product technical knowledge. 1 Process technical knowledge. 2

Management ability. 3 Market knowledge. 4 (25)

Other (Please specify) 5 ____________________________

13. Which additional skills do you now believe you needed more of, in order to successfully meet the demands of your present job ? If more than one, please put your first choice in the left hand box, and your second in the right hand box.

Technical 01 | Managerial 02 | Marketing 03 | Design 04 | Development 05

Production 06 | Financial 07 | Project analysis 08 | General practical experience 09

None 10 | Other (please specify) 11 ____________________________

(26-27) (28-29)

14. Which of these skills referred to in Question 13 have you been trained in since taking up your present position ?

Please indicate only the number corresponding to the skill.
If you have been trained in more than one, please give the numbers in the box below, beginning at the left hand side.

(30-31) (32-33) (34-35)

If you have answered "none" to this question, please now move on to Question 16.

15. What format did this training take ?

Internal classes or seminars. 1 | Written Manuals. 2

Formal on-the-job experience eg. Job rotation. 3 (36)

Other on-the-job training. 4 | Off-the-job technical training. 5

Other. (Please specify) 6 ____________________________

16. Have Ferguson ever assigned you to any areas outside your principal responsibility, purely in order to familiarise you with other aspects of the company's operation.

To answer this question, please give the numbers only in the boxes below, beginning at the left.

Research	Design	Development	Production	Test and Inspection
01	02	03	04	05

Sales	Purchasing	Teaching and training	Marketing	Personnel
06	07	08	09	10

Finance	Administration	Service	Work study	Resource planning
11	12	13	14	15

Other (Please specify) ______________________________
16

No other areas
17

(37-38) (39-40) (41-42)

17. Have you ever held a management position. YES 1 NO 2 (43)

If "YES", please give the title of the most recent, ______________________________________ (44)

and the grade.	T1	T2	T3	T4	P1	P2	P3	P4	P5	Higher	
	01	02	03	04	05	06	07	08	09	10	(45-46)

If "NO", please now move to Question 21.

18. How important was your technical background to your first managerial position ? (47)

Irrelevant	Not really important	Neither important nor unimportant	Quite important	Very important
1	2	3	4	5

19. What was the title and grade of your position immediately prior to your first management position ?

Title: ____ (48)

Grade:	T1	T2	T3	T4	P1	P2	P3	P4	P5	Higher	
	01	02	03	04	05	06	07	08	09	10	(49-5[illegible]

20. What age were you when you became a manager ?

Under 20	21-25	26-30	31-35	36-40	41-45	(51-52)
01	02	03	04	05	06	
46-50	51-55	56-60	Over 60			
07	08	09	10			

21. Is your present immediate superior an engineer ? YES 1 NO 2 (53)

22. Does your present immediate superior have;

engineering qualifications, 1 engineering experience, 2 both or 3 neither 4 (54)

EDUCATION

23. Which of the following, or it's equivalent from outside the English education system, is the highest academic qualification you hold ?

C.S.E 01 'O' Level 02 'A' Level 03 O.N.C. or BEC/TEC Equivalent. 04

O.N.D. or BEC/TEC equivalent. 05 H.N.C or BEC/TEC Equivalent. 06

H.N.D or BEC/TEC Equivalent 07 Batchelor's degree 08 (55-56)

Master's degree 09 Doctorate. 10 Other (Please specify) 11 ____________

24. Into which one of the following categories could you best fit your course, or the main subjects studied ?

Mechanical engineering 1 Electrical engineering 2 Electronic engineering 3

Production engineering 4 Industrial engineering 5 Work study 6 (57)

Radio/T.V. engineering 7 Computer science 8 Other (Please specify) 9 ______

25. Was your course a "Sandwhich Course" YES 1 NO 2 (58)

If "NO", please continue to Question 28.

26. If "YES" was it a "Thin" (1) or "Thick" (2) sandwhich ? (59)

27. Did you spend the industrial release period with Ferguson ?

YES 1 NO 2 (60)

28. How relevant were the following aspects of your principal college course to the needs of your first job in engineering ?

1 ________3 ________5

Completely irrelevant Very relevant

Lecture material.	1	2	3	4	5	(61)
Tutorial discussions.	1	2	3	4	5	(62)
Practical exercises.	1	2	3	4	5	(63)
Equipment used for practicals.	1	2	3	4	5	(64)

29. Was the subject you studied at college your first choice at the time you were deciding which courses to apply for ?

YES 1 NO 2 (65)

If "YES", please continue to Question 31

30. If "No" to Question 29, what subject would you have preferred to study ?

Preference ____ (66)

31. Was there a time interval between when you first left full-time education, with no plan to return, and when you began your highest academic/ professional qualification ?

YES 1 NO 2 (67)

If "NO", please continue to Question 33.

32. If "YES" to Question 31, how long was the interval ?

Less than a year 01: Between: 1 and 2 years 02 2 and 3 years 03

3 and 4 years 04 4 and 5 years 05 5 and 6 years 06

6 and 7 years 07 7 and 8 years 08 8 and 9 years 09 (68-69)

9 and 10 years 10 10 and 20 years 11 Over 20 years 12

33. What was your primary reason for choosing to study for this academic/professional qualification ?

Improve your chances of promotion. 1

Improve your abilities and position in the job market. 2

Increase your job competence. 3

To develop a specialisation. 4 (70)

To train for the sort of work you wanted to move into. 5

Interest in the subject. 6

Other (Please specify) ______________________________ 7

01	02	03	04	05	06
1	1	2			

34. Are you currently engaged in any course of study for an academic/professional qualification ?

YES NO (07)
1 2 If "NO", please continue to Question 37.

35. If "yes" to Question 34, please give the title of the course.

Course title. ______________________________ (08)

36. What was your primary reason for choosing to study for this current higher qualification ?

Improve your chances of promotion. 1

Improve your abilities and position in the job market. 2

Increase your job competence. 3

To develop a specialisation. 4 (09

To train for the sort of work you wanted to move into. 5

Interest in the subject 6

Other (Please specify) ______________________________ 7

GENERAL TRAINING.

37. Since you joined Ferguson have you participated in any job related training courses (as opposed to academic courses) ?

YES 1 NO 2 (10)

If "NO", please continue to Question 40.

38. What were the titles of theses courses ? Please give the one you consider to have been the most relevant first.

Title. ______________________ (11)

______________________ (12)

______________________ (13)

______________________ (14)

______________________ (15)

39. At whose instigation did you participate in a course ?

Your own 1 Your immediate superior 2 Your departmental manager 3 (16)

The training manager 4 A trade union representative 5

Other (Please specify) ______________________ 6

40. If "No" to Question 37, would some training have been helpful ?

YES 1 NO 2 (17)

41. Do you think you would benefit from further training ? (18)

YES 1 NO 2

42. If you have not participated in any job related training, was this because. . .

In the field you needed training in, there was none available.	1	
You were not given the opportunity to participate in what was available.	2	(19
You were not interested.	3	
You had too many other priorities.	4	
You have only just joined Ferguson.	5	
Other. (Please specify) ________________________________	6	

43. In what areas would you have liked further training ?

To answer this question, please put the numbers corresponding to the areas in which you would have liked further training in the boxes below, with your main preference on the left, your second next, and so on to the right.

Research 01   Design 02   Development 03   Production 04   Test and Inspection 05

Sales 06   Purchasing 07   Teaching and training 08   Marketing 09

Non-technical management 10   Technical management 11   Administration 12

Service 13   Other (Please specify) 14 ________________________________

(20-21)		(22-23)		(24-25)	

44. In what areas would you like further training in the near future ?

To answer this question, as above, please put the numbers corresponding to the areas in which you would have liked further training in the boxes below, with your main preference on the left, your second next, and so on to the right.

Research 01	Design 02	Development 03	Production 04	Test and Inspection 05
Sales 06	Purchasing 07	Teaching and training 08	Marketing 09	
Non-technical management 10	Technical management 11	Administration 12		
Service 13	Other (Please specify) 14 ______________			

(26-27) (28-29) (30-31)

45. Please indicate the value and relevance of both your academic education, and your training and within Ferguson, with respect to the following issue

1 ________ 3 ________ 5
Of no value at all — Very valuable

Example:

	Academic education.	Company training.
Ability to: supervise team projects.	1 2 3 4 5	1 2 3 4 5

	Academic education.	Company training.	
Ability to :			
work independently.	1 2 3 4 5	1 2 3 4 5	(32-33)
work as part of a team.	1 2 3 4 5	1 2 3 4 5	(34-35)
supervise team projects.	1 2 3 4 5	1 2 3 4 5	(36-37)
recognise technical opportunities for product innovation.	1 2 3 4 5	1 2 3 4 5	(38-39)
recognise technical opportunities for process innovation.	1 2 3 4 5	1 2 3 4 5	(40-41)
carry out the managerial requirements of your job.	1 2 3 4 5	1 2 3 4 5	(42-43)

FIRST JOB AND CAREER PLANS.

46. What was your first occupation after you first left full-time education ?

Occupation. ______________________________ (44)

47 . Was it; Engineering related / Non-engineering but other industrial / Non-industrial

	Engineering related	Non-engineering but other industrial	Non-industrial	
47 . Was it;	1	2	3	(45)

48. Which one of the following were the most influencial in determining your first engineering position ?

Location 1 Salary 2 Status of the position 3 (46)

Reputation of the company 4 Management opportunity 5

Research opportunity 6 Technical opportunity 7

Lack of alternatives 8 Other (Please specify) 9 ______________________________

____

49. What was your father's occupation at the time you chose to go to college or begin your apprenticeship/training.

Occupation ______________________________ (47)

	Engineering related	Non-engineering but other industrial	Non-industrial	
50. Was it;	1	2	3	(48)

51. Which of the following best characterises your ultimate career goals as they were at the time you took your first job, and as they are now ?

	(49) Then	(50) Now
Academic career.	1	1
Career in industry -		
Management career in a large company.	2	2
Management career in a small company.	3	3
Technical career in a large company.	4	4
Technical career in a small company.	5	5
Career in consultancy	6	6
Be a self employed engineer.	7	7
Leave engineering completely.	8	8
Other (Please specify). ______________________	9	9

ATTITUDES AND SATISFACTION

52. Which of the following do you think are important to Ferguson's overall success, and, which do you think are rewarded by the company.

1 ________ 3 ________ 5

Unimportant/ Unrewarded. — Important/ Rewarded.

Example:

	Importance	Rewarded
Effectively manage manpower.	1 2 3 4 5	1 2 3 4 5

Ability to :	Importance	Rewarded	
Identify and address important technical problems in my field.	1 2 3 4 5	1 2 3 4 5	(51-52)
Generate innovative ideas for new productive processes.	1 2 3 4 5	1 2 3 4 5	(53-54)
Generate innovative ideas for variations on existing productive processes.	1 2 3 4 5	1 2 3 4 5	(55-56)
Generate innovative ideas for new products.	1 2 3 4 5	1 2 3 4 5	(57-58)
Generate innovative ideas for variations on existing designs/products.	1 2 3 4 5	1 2 3 4 5	(59-60)
Work in groups to facilitate team project work.	1 2 3 4 5	1 2 3 4 5	(61-62)
Work independently without supervision.	1 2 3 4 5	1 2 3 4 5	(63-64)
Effectively manage manpower.	1 2 3 4 5	1 2 3 4 5	(65-66)
Effectively mangage financial and other resources.	1 2 3 4 5	1 2 3 4 5	(67-68)
Be flexible and adaptive in your approach to tasks and the use of your skills.	1 2 3 4 5	1 2 3 4 5	(69-70)

01	02	03	04	05	06
1	1	3			

Follow up and implement ideas generated by superiors.	1 2 3 4 5	1 2 3 4 5	(07-07)
Effective and efficient communication.	1 2 3 4 5	1 2 3 4 5	(09-10)
Problem solving.	1 2 3 4 5	1 2 3 4 5	(11-12)

53. How satisfied are you with the following ?

1	2	3	4	5
Very dissatisfied	Fairly dissatisfied		Fairly satisfied	Very satisfied

Promotion opportunities in general.	1	2	3	4	5	(13)
Technical promotion opportunities.	1	2	3	4	5	(14)
Managerial promotion opportunities.	1	2	3	4	5	(15)
Opportunities to participate in management decision making.	1	2	3	4	5	(16)
Relationships with your immediate boss.	1	2	3	4	5	(17)
Training and re-training.	1	2	3	4	5	(18)
Security of employment.	1	2	3	4	5	(19)
The extent to which your work is interesting.	1	2	3	4	5	(20)
The extent to which you are using your technical expertise.	1	2	3	4	5	(21)
Pay	1	2	3	4	5	(22)
Fringe benefits.	1	2	3	4	5	(23)
Length of working hours.	1	2	3	4	5	(24)
Holidays and leave entitlement.	1	2	3	4	5	(25)
Present working environment.	1	2	3	4	5	(26)
Proposed working environment.	1	2	3	4	5	(27)
Recognition for your professional specialisation.	1	2	3	4	5	(28)
Your status in the company.	1	2	3	4	5	(29)

54. Please list any professional organisations of which you are a member or an active participant.

I.E.E.	1	B.I.M.	5	(30)
I.Mech.E.	2	Inst' of Man'gmt Services.	6	
I.E.R.E.	3	Inst' of Indust' Man'gmt.	7	
B.C.S.	4	Other (Please specify) ____________	8	

55. When did you last attend a conference, seminar or trade exhibition related to your work or profession ?

Within the: Last month 1 | Last 6 months 2 | Last year 3

Last 5 years 4 | Never 5

(31)

56. How would you best describe it ?

A conference 1 | A trade exhibition 2 | A seminar 3 (32)

57. What was the basic purpose of the conference ?

Information 1 | New issue 2 | Training in specific area 3 (33)

Training in general 4 | Competition appraisal 5

Other (Please specify) ______________________________ 6

58. At whose instigation did you attend the conference or seminar ?

Your own 1 | Your immediate superior 2 | Your departmental manager 3

The training manager 4 | A trade union representative 5

Other (Please specify) ______________________________ 6 (34)

59. Do you ever think of leaving Ferguson ? (35)

Very frequently 1 | Frequently 2 | Sometimes 3 | Seldom 4 | Never 5

60. Are you: male 1 | female 2 (36)

61. What is your age ?

Under 20 01	31-35 04	46-50 07
21-25 02	36-40 05	51-55 08
26-30 03	41-45 06	56-60 09
	Over 60 10	

(37-38)

That is the end of the questionnaire.

Thank you very much for your kind cooperation.

Appendix III

The report presented the firm.

ATTITUDES AND SATISFACTION

AMONG ENGINEERS AND TECHNICIANS

IN

THORN EMI FERGUSON ENFIELD.

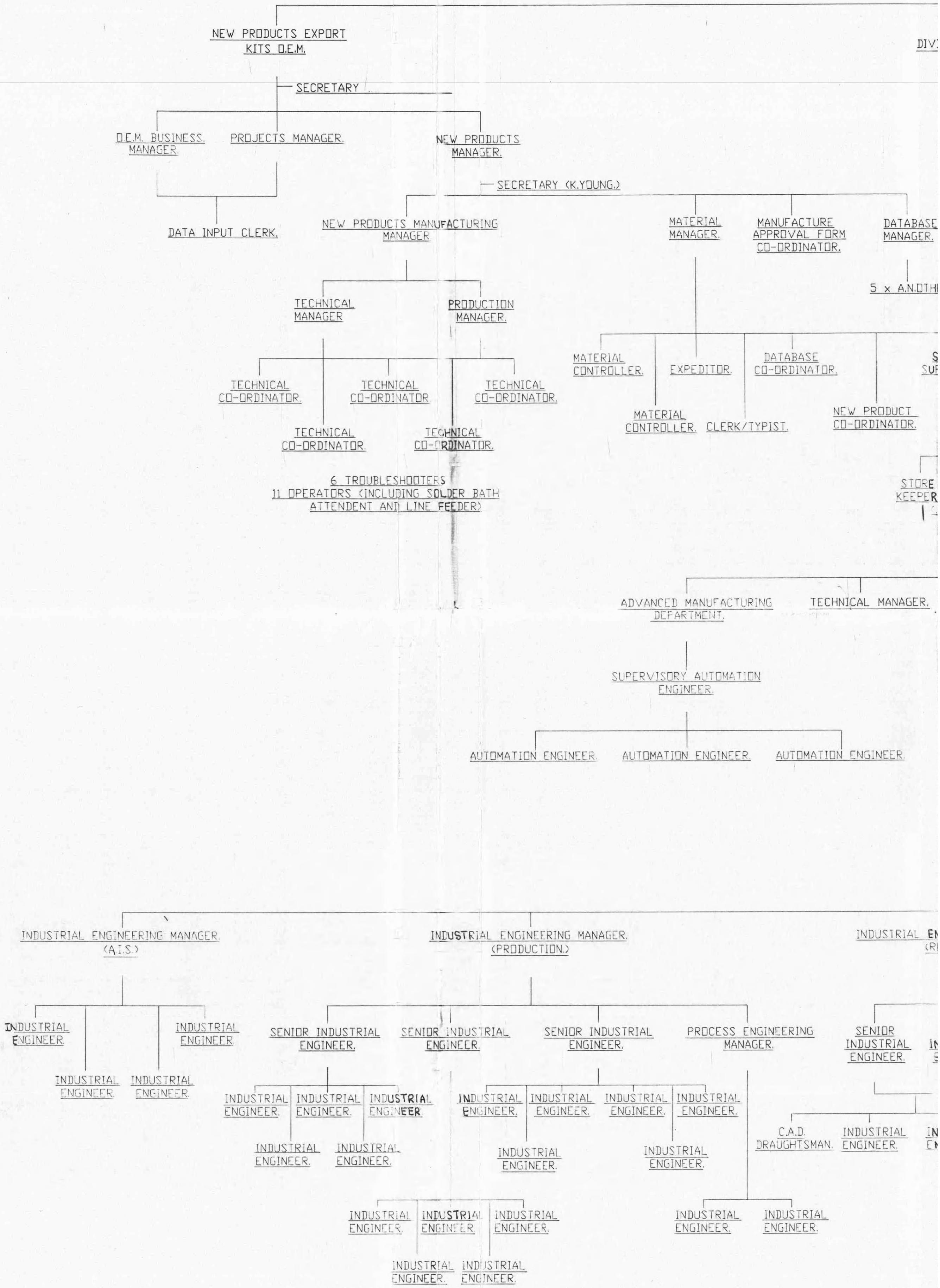
SOME ORGANISATIONAL IMPLICATIONS.

AN OVERVIEW AND PRELIMINARY RECOMMENDATIONS.

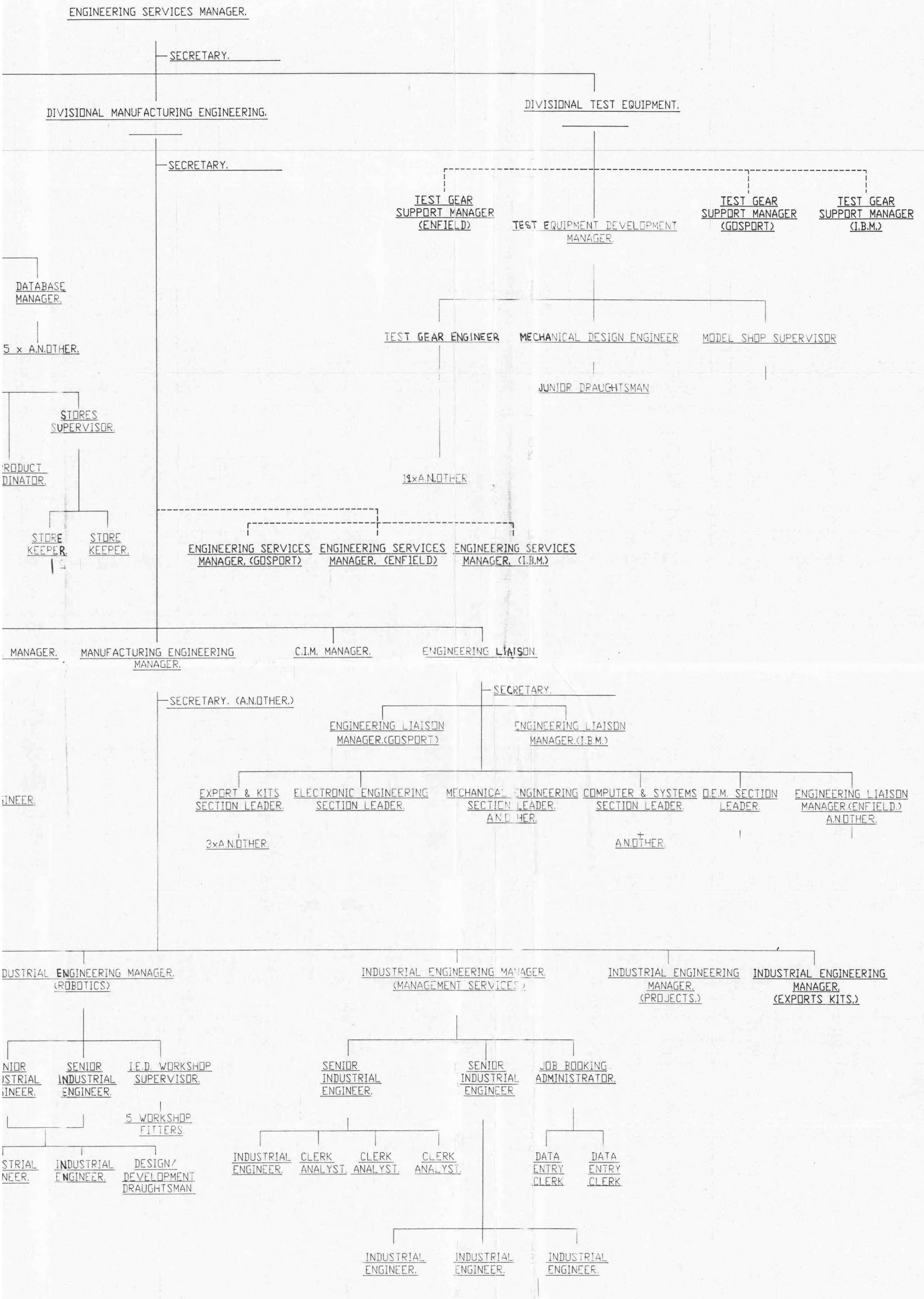
Alex Swarbrick.
Department of Industrial Relations
and Personnel Management.
London School of Economics.
December 1986.

Appendix IV

Organisation Chart of
Thorn E.M.I. Ferguson
Engineering Services Division.


NEW PRODUCTS EXPORT KITS O.E.M.
DIV
SECRETARY
O.E.M. BUSINESS MANAGER.
PROJECTS MANAGER.
NEW PRODUCTS MANAGER.
SECRETARY (K.YOUNG.)
DATA INPUT CLERK.
NEW PRODUCTS MANUFACTURING MANAGER
MATERIAL MANAGER.
MANUFACTURE APPROVAL FORM CO-ORDINATOR.
DATABASE MANAGER.
5 x A.N.OTH
TECHNICAL MANAGER
PRODUCTION MANAGER.
TECHNICAL CO-ORDINATOR.
TECHNICAL CO-ORDINATOR.
TECHNICAL CO-ORDINATOR.
TECHNICAL CO-ORDINATOR.
TECHNICAL CO-ORDINATOR.
MATERIAL CONTROLLER.
EXPEDITOR.
DATABASE CO-ORDINATOR.
MATERIAL CONTROLLER.
CLERK/TYPIST.
NEW PRODUCT CO-ORDINATOR.
6 TROUBLESHOOTERS
11 OPERATORS (INCLUDING SOLDER BATH ATTENDENT AND LINE FEEDER)
STORE KEEPER
ADVANCED MANUFACTURING DEPARTMENT.
TECHNICAL MANAGER.
SUPERVISORY AUTOMATION ENGINEER.
AUTOMATION ENGINEER.
AUTOMATION ENGINEER.
AUTOMATION ENGINEER.
INDUSTRIAL ENGINEERING MANAGER. (A.I.S.)
INDUSTRIAL ENGINEERING MANAGER. (PRODUCTION.)
INDUSTRIAL EN
INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.
SENIOR INDUSTRIAL ENGINEER.
SENIOR INDUSTRIAL ENGINEER.
SENIOR INDUSTRIAL ENGINEER.
PROCESS ENGINEERING MANAGER.
SENIOR INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.
C.A.D. DRAUGHTSMAN.

E.S.D.


ENGINEERING SERVICES MANAGER.
SECRETARY.
DIVISIONAL MANUFACTURING ENGINEERING.
DIVISIONAL TEST EQUIPMENT.
SECRETARY.
TEST GEAR SUPPORT MANAGER (ENFIELD)
TEST EQUIPMENT DEVELOPMENT MANAGER.
TEST GEAR SUPPORT MANAGER (GOSPORT)
TEST GEAR SUPPORT MANAGER (I.B.M.)
DATABASE MANAGER.
5 x A.N.OTHER.
TEST GEAR ENGINEER
MECHANICAL DESIGN ENGINEER
MODEL SHOP SUPERVISOR
JUNIOR DRAUGHTSMAN
STORES SUPERVISOR.
RODUCT DINATOR.
19xA.N.OTHER
STORE KEEPER.
STORE KEEPER.
ENGINEERING SERVICES MANAGER. (GOSPORT)
ENGINEERING SERVICES MANAGER. (ENFIELD)
ENGINEERING SERVICES MANAGER. (I.B.M.)
MANAGER.
MANUFACTURING ENGINEERING MANAGER.
C.I.M. MANAGER.
ENGINEERING LIAISON.
SECRETARY. (A.N.OTHER.)
SECRETARY.
ENGINEERING LIAISON MANAGER.(GOSPORT)
ENGINEERING LIAISON MANAGER.(I.B.M.)
INEER.
EXPORT & KITS SECTION LEADER.
ELECTRONIC ENGINEERING SECTION LEADER.
MECHANICAL ENGINEERING SECTION LEADER. A.N.OTHER.
COMPUTER & SYSTEMS SECTION LEADER.
O.E.M. SECTION LEADER.
ENGINEERING LIAISON MANAGER (ENFIELD.) A.N.OTHER.
3xA.N.OTHER.
A.N.OTHER.
DUSTRIAL ENGINEERING MANAGER. (ROBOTICS)
INDUSTRIAL ENGINEERING MANAGER. (MANAGEMENT SERVICES)
INDUSTRIAL ENGINEERING MANAGER. (PROJECTS.)
INDUSTRIAL ENGINEERING MANAGER. (EXPORTS KITS.)
NIOR ISTRIAL INEER.
SENIOR INDUSTRIAL ENGINEER.
I.E.D. WORKSHOP SUPERVISOR.
SENIOR INDUSTRIAL ENGINEER.
SENIOR INDUSTRIAL ENGINEER.
JOB BOOKING ADMINISTRATOR.
5 WORKSHOP FITTERS.
STRIAL NEER.
INDUSTRIAL ENGINEER.
DESIGN/ DEVELOPMENT DRAUGHTSMAN.
INDUSTRIAL ENGINEER.
CLERK ANALYST.
CLERK ANALYST.
CLERK ANALYST.
DATA ENTRY CLERK
DATA ENTRY CLERK
INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.
INDUSTRIAL ENGINEER.

LIST OF CONTENTS.

ACKNOWLEDGEMENTS.

I would like to express my thanks to the following people for their tremendous help with the collection of all the data for this survey and report.

Jim Donovan, Ian Cooper and Les Wright for their initial enthusiasm for the project and their continued support throughout.

John Rodwell, Harry Cosford, Ed House and the staff of their departments for their practical direction and assistance, and their own valuable comments and suggestions.

All the engineers and technicians who took part through the questionnaire, interviews and the observations, for their patience, honesty and co-operation.

All the secretaries who have been involved, without whose efficiency, patience and generous assistance none of the day to day running of the survey would have been achieved.

SUMMARY.

Having studied the attitudes, satisfactions and dissatisfactions of a number of engineers and technicians, several consistent "themes" were identified.

Findings showed that although many engineers felt positive towards the company, considerable frustrations were expressed. Many engineers were dissatisfied with promotion opportunities, and also felt frustrated by a lack of involvement in whole projects.

The mechanistic and functionally divided organisational structure appeared to be at the root of many of the other sources of dissatisfaction. These included poor communication, and ambiguity of corporate, departmental and individual objectives.

It is suggested that any change in policy or practice regarding the recruitment and utilization of engineers and technicians, will bring little lasting benefit to Ferguson or the individuals concerned without preceding it by a critical re-evaluation of the organisational structure of the engineering departments, and the implementation of any appropriate changes.

INTRODUCTION.

Reasons for the survey.

The survey was made at the invitation of Mr Jim Donovan (Personnel Director), Mr Ian Cooper (Executive Chief Engineer) and Mr Les Wright (then Engineering Services Manager), after discussion of an international research project being conducted into the utilization of engineering talent and the reported skill shortage in the Electronics Industry. The study is being conducted by Prof. Keith Thurley and Mr Alex Swarbrick of the Department of Industrial Relations and Personnel Management at the London School of Economics and Political Science.

The focus of the study is the attitudes, aspirations and expectations of engineers in the electronics industry, and an analysis of the factors which contribute to the formation of those attitudes. The countries so far involved are West Germany, Japan and Great Britain.

The Terms of reference of the study in Ferguson can be seen in full at Appendix 1. This project sought to establish what motivates, satisfies and dissatisfies engineers and technicians concerning their work, with the object of determining ways in which their skills might be more fully or more appropriately deployed, to the mutual advantage of the company and the individual concerned.

Consequences of the survey.

Arising out of the investigations made into engineering skills utilization and shortage, was an indication that the apparent problem was merely symptomatic of more fundamental organisational issues, some causes of which I have suggested in the following pages.

It is hoped that the survey will not only be a very valuable contribution to the international study, but that for Ferguson, it will also be a significant contribution to the continuing appraisal of the company's progress towards it's goals, as defined by the recent major restructuring.

METHODOLOGY.

The Sample

From the Personnel record cards and the computerised data, all those performing engineering or technical functions in R and D and ESD were identified. The records were also checked for any individuals with engineering qualifications, who are not employed in directly related departments, and for those in responsible engineering positions but without formal engineering qualifications.

Pilot Survey.

After amendments had been made to the questionnaire following a pilot study, the engineers were invited, through their department heads, to take part in the questionnaire stage.

Questionnaire.

This involved attending a group session with 10 to 15 others in order that any queries arising from the questionnaire could be answered as they arose. Completed questionnaires were collected from 163 individuals.

Interviews.

After preliminary analysis of the data, 35% of those with H.N.C. or higher qualifications were interviewed concerning their work, aspirations and attitudes. The samples were taken in proportion to the qualification mix in each department.

Observations.

The interview stage was followed by a period of nearly a month spent in R and D and ESD, gathering more information through informal questioning, discussion, and observing engineers in their daily work.

Analysis.

The questionnaire data was analysed mainly by the variables Job, Department, Length of service and Qualification. The interview data and the observations were subjected to a content analysis to confirm or refute some of the results which emerged from the questionnaire data. The observations also provided a very valuable insight into the day to day functioning of the various departments involved in the study.

KEY RESULTS.

Job titles by which respondents described themselves.

46%	Engineers.
16%	Section or Group Leaders.
14%	Other technical.
13%	Technicians.

The departments from which the sample was drawn.

19%	Advanced Development.			
17%	Product Development.	i.e.	52 %	R and D
16%	Other R and D.			
45%	E.S.D.		45 %	E.S.D.

Qualifications

26%	HNC or equivalent.
18%	Batchelors degree.
15%	ONC or equivalent.

Training.

Asked whether they had received any job related training, since joining Ferguson, 55% said "NO".

Asked if they believed they would benefit from some training, 85% said "YES".

Feelings towards the company.

55% of the sample as a whole said they would like to give their best efforts to the company's success.

Career.

Asked about their career aspirations on joining the firm and now, 55% said "Technical career in a large company". The other preferences were as follows.

11% Technical career in a small company
9% Management career in a large company
1% Leave engineering completely.

Some change of attitude over the period of service with the company, showed present career preferences as follows.

35% Technical career in a large company.
20% Management career in a large company.
12% Leave engineering completely.
6% Technical career in a small company.

Importance and Reward.

Asked to say whether they thought various items in a list of issues were important to the company's success in their own opinion, over 50% believed all the issues to be important.

However, no issue was believed by more than 30%, to be rewarded by the company. The most striking result was found concerning "Effective and efficient communication."

83% considered it to be fairly or very important, but only 24% thought it was rewarded.

Satisfaction and dissatisfaction.

The items with which the highest percentage were very or fairly satisfied were as follows.

64% Relationship with your boss.
62% The extent to which your work is interesting.
58% Proposed working environment.

The items with which the highest proportion were fairly or very dissatisfied were as follows.

63% Training.
61% Participation in management decision making.
60% Fringe benefits.

Many other issues attracted between 40% and 50%, including,

General, technical and managerial promotion opportunities.
Pay.
Working hours.
Present working environment.
Professional recognition.
Status.

INTERVIEW RESULTS.

Due to the subjectivity that interview data is prone to, every effort was taken to ensure that remarks made were qualified by respondents, and that explanations and examples were given to support critical comments. Consequently there was considerable consistency of results between the respondents.

Many of the respondents suggested that they would like to give their best efforts to the company's success and many expressed optimism regarding the company's future.

Numerous remarks however, expressed disappointment and frustration concerning promotion, training, involvement in decision making, communication and definition of corporate, departmental and individual objectives.

Promotion.

It was felt that although promises had been made regarding time periods for promotion, many engineers understood from the organisational hierarchy that there was a disproportionate number of engineers pursuing a very limited number of positions.

Training.

Whilst those who had been provided with training seemed satisfied, there were many who indicated that they would have liked training but hadn't been offered the opportunity. Frustration arose from requests, to departmental leaders, for training which were turned down.

Several respondents, having been provided with training, were disappointed when they returned, especially from external courses, to find no use being made of their newly acquired knowledge, no debriefing, and often no recognition at all that they had been away on a course.

Involvement.

Management decisions were seen to be made several stages up the hierarchy, and where there was any involvement on the part of engineers and technicians, it was not expected by them to be of any influence. Where they believed they had valuable contributions to make, this inevitably led to disappointment and frustration.

Communication.

It was acknowledged that management were making serious attempts to communicate more effectively, but that there was still considerable scope for improvement. Considerable resentment was expressed regarding the amendment to working hours. This was reported consistently as a unilateral decision and apparently, without adequate explanation.

In addition to the practical impact of the change itself, confidence in management's communication attempts and there motives was seriously shaken.

Definition of objectives.

There was an apparent lack of understanding of corporate, departmental, and individual objectives. Commitment to the direction in which the organisation is moving was seen more as faith, than trust based on knowledge.

Many engineers suggested that there is very little understanding of corporate objectives, and this same opinion was expressed through informal discussion with individuals outside the engineering departments.

Considerable confusion was expressed by individuals from E.S.D in particular. Very few of the engineers were able to describe the interaction of other areas in the department. This led many of the engineers to express confusion and doubt with regard to the objectives of the company as a whole.

Concerning the work that their department was engaged in, and their own part in that work, many felt isolated by their involvement with only a small part of a project. Difficulties and frictions were described arising at the interface of departments as fragments of a project are passed through the system.

OBSERVATION RESULTS.

During the observations, much valuable information was gathered on the day to day operation of the various departments being studied. Many of the remarks made in informal discussions with engineers, confirmed the sentiments expressed by others in the formal interviews.

Systems.

Serious inadequacies in the operating systems were suggested in discussion with engineers and engineering managers who had experienced frustration at time wasted attempting to perform tasks as simple as acquiring components. Exchanges of information whether in writing or through meetings was described as far from efficient or effective. Often it was unclear why certain information was requested of an individual, for whom it was intended and what use the recipient had for the information.

Objectives.

Ambiguity of objectives, corporate, departmental and individual was widely noticed, and particularly within E.S.D. where poor understanding of departmental objectives was not surprisingly interpreted as an absence of them (See Appendix 2 for some of the relevant comments on this issue.).

Communication.

Communication at all levels appeared to be a source of concern among engineers. Often what was communicated was described as inappropriate, inconsistent with previous communications and infrequent.

Amongst graduates a degree of cynicism was apparent in their comments about the " Indoctrination Programme " which was seen by many as irrelevant to the reality of their expectations, and life in the lab or factory.

Poor communication was also given as a key reason for unnecessary duplication of effort in certain areas of E.S.D. in particular.

Practical implications.

Many engineers suggested that their work was much less demanding than they would like and that they had much more to offer the company.

Departments claimed that their work was hampered by "previous" departments overshooting time schedules. This heightened departmental insularity as the blame for the difficulties was focussed on other departments or individuals, rather than seeing the problem as a "technical" issue. This problem was particularly evident in E.S.D. test gear design lab, who described themselves as the "tail end Charlies". They felt that by the time all other departments had overshot the schedule, there was an unrealistic amount of time left in which they were expected to design and develop test gear.

DISCUSSION.

The Issues.

From the research it is clear that the utilization of engineering talent, and the satisfaction and attitudes of the engineers is largely a by-product of the behaviour and structure of the organisation.

Any policy relating to procurement, utilization and satisfaction of engineers, will produce minimal and transient success unless it is set in the context of a broader re-evaluation of the organisation of the engineering departments.

History.

Until recently, many companies in the consumer electronics industry, were technology led, and the organisational structure which had evolved was most effective for the prevailing market and technological environment. The success of the firm depended upon an environment in which next year was largely the same as last year, the market was fairly stable and predictable, product life-cycle was relatively long, work tasks could be functionally divided and decisions largely programmed.

From the comments of engineers and others, the structure of Ferguson was not unlike this up to only quite recently. There was no marketing department as such up to only five years ago. The styling aspect of T.V. design was described as basically little more than Henry Ford's "any colour as long as it's black ", ie. walnut finish or teak finish !

A mechanistic system of management and functional division of tasks under such conditions can be very effective, and the establishment of such a structure is easy to understand.

However,it is questionable whether the systems of management in both E.S.D. and R and D, are the most appropriate with regard to the dynamic market and technological environment in which the firm now finds itself.

In the closing pages of this report, I draw the readers attention to some considerations to be taken in order to make more effective the changes being undertaken.

CONCLUSION.

Skill utilization and the organisation.

There is a considerable amount of under-utilisation and mis-utilisation in several departments. Under-utilisation refers to circumstances in which engineers are engaged largely in work far below their full potential. Mis-utilisation refers to circumstances in which engineers are engaged in work which is of little or no relation to their qualification or experience.

A certain amount of under-utilization is almost unavoidable. However all efforts should be taken to minimize it.

The issues facing R and D, and E.S.D. are slightly different, though the consequences are similar, and the outcome of neglecting the issue will be equally serious for both the departments, and for the firm as a whole.

In R and D, in general, the tasks facing the department have been broken down into functional specialisations, with individuals pursuing goals some distance removed from the real objectives of the department as a whole. Such a system causes problems for communication,which management tend to attempt to solve by the appointment of intermediaries in each group to take care of the troubles arising at the interface with other departments. The word used in the Burns studies is a familiar one; "liason" engineers.(See Appendix 3)

Career development.

Lack of career structure can be a source of low motivation, especially when it involves defeated expectations.

There is evidence to suggest that this is a major cause of dissatisfaction, and the dramatic rise in the number of those who wish leave engineering completely, or move into a management career is a clear indication of the disillusionment experienced.

Training.

The absence of the training from which engineers believe they would benefit, furthers their alienation from the objectives of the concern as a whole. Along with the disappointment with career structure and the denial of greater involvement, this clearly contributes to much of the dissatisfaction described.

RECOMMENDATIONS.

This study was not a consultation survey, and no precise directives for action have been produced. However from the data, suggestions can be made as to where Ferguson might focus attention.

The firm has made great efforts to adapt to the dynamic nature of the technological and market environment. In conditions of change there are continually fresh problems to face, and unanticipated actions to be taken.

The evidence suggests that the most important issue threatening the effectiveness of the engineering departments, is the organisational structure. For the following reasons, the present system seems to have shortcomings;

Communication problems which result from functional divisions of the work.

Isolation from group objectives and the tendency to insularity.

Fixed group boundaries becoming blurred as other groups or individuals become involved in the same work in order to overcome short-term difficulties.

In E.S.D., ambiguity of objectives reinforces the insularity of departments until groups find more efficient ways of reaching their own ends rather than those of the firm as a whole.

The efficiency and effectiveness of communication is poor.

As a result of these findings, we would suggest the following as considerations to be taken.

1. Reassess the organisational structure and the group boundaries in the engineering departments.

2. Ensure that nothing inhibits the flow of information, advice and effort.

3. Examine the responses necessary to the forces of external conditions. This may lead to a re-definition of the management system.

4. Where possible, see the problem as a technical issue rather than a human problem. Thus, individuals and groups will not seek to apportion the blame for failure

in the system to other individuals or other groups in order to absolve themselves of any liability.

These recommendations are made with the aim of assisting the firm to pursue more effective and efficient ways of achieving the objectives of the concern as a whole.

It is hoped that this survey will not only have been a very valuable contribution to the international research project, but that it will also have provided some contribution to the assessment of Ferguson's progress since the reorganisation, and will have provided some suggestions for future action.

LIST OF APPENDICES

APPENDIX 1

TERMS OF REFERENCE

FOR THE FERGUSON, L.S.E ENGINEERS PROJECT.

1. To describe and analyse ;

 a) the individual characteristics, education, training and experience and careers of the engineers employed by Thorn EMI Ferguson,

 b) the present and emerging work organisation of the engineers concerned, through observation and informal interviews,

 c) the attitudes, expectations and perceptions of the engineers to their work, future careers, identity etc. This is to be studied through briefing groups and a self-administered questionnaire.

2. & k 1 2 H T o check the validity of the data coll pretations of this information by small group feedback and discussion, first with a few of the engineers involved, and after this , with a group of management staff, engineers, and union and professional representatives if relevant.

3. To report back to the steering committee with the analysis of these results and as suggested plan for the next stage of the research.

APPENDIX 2

QUOTATIONS FROM INTERVIEWS

Positive feelings towards the company.

"There's a charisma about the firm."

"When you see the firm changing for the better, it wins your loyalty."

"People know the products and the outside world knows the name."

Promotion.

"The only way to get on is to leave the company."

"I was told on induction it would be 2 years to middle management - no chance, ... 10 years to Section Leader".

Training.

"They say people are our greatest asset and training our greatest investment, but in reality it doesn't happen that way."

Regarding the bosses attitude to training,

"It's like he's spending his own money !".

Involvement and isolation.

"In a small firm you were under a microscope. Here they don't know if you're dead or alive sometimes."

"Responsibility for doing work is always passed down. Responsibility for decisions isn't ever. Management would believe an outside consultant before anything someone in his own department said."

"I just hope the decisions made are the right ones. They get made 2 or 3 wrungs up the ladder. You get resigned to it.

Communication.

"It takes too long to get useful information to and from management."

"The firm says "We're all together", then the hours change from 37 to 39 hours."

Definition of objectives.

"You never hear the overall policy. At the engineering level nobody knows what's happening. News letters tell you nothing about policy objectives."

Concerning E.S.D.

Asked how his work fitted in to the objectives of E.S.D. one respondent said,

"What's E.S.D." "I've never heard of E.S.D."

"The system, E.S.D., is only making us more remote from the factory".

"E.S.D. is a bit of a monster".

"E.S.D. has become an empire in it's own right".

"Bosses in E.S.D. aren't engineers so they have no excuse to be poor managers".

"If I was a shareholder, I'd be in here and tear the place to bits. E.S.D. is top heavy. The top looks neat and tidy and the bottom is rotting away".

Other comments regarding pay and rewards.

"Pay is very low. I could get another '5,000 and a car in technical sales."

"A lot of people are on the edge of leaving. A little pay boost, or just knowing they're needed would be enough to stop them."

Regarding graduates.

"I feel the firm were fairly dishonest with graduates to start with. They found out what it was like after a while".

"The firm never seems to have had too many graduates before and now they are learning by their mistakes".

APPENDIX 3.

Quotations from : "Management in the Electronics Industry. A Study of eight English companies." By Tom Burns. Social Science Research Centre. University of Edinburgh 1958.

"If the firm regards itself as a system which is being 'driven' from it's market connections, then the sales function, in it's very broadest sense is something discharged by the whole firm."

"(In mechanistic systems) . . . the problems and tasks facing the concern as a whole are broken down into functional specialisations; each individual pursues his task as something distinct from the real tasks of the concern as a whole, as if it were the subject of a sub-contract, with somebody 'at the top' responsible for seeing it's relevance; the technical methods, duties and powers attached to each functional role are precisely defined. Interaction with management tends to be vertical i.e. between superior and subordinate; . . . . .management is visualised as the complex hierarchy familiar in organisation charts, and operates as a simple control system, with information flowing up through a succession of filters, and decisions and instructions flowing downwards through a succession of amplifiers."

"The usual response to difficulties of passing designs through, - correctly read in most cases as a problem of interpretation - has most usually been met by the creation of special intermediaries, whose job it is to interpret. There were, in many concerns, groups of highly trained people whose positions depended upon the continued existence of these difficulties."

"Their first response therefore, when there is an admitted need for communication, is to tether functionaries to their posts and to appoint persons who will specialise in 'liason'."

"It is an attempt to solve the problems set by conditions of change, by other means than the adaptation of the management system to an organic form. The creation of special intermediaries and liason groups seems to offer the possibility of retaining the traditional and familiar mechanistic system with it's clear definition of function and of lines of command and responsibility."