# PRODUCT INNOVATION
# IN A MEDIUM SIZE
# MATURE MANUFACTURING COMPANY

by

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Summary

This thesis is concerned with the management of product innovation inside the medium size, mature, manufacturing company. An academic perspective of innovation is integrated with an account of direct participation acquired over a two year period. The emergent synthesis provides fresh insight into some of the problems associated with producing and sustaining innovation.

Product innovation is a very complex activity, and it presents particular difficulties for mature industry. However, the ability to innovate is fundamental to a company's continued survival.

Three aspects of product innovation are examined in detail. Firstly, is the requirement to separate innovation activity from the on-going business interests; dependency between the degree of separation and novelty is supported. Secondly, a simple sequential model of the innovation process is tested and shown to be of considerable practical value. Thirdly a relationship is established between the age of the recipient market and the type of innovation to be found in that market. All three aspects are found to have important implications for management in their pursuit of innovation.

Management deficiencies which inhibited the successful resolution of innovation-linked problems are described and solutions which stress the need for commitment and coherency are proposed.

The long existing management structure in the mature company which mitigates against successful and continuing innovation are examined in detail and a strategy is evolved which uses the intrinsic strengths of the mature company to promote innovation of a kind compatible with success in the market.

A set of guidelines of practical value is presented for those managers wishing to pursue, and sustain, product innovation in the medium size mature company.

KEY WORDS: PRODUCT INNOVATION, MANAGEMENT, INDUSTRY, COMPANY CHARACTERISTICS.

to my parents

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# INTRODUCTION TO THE THESIS

## *1.0.0 Outline Of Chapter*

This chapter provides an introduction to the nature of an IHD Ph.D thesis and comparison is made between the IHD Ph.D and the more traditional Ph.D. This thesis is described in terms of its area of involvement and the environment within which it was conducted.

### *1.1.0 Introduction*

The current rate of decline of the British manufacturing base gives rise to concern amongst politicians, academics, and industrialists alike. The effect of this decline is witnessed in the levels of mass unemployment, factory closures, and a worsening balance of trade deficit in manufactured goods. Any argument on the causes of this decline has its opponents, and numerous causes can be found. British industry has repeatedly shown an inability to produce the types of product desired by the customer. In other words it has failed at product innovation.

In preparing the material for this thesis the writer spent some two years assisting a manufacturing company conduct product innovation. An account of this practical work is contained in the thesis. This account is integrated with an academic review of product innovation, and the synthesis provides a unique insight into the complexity which faced a manufacturing company. From this lessons are sought for the central issues facing manufacturing industry.

## BACKGROUND

### *1.2.0 The IHD Scheme*

The writer prepared this thesis while a postgraduate student of the University of Aston Interdisciplinary Higher Degree (IHD) scheme. The IHD scheme provides a course of study which leads to the degree of Ph.D. However, in its approach to this study, it is dissimilar from a traditional Ph.D. The IHD scheme was established in 1969 to encourage participation between the research needs of industry (or other external organisation) and the academic resources of Aston University. IHD research is dissimilar in that it is problem-orientated and requires the participation of a collaborator external to IHD. A detailed description of the IHD scheme can be found in Cochran.(1)

### *1.2.1 The External Collaborator*

The external collaborator supporting this project, from 1982-1984, was Geest Industrial Group Ltd. In 1982 Geest Industrial Group was a medium size manufacturing company as defined in the companies act, 1981, and a wholly owned subsiduary of Geest Holdings Ltd. Industrial Group was formed in 1936 and by the early 1980's employed some 150 people, operated from three distinct sites, and produced a turnover of some £4-5M. The company's accounts show that from 1978 onwards it returned pre-tax losses, culminating in its closure in July 1984. Events leading to this closure are described in detail in appendix A.

### *1.2.2 Research Methodology*

Two research methodologies are present in this thesis. One (action research) was applicable as a result of the presence of the external collaborator and the other (grounded theory) as a consequence of his absence.

The research methodology favoured by IHD is action research. This is an approach to academic research which requires the presence of an external collaborator, Rapoport provides a description:

> "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework."(2)

As with all IHD projects it was the intention in 1982 that this thesis present an account of action research. Certainly the opportunity to conduct action research was present, the organisation of this research was not dissimilar from that reported by Clark (citing Heller), in which the writer (practitioner) is:

> "...joining a situation in which a decision about action has been taken by members of the sponsoring system. The role of the practitioner is to document the change process and provide feedback on the...change process so that it might be stopped, modified, or accelerated."(3)

From October 1982 until July 1984 a considerable quantity of data was collected, by the writer, detailing the company's approach to an 'immediate problematic situation'. However the closure of Geest Industrial Group in July 1984 removed the opportunity for feedback and, by implication, concluded the action research. This placed the writer with a detailed, and practical, account of two years of problem solving at Geest, the analysis of which would certainly provide for a unique insight into the internal working of a manufacturing company, and be of particular relevance to those manufacturing companies faced with a similar situation. The research methodology subsequently adopted for this analysis is that of grounded theory. Grounded theory describes the technique of relating empirical data to the existing body of literature in an attempt to validate, or otherwise, the theories presented in this literature. To quote the creators of grounded theory: "...such a theory fits empirical situations..."[4]

The ability to adopt an alternative research methodology, when at least half-way into this thesis, was made possible because both action research and grounded theory have, inherent to their operation, a need for empirical data.

### *1.3.0 The Research*

It was initially intended that this thesis be concerned with the writer's participation in a single product innovation at Geest. However subsequent (and unforeseeable) events within the management of this company presented the opportunity to participate in three separate attempts to innovate. Each attempt had its own particular set of characteristics:

1) The initial project remit of October 1982, called for the development of a low cost intelligent truck. This truck was to represent an entirely new concept in materials movement. It would be a complex project and had a remit which emphasised the considerable engineering content. In March 1983 the low cost intelligent truck project was abandoned.

2) The revised project remit, April 1983, was aimed at providing replacement models for the company's existing and outdated range of small electric trucks. The intention was to develop a product whose design characteristics would be acceptable to a market (or market segment). This remit did recognise the need for considerable market research.

3) In November 1983 the remit was again redefined. In addition to work on the small electric truck project the writer was to provide product development support to both company sales divisions. This support was to involve a series of exercises each aimed at determination of the viability of the company adopting a particular range of product.

Thus in preparing the industrial material for this thesis the writer was afforded a unique opportunity to participate in three distinct approaches to product innovation. These three approaches all differed with regard to the type of product innovation being attempted and they illustrate particular management responses to the innovation process. This thesis examines the implications for management of such differences and it describes the technical and marketing functions associated with the three approaches.

A review of the literature on product innovation is presented and followed with a description and analysis of the three attempts (by Geest) to conduct product innovation. The literature on product innovation is considerable and this review/analysis could have taken many forms; the approach chosen is one which capitalises on the dissimilarity between the attempts. All differed significantly in terms of:

1) The Product - and the corresponding stage of development of the component industry.
2) The Market - and its age and influence on the product design.
3) The Management - and the characteristics of the approach.

The review of literature in the following chapter will address the significance of these three variables and present a framework for the analysis, in a subsequent chapter, of the three attempts to innovate at Geest.

### *1.3.1 Outline Of Thesis*

This thesis comprises seven chapters. The purpose of chapter one is to provide the reader with an insight into the objectives of this thesis and the environment within which it was conducted. The second chapter presents a review of literature on product innovation concentrating on an examination of the dissimilarity between types of product innovation, and the implications for management. Chapters three to five all describe the performance of product innovation within Geest Industrial Group. Each chapter represents an attempt by the company to achieve a particular type of product innovation. Chapter three is concerned with the creation of a conceptually new product, chapter four reviews the development of a new product intended as a replacement for a range of existing yet obsolete models, and chapter five considers the adoption of new manufactured products into the company product range. In chapter six the merit and applicability of each of the above three dissimilar approaches is analysed with reference to the current literature. Chapter seven presents the major findings and conclusions resulting from this research.

## *CHAPTER TWO*

## *REVIEW OF LITERATURE ON PRODUCT INNOVATION*

CONTENTS:

# REVIEW OF LITERATURE ON PRODUCT INNOVATION

## *2.0.0 Outline Of Chapter*

This chapter presents a review of literature on product innovation. The review is introduced with a description of both the economic, and the company, need to conduct innovation. The body of the review is concerned with three aspects of product innovation, each aspect chosen because of a particular relevance towards the practical experiences of innovation at Geest. This chapter is concluded with a summary of the findings.

### *2.1.0 Introduction*

This thesis seeks to examine aspects of the management of innovation and as already stated it is an area of considerable complexity and the subject of much literature. It is the intention to be selective in the review of literature. There are valuable generalisations relating to the management of innovation and these are reviewed, there are also inherent differences and to enable account to be taken of the dissimilarity between the attempts to product innovate at Geest there is a need to be aware of the impact of certain of these differences. There is a need from the review to be able to recognise and thus 'tie' management practices to the particular characteristics of the innovation sought. With respect to the attempts to innovate at Geest there are three areas of significant difference. Firstly, in the management of each attempt. Secondly, in the stage of development of the product. Thirdly, in the age of the recipient market. In this chapter the argument for adopting dissimilar management approaches and the implications arising from the latter two factors are examined along with, and preceded by, an account of the economic pressure on the manufacturing company to innovate. This chapter is thus structured as follows:

- 2.1.0 - Introduction.
- 2.2.0 - Description of the economic pressure on the manufacturing company to introduce new products.
- 2.3.0 - Description of the implications which the pursuit of product innovation carry for organisation and management.
- 2.4.0 - Description of the process of realisation of a new product and the implications for management.
- 2.5.0 - Description of the implication which the age of the recipient market carries for the pursuit of product innovation.

### *2.2.0 Economic Benefit*

The need for companies to participate in product innovation is explained in terms of the competitive operation of the capitalist system. Economic benefit is associated with the successful outcome of an innovation.

At the company level, today's fundamental problem is to survive in an increasingly complex environment.[1] Survival necessitates taking the correct action while facing continually changing circumstances. In this respect the survival potential of any company can be gauged from its innovative ability for creating, developing or adopting new products. It is only through such activity that a company derives the means for subsequent economic benefit and so improves its long term viability. Indeed Rosegger[2] argues that the majority of innovative activity is undertaken solely in the expectation of economic benefit: "...with all other effects second-order in nature...". There is no alternative, and the consequences of neglect are described by Mueller:

> "An organization which does not confront change, or believes that it need not innovate, stagnates, decays, and dies."[3]

This relationship between innovation and economic benefit has been the subject of study for some considerable time.

According to Heertje,[4] Marx was the first economist to realise fully the significance of technical change for economics and society. Marx and subsequently Schumpeter, have both attempted to incorporate technological change into a coherent theory of the operation of the economy. Both authors hold the view that: "...changes in methods of

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Schumpeter argues that the whole purpose of capitalism lies in encouraging the introduction of new combinations. His conclusion is that innovation is itself a function of the capitalist mode of operation and following from this, that technical development is a consequence of capitalism rather than an independent cause of the expansion of production:

> "Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary ... The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers goods, the new methods of production or transportation, the new markets, the new forms of industrial organisation that capitalist enterprise creates."[5]

Schumpeter thus places innovative activity at the heart of the operation of the economic system. In Schumpeter, innovation is made identical with capitalism.[6] It is in the very operation of the capitalist system that the incentive exists to conduct innovation. Competition is based on innovation. When initially proposed these conclusions appeared to contradict the then existing economic models on competition, the latter having as their basis the pre-eminence of price competition. This conflict is resolved if the concept of the evolution of the market (as described later in this chapter) is accepted. In essence, a market as it evolves is reported to behave in a predictable pattern. At the beginning of a new market competitive action is based on product performance, as the market matures emphasis switches to competitive action based on price. Thus Schumpeter reconciles the appearance of innovation in terms of the operation of the economy the healthy functioning of the latter is reported to require innovation. Appropriately, the economy also incorporates the means to stimulate innovation and at the company level economic benefit is this stimulus. To quote a recent OECD report on innovation; innovative firms benefit from having: "...higher average growth rates..."[7] than their non-innovative counterparts. According to a study by Mansfield:

> "...the average effect of a successful innovation was to raise a firm's annual growth rate by 4 to 13 percentage points..."[8]

Miller and Friesen[9] have reported similar findings.

However, the act of conducting innovation can be costly, and high failure rates are reported.[10] Mueller and Tilton provide an account of the situation facing the company:

> "In the innovative stage, the major deterrent to entry is uncertainty. The chief inducement is the potentially very profitable position a firm can establish as an industry leader should the innovation be successful..."[11]

So in capitalism it is the opportunity for economic benefit that provides the stimulus for innovation and the basis for competition. Now if innovative ability is a direct measure of competitiveness, as it is suggested, then it would have to be present to some degree in all companies in order that they survive. Rosson and Martin[12] state that the prosperity of a company would appear to be to a large extent dependent upon its success or failure in introducing new products.

### *2.2.1 The Rate Of Innovation*

Not only is the ability to innovate in itself important, but increasingly so is the frequency at which it is performed.[13] A company has to conduct change in an orderly manner and at a rate sufficient to satisfy conditions which are imposed by its competitors. A rate which is too high can result in chaos; one which is too low may end in bankruptcy.[14] According to Schon[15] the minimum acceptable rate of change is increasing, forced up by the progressive shortening of product and process life cycles. An increasing urgency to conduct change is also reported by the management consultancy firm of Booz. Allen & Hamilton:

> "During the 1980's managers in all industries expect new products to fuel industry sales and profit growth ... To support these new product targets, companies expect to double the number of new products introduced over the next 5 years."[16]

The ability to conduct change, by itself, may be insufficient to guarantee survival. Effective competition is becoming increasingly associated with a required minimum rate of change. To quote Rockwell and Particelli:

> "The winners of tommorow will be companies that realize success is a journey, not a moment in time."[17]

Thus product innovation is a means of competition, and company survival is reportedly dependent upon the effectiveness and frequency with which this is performed. Nevertheless the product innovation activity is more often than not associated with commercial failure.[18] In this respect it is essential to understand what is involved in product innovation so as to appreciate the complexity and the difficulty faced by the manufacturing company.

### *2.2.2 The Need For Product Innovation: Summary*

Product innovation is an activity essential for the healthy operation of the capitalist economic system, and at the company level economic benefit is the stimulus.[2] Product innovation provides a means of competition and its successful conducting is fundamental to the long term survival of a company.[3] A shortening of the product life cycle and accelerating rates of innovation require that all companies pay greater attention to the pursuit of product innovation.

### *2.3.0 Resisting Change*

This section will review the literature on the management of innovation. It examines the reason for the difficulty which surrounds it and discusses the need for managerial and organisational separation.

A basic difficulty with conducting innovation is that the characteristics favourable to the management of this activity are not those to be found in the more immediate business operations. Furthermore, the problem with attempting to integrate suitable characteristics is that they will conflict with those established to manage the operation of the existing business,[19] yet qualities associated with the management of innovation are recognised as being a key factor in the outcome. Block[20] reports that the high incidence of venture failures by companies attempting to diversify is due to the mistaken assumption that the management methods that are successful for operating companies can be applied to starting new businesses. This failure arises as a result of a fundamental difference in objectives. Innovation is undertaken for the purpose of creating change. On the other hand an established business will have developed and be operating mechanisms specifically designed to minimise change. In any business both actions are important, however, innovation has no benefit if pursued solely as an end in itself. Existing processes represent an investment by the company in that they are established and understood:

> "Change means interference with learned processes, habits, and facts. It means unlearning, relearning and inefficiency."[21]

In this respect some resistance to change is not only normal but perhaps even desirable. According to Schon[22] an organisation totally devoid of resistance to change would 'fly apart at the seams'. For its own protection the organisation must be ambivalent about radical technical innovation. It must both seek it out and resist it otherwise the technical organisation would be perpetually and fruitlessly shifting gears.

An organisation's resistance to change can take many forms.

In some large companies the 'new idea forms'[23] which must be filled out by would-be innovators requires a fullness and precision of detail impossible early in the life of a new product idea. Such screening mechanisms are flawed, operating on the untenable premise that each idea be developed before support is given for its development. Insurmountable barriers can also result from the rigid application of classical financial analysis to the early stage of innovation.[24] Kottcamp considers a more subtle financial barrier is the practice of placing responsibilities for innovation on the research department but keeping financial control in the hands of profit-centre management, that is:

> "To hold one function responsible for long term results while financially controlling it via a corporate unit answerable for short-term gains..."[25]

Companies can inhibit innovation and are often good at doing so. Accepting that not all innovation is necessarily good or appropriate then this action may have some benefits. The fact remains however that a measure of innovation is essential for long term survival.

### *2.3.1 Organisational Issues*

McIntyre[26] noted that many of the weaknesses of established companies from the point of view of innovation are the very strengths which generate great economic efficiencies in managing already developed products, markets, and technologies. The management practices associated with both objectives are, he concludes, incompatible. Ansoff and Brandenburg[27] point out that the performance objectives for business are often inherently incompatible. For example, with its implications for product innovation, they suggest that it is not possible in a business situation to maximise both current operating efficiency and strategic responsiveness. The reason for the apparent inability of established companies to innovate is explained by Hlavacek and Thompson who argue that the difficulty lies in the managements willing adoption of bureaucratic strategy.[28] A strategy which they consider has a strong tendency to individualise work and reduce it in scope and responsibility, the aim of this being to create routines. To quote Hlavacek and Thompson:

> "Routinization in turn depends upon stabilizing the organizations condition of operation - its markets, products, materials and technology. Far from a drive to innovate, the bureaucratic organisation has many reasons for fostering the opposite condition - a tendency to stifle innovation."[29]

For individuals operating in such an environment March and Simon[30] argue that the natural tendency will be that the performing of routine tasks takes precedence over any non-routine tasks. This incompatibility is also recognised by Galbraith, who explains the conflict in terms of differing objectives:

> "An organisation that is designed to do something well for the millionth time is not good at doing something for the first time."[31]

As a means of resolving this conflict Galbraith recommends the establishment of two distinct organisations - an innovating organisation and an operating organisation. Such an approach is also favoured by Ward,[32] and by Drucker.[33] Developing this line of thought, Galbraith,[34] suggests that for organisations where there are at least two products at the innovative stage, an organisation focused on each product separately would appear the most appropriate. According to Nylen,[35] the entrepreneur has need for an open organisation structure to encourage creativity and risk taking; whereas the on-going products manager favours an organisation structure designed to maintain tight and detailed control.

Burns and Stalker, in a study of industrial firms in the UK found that different systems of management practices were required by those firms operating in a stable environment to those dealing with conditions of change:

> "One system to which we gave the name 'mechanistic' appeared to be appropriate to an enterprise operating under relatively stable conditions. The other 'organic'appeared to be required for conditions of change...
>
> In mechanistic systems, the problems and tasks facing the concern as a whole are broken down into specialisms. 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...
>
> Organic systems are adaptable to unstable conditions, when problems and requirements for action arise which cannot be broken down and distributed among specialist roles within a clearly defined hierarchy. Individuals have to perform their special tasks in the light of their knowledge of the tasks of the firm as a whole."[36]

Lawrence and Lorsch give support to these findings.[37]

Donaldson,[38] for example, reports finding that innovative activity requires an organic structure while the routinized operations of the mature industry benefits from a mechanistic structure.

Quinn puts forward another reason why innovation activity should be separated from established business operations. He suggests that established companies may face costs associated with innovation that the newcomer need not bear, for example, those associated with converting existing operations and customer bases:

> "By contrast, a new enterprise does not risk losing an existing investment base or cannibalising customer franchises built at great expense. It does not have to change an internal culture that has successfully supported doing things another way or that has developed intellectual depth and belief in the technologies that lead to past successes."[39]

Given the organisational separation of these two activities can a company then create the appropriate supportive characteristics without inherent conflict ?

Chakrabarti[40] considers that the effectiveness of any new product team will depend much upon the initiative and ability of the members in co-ordinating and promoting the new product ideas in various functional departments and the management hierarchies. This again will depend upon the organisational environment created and nurtured by the management philosophy and practices. Bower[41] likewise comments that successful innovation requires the attention of top management and a nurturing atmosphere.

In recognising their inability to innovate, according to McIntyre,[26] many large firms resorted to venture teams in an effort to stimulate innovation within existing organisations. However a 1977 survey indicated that venture teams were not wholly successful. In a study of ten major corporations Dunn found that:

> "The venture groups ... were at best ineffective and at worst, embarrassing failures."[42]

None of the companies in his survey continued to use venture groups. McIntyre[26] suggests the reason for this is that the venture teams although set up to avoid the corporate hierarchy, were not able to escape from substantial organisational interference. Hearne[43] found that many of the companies he studied applied the same organisational characteristics to each business unit they operated, whether or not they were appropriate. Yet organisational separation is recognised as a fundamental requirement for the healthy operation of an innovating unit. To quote Nylen:

> "The principle is straightforward - new-product programmes must be organisationally separated from the management of ongoing products."[44]

The failure to provide adequate separation will lead to a conflict of interests arising and in such a conflict it is reported that the more routine activity will predominate.

### *2.3.2 Management Issues*

According to Nylen[35] the reason for the inability of companies to product innovate may be managerial rather than technical. Four managerial factors which he considers contribute to this inability are:

1) Lack of commitment from top management.
2) Organisation for new products is inadequate.
3) The role of the marketplace in new product development is often misunderstood.
4) Management fails to accept the risks inherent in the new product process.

Characteristics associated with management play a critical role in the new product development process. With regard to their influence on the outcome Maidique (citing Arrow) makes the comment:

"There is plenty of reason to suppose that individual talent counts for a good deal more than the firm as an organisation."(45)

This view is also supported by Rothwell and Cooper.(46,47) To Rothwell this is a statement of fact and in his study of innovation in technically progressive firms he concluded that:

"...while chance and uncertainty can upset even the best laid schemes, responsibility for the success or failure of innovations rests firmly in the hands of the innovating companies' own management."(48)

Yet the climate within these companies is likely to evolve to produce an infrastructure intolerant of change. A trait which may be to the benefit of routine business activity but one which can seriously hinder innovation. Schon argues that the large company is likely to pay only lip service to the activities of the entrepreneur, a situation which is sustainable through the actions of those managers controlling the necessary authorisation. To quote Schon:

"The large corporation has created a race of "entrepreneurs without authority". The entrepreneurial task has been delegated to those below but not the independence to carry it out."(49)

"In order to justify investment, the subordinate must bring his ideas to the boss before they have proved themselves, and at that early stage he can never adequately defend them."(50)

Such actions by the large companies cannot truly reflect the entrepreneurial spirit upon which they were founded. Given that companies are founded on a new idea or innovation then some quality associated with the origin of the company must be lost in its development. Therefore the problem, as regards a company's resistance towards innovation, must lie somewhere in the evolutionary development of that company. Rothwell and Zegveld offer an explanation to this phenomenon:

> "As a company grows through exploiting its initial innovation, its management requirements change from something that is normally an idiosyncratic management style which is innovative, fluid and willing to accept high-risk developments, to one of stable management which has high administrative skills and is capable of ensuring the efficient running of the increasingly more complex organisation. Administrators, in general, tend to take a jaundiced view of risk-taking and innovation..."[51]

A similar account is given by Collier[52] and by Hearne.[53] Both these authors describe a relationship existing between the growth of the company and an increased inability to innovate. Within these growing companies it is the appearance, and subsequent actions, of the business administrator which comes in for strongest criticism. The suggestion is that these companies, as they mature, develop internal characteristics and a managerial style which promotes stability. On the other hand innovation involves risk, uncertainty, and change. To quote De Bono:

> "...there is risk as to whether the thing will work. There is risk as to whether it will have significant value. There is risk as to whether the market will accept it. There is risk as to whether the production process wil be feasible. There is risk as to whether it can be sold at an acceptable price. There is risk that a competitor may catch up quickly or leapfrog what has been done."[54]

While the 'critical administrator'[53] may profitably optimise existing businesses, the longer term success of a business is determined by its ability to manage change.

The distinction between the management characteristics favourable to existing business and those favourable to change have been studied by Basil and Cook.[55] They noted that the ability of a company to innovate is dependent, in part, on the ability of individual managers to be responsive to change. Guetzkow identifies a number of contrasting features between 'traditional' and 'change responsive' management and argues that the problem for management is one of very careful judgement in designing the correct system of operation:

> "...organisations exhibit simultaneous demands for routinization and for innovation. The balance of these countervailing pressures determines the organisation's climate for the creative member."[56]

The literature would suggest that in a mature company this 'balance' is biased towards routinization. A consequence of which is that innovation to be effective must be forcefully pursued. Just how innovation is pursued within the mature company has been studied by Schon. He conducted a study into the characteristics associated with successful innovation in large organisations and, in particular, in the military services. His finding was that in each case of a successful outcome there could be found, what he referred to as a 'product champion'.[57] This being a person whose rewards and future are identified with the outcome of a new product programme. Schon's analysis of the innovation process led him to identify four basic themes:

1) At the outset, the new idea encounters sharp resistance.
2) Overcoming this resistance requires vigorous promotion.
3) Proponents of the idea work primarily through the informal rather than the formal organisation.
4) Typically, one person emerges as champion of the idea.

To Schon: "...the new idea either finds a champion or dies."[58]

Chakrabarti[59] has identified a number of characteristics associated with the product champion and the successful management of innovation, these include:

| | |
|---|---|
| Technical competence - | The champion should have a sound technical understanding of the product. |
| Knowledge about the company - | The champion should have a clear understanding of the company's needs. |
| Knowledge of the market - | The champion must have a realistic idea about the products marketing potential. |
| Drive and aggression - | The product champion must have some amount of drive and aggression. |
| Political astuteness - | The art of the product champion lies in political astuteness. The champion will have to get along with different types of people, communicate with them, and get work done without serious antagonism being created. |

Perhaps it is the latter aspect 'political astuteness' which is a prerequisite for successful championing. For example, a major stumbling block for innovation would appear to be the associated risk it carries. Companies in normal development tend to evolve so as to minimise risk. However with 'political astuteness' it is argued that a champion will act to reduce a companies perception of this associated risk. This was the conclusion of participants at an R&D management conference on the product champion concept. The conference report contains the following comment:

"They believe that effective champions actually reduce the risks that they face by acting on probabilities and by presenting their arguments incrementally, but tenaciously, so as to reduce the perceptions of others that what they are doing is in any way unusual or risky."[60]

Nevertheless, product championing as a concept can provide no basis for a coherent innovation strategy. It relies on opportunism and the uncoordinated actions of individuals.

Support is given to the view that the prime requirement for the successful management of innovation is entrepreneurship, not only as far as individuals are concerned, but also in terms of organisational structures capable of overcoming functional barriers within the company.[37] However, because entrepreneurship is idiosyncratic it follows, according to the authors, that within each company there will tend to evolve unique approaches to its management. Jewkes[61] et. al., comment on the idiosyncratic nature of innovation and suggest that it is a great and dangerous over-simplification to suppose that innovation can always be handled by any one single kind of organisation.

While it is true that certain characteristics of the innovation process will be particular to the company, it is also true that certain aspects will be common. In this respect, literature does suggest that companies should approach the management of innovation on the basis of the uniqueness/complexity being sought. Distinct managerial approaches to new product development are described by McTavish.[62] The entrepreneurial approach is identified as being highly relevant to radical new product development and a hierarchial management structure more appropriate to product line extensions. Following from this the organisational structure relevant to new product development is described as falling into two classes - free standing groups such as new product departments and venture groups, and functionally based units operating as part of planning, marketing, R&D, or engineering.

According to McTavish the degree of product innovation required of a company changes in accordance with the evolutionary characteristics of its markets. A consequence of this is that supporting new product development is not simply a matter of choosing a structure and management style to fill a given situation. Rather it resides more in a management willingness and ability to meet the changing needs of its market - it is management 'style' changes which are crucial in enabling new product objectives to be met most effectively.

On the subject of management styles the management consultancy firm of Booz. Allen & Hamilton describe a similar phenomenon:

> "Successful companies appear not only to select a management style appropriate to immediate new product development needs, but also to revise and tailor that approach to changing new product opportunities. For example, a major instruments and controls company that historically had used an entrepreneurial management approach to new product development is moving to a more structured, top-down managerial style as it finds some of its high-technology market segments maturing. A major industrial components company is moving to a less structured, more entrepreneurial style as it positions itself to enter emerging high-technology growth segments."[63]

Thus it is argued that companies wishing to compete for tommorrows markets are required to pay more than just lip service towards innovation. Such companies must strive towards providing comprehensive organisational and managerial support for innovative activity. Support sufficient to protect the activity from both routine company operations and from the actions of their administrators.

*2.3.3 Management And Organisation: Summary*

Both organisation and management characteristics play a significant part in deciding the outcome of an innovation programme. However the types of characteristics favourable to innovation do not integrate well with those characteristics favourable to the conducting of more immediate business interests.

*Organisation:* The propensity of the large organisation to promote routines is, according to Hlavacek and Thompson,[28] one of its greatest strengths. However as both they and March and Simon[30] report - routines do not favour the introduction of innovation. To overcome this dilemma Galbraith,[31] Ward,[32] and Nylen[35] all argue of the need for two distinct organisations within a company - one to promote the immediate business interests and the other to promote innovation.

*Management:* The studies of both Collier,[52] and Rothwell and Zegveld[51] describe a process whereby innovation within a company is increasingly constrained as a company matures. The authors argue that this is the result of fundamental changes in the priorities of management, brought about by the need to capitalise on the existing business opportunities. A transition which is characterised by the appearance of, what Hearne[43] refers to as, the 'critical administrator'. Nylen[35] suggests that, in the mature company, product innovation will only occur if it is managed separate from the immediate business interests.

Recent studies by McTavish[62] and Booz. Allen and Hamilton[63] argue that the organisational and managerial approach towards innovation should be conducted separate fron the immediate business interests, only, in as much as the uniqueness/complexity of the particular innovation demands.

This thesis will subsequently examine the association between the complexity/uniqueness of an innovation and the corresponding need for separation from the immediate business interests.

### 2.4.0 *Definitions*

The three accounts of product innovation, at Geest, represent attempts to complete particular, and dissimilar, stages of the innovation process.

The first use of discrete (economic) stages to describe innovation is credited to Schumpeter. Freeman makes the comment:

> "We owe to Schumpeter the extremely important distinction between inventions and innovations ... An invention is an idea, a sketch or a model for a new or improved device, product, process or system ... An innovation in the economic sense is accomplished only with the first commercial transaction..."[64]

The distinction between invention and innovation was first advanced by Schumpeter in 1911.[65] Prior to this, invention and innovation had tended to be used loosely as if they were interchangable descriptors of the same activity - as they still are by lay writers - which ignores the fact that whereas invention is a prerequisite of innovation it is not in itself a sufficient condition. To Schumpeter innovation is an activity quite distinct from that of invention.[66] This argument forms the basis for numerous models of the innovation process. Its use also assists with the description and analysis of innovation activity. For example, in the relationship between invention and innovation, communication is reported to play a key role.

In most cases, the idea for an innovation originates with the communication about a need, followed by a search for technical possibilities to meet the need.[67] In both stages knowledge is reported to be frequently transferred through informal and oral sources.[68,69] According to Utterback[70] most of the ideas subsequently developed and implemented by companies have origins elsewhere. In a study of 157 successful commercial innovations, Myers and Marquis[68] found that 98 of the ideas were a consequence of information being received from sources outside the company. Mueller[71] in a study of the sources of innovation at Du Pont reports similar findings. Sources frequently referred to are a company's customers and its competitors.[72] Ideas form the starting point of the innovation process. Their subsequent transition to commercialisation has been the subject of much study.

### *2.4.1 The Innovation Process*

The description of the innovation process by Pavitt[73] is not too far removed from that proposed by Schumpeter. Pavitt describes this process as comprising the three stages:

1) Invention, which occurs when the feasibility of a new product or production process is postulated or established.

2) Innovation, which occurs when, for the first time a company sells a new or better production process, with resulting commercial success.

3) Diffusion, whereby a new or better product or production process is produced or used by a wide number of companies.

However, this model is uncommon and places no emphasis on the product development stage. A more popular model is described by Bessant who in an examination of eight models of the innovation process comments: "All...have in common discrete stages for invention, development and adoption /diffusion..."[74]

The existence of these or similar discrete stages have been reported by others. Utterback[70] identifies the three stages of innovation as:

1) Generation of idea.
2) Development.
3) Diffusion.

Goldhar et. al.,[75] proposes a fundamentally similar model.

Models such as the above are termed linear. Their main advantage is simplicity. To quote Klien, the linear model views innovation as:

> "...an orderly process, starting with the discovery of new knowledge, moving through various stages of development, and eventually emerging in a final viable form."[76]

Describing the innovation process as comprising three distinct stages is a considerable simplification and in practice there are major differences in the way each new product is proposed, developed, and commercialised. In this respect, Cooper argues that: "...the new product process is not the sequential or series process so often portrayed..."[77] Cooper describes this process as comprising numerous steps, each interdependent and interwoven with the others, an effect which makes separation difficult. To this end 'countless conceptual' models have been produced to explain the innovation process.[78] Irrespective of the model chosen fundamentally different skills are required as the innovation process evolves, and in describing the innovation process as comprising distinct stages researchers are acknowledging that different sets of skills are associated with the successful conducting of each stage. However the concept of a three stage process applies solely to the evolution of the product. In this respect, and given that access to the earlier research work is available, a particular company may choose to join this process at a later stage. In doing so it not only accelerates the innovation process but it also, by implication, reduces the need for certain associated (in-house) skills. Different sets of skills are associated with each stage in the innovation process. Consequently a transfer of knowledge, experience, etc. between stages may be the best means in a particular circumstance for the companies involved to derive maximum benefit. For example, such arrangements may be observed with patents and royality fees, and with factoring and franchising operations. The innovation process is now examined. Its three stages are as identified by Bessant.

*Invention.* An important characteristic of invention as a problem solving activity is that it concerns itself with problems to which there exist no logically correct answers.(79)

This being so an inventor will be required at some stage to depart from the restrictions imposed by traditional logical thinking. Such problem solving calls on the inventor to display acts of 'creativity'. Creativity involves 'perceiving in an unhabitual way' and breaking clear of fixed ideas and conventional thinking:

> "It is intuitive and instinctive, rather than rational..."(80)

Styles of thinking have been studied extensively by De Bono. In this respect De Bono identifies two distinct styles as being vertical thinking and lateral thinking, and explains their difference as follows:

> "A vertical thinker will try to find out why an idea will not work so that he can reject it. A lateral thinker will try to see what can be made of the idea even if he knows it to be inadequate."(81)

To De Bono lateral thinking is a prerequisite for change and a refusal to use lateral thinking is to condemn oneself to moving always in the same direction. Considerable research has been undertaken to develop techniques for improving the quality of 'creativity' exhibited by individuals and by groups.[82,83] Barrett[84] describes a number of current techniques including brainstorming, attribute listing, synectics, bionics, morphology, and deliberate dreaming. According to Utterback,[85] consultants, consulting activity and information resulting from diversity in work assignments also play major roles in stimulating 'creativity'. Gordon and Morse[86] likewise note that consultation outside the work setting tends to enhance the generation of ideas. The important point in all this, and the point made by Holt, is that invention is not in the traditional sense manageable. To quote Holt:

> "This is a creative process which cannot be controlled directly...One is faced with a complex psychological process of a conscious, subconscious and overconscious nature. An innovative idea represents an unpredictable chance occurance; therefore, it is not possible to order creative ideas and schedule the time of their arrival."[87]

Bessant notes that the techniques and conditions which favour creative activity are different from those applicable in the latter stages of innovation.[74] This view is supported by De Bono. His research indicates that it is lateral thinking which generates an idea and vertical thinking which develops it.[88]

*Development.* Johnson describes this stage as being: "...largely devoted to bringing an invention to the stage where it can be produced commercially."[89] Unlike invention, all develoment work is considered to have definite commercial objectives. The progression through this stage is ordered and progress is achieved by problem solving.[90,91]

Management planning techniques can play an important part in the development activity. A number of techniques are available including; critical path analysis,[92,93] performance evaluation and review technique,[94,95] and systems analysis.[96] Their use enables management to both review and control the progress of a project and to identify the critical stages. Such a capability can be very important. Development is undertaken for the purpose of commercialisation. These two activities are interdependent and the success of the latter is, to a degree, dependent on the efficacy of the performance of the former. Development costs are quantifiable and will be met only if they are considered to be recoverable during commercialisation. By the same argument the amount of time a project spends in the development stage must be offset against the financial consequences of aiming for an earlier/later launch date.[97]

Development costs tend to comprise the major component of an R&D budget. Research[98] of USA levels of R&D expenditure have indicated that the cost associated with development accounts for approximately 75% of the total. Similar results were reported in a study of UK levels of R&D expenditure.[99]

*The Adoption/Diffusion Decision.* As mentioned in the chapter outline it is only at this stage that innovation, in the economic sense, takes place. Nevertheless with respect to the product this stage does presuppose the successful completion of the invention and development stages.

Rogers and Shoemaker decribe the innovation decision process as a mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject, and to confirmation of this decision.

They describe this process as comprising the four stages:[100]

1) Knowledge.
2) Persuasion. (attitude formation and change)
3) Decision. (adoption or rejection)
4) Confirmation.

Mansfield[101] has examined the link between the speed of the adoption process and the variables of size of company, liquidity of its assets, its growth rate, profit trends, age of its president, and the profitability of innovations. His findings confirmed the existence of a direct relationship between receptivity to innovation, the size of the company, and the profitability of the innovation. This relationship did not exist for other variables. This direct relationship between the size of a company and its earlier receptivity to innovation is reported by Webster.[102] His findings support the view that the larger the net investment required for adoption the more resistance there will be, especially, in the case of the smaller company. Other researchers have emphasized the connection between earlier receptivity to innovation and the existence of an economic 'crisis' or precipitating circumstances.[103] According to March and Simon:

> "The rate of innovation is likely to increase when changes in the environment make the existing organisational procedures unsatisfactory. We would predict efforts towards innovation in a company whose share of the market, total profits, or rate of return on investment had declined."[104]

Wilson reported a similar effect and states: "...that an economic crisis led to a faster rate of adoption..."[105]

The study by Smith, et. al.,[106] however warns of dangers with attempts to increase innovation which either involve or result in a greater degree of participation by 'top management'. Such participation according to the authors can result in the appearance of 'crash' programmes:

> "...with short cuts, down playing of unfavourable results, and large cost over-runs."[107]

In a discussion of the failure of this approach Smith concludes that 'crash programmes do indeed crash'.

There are clear differences between the three stages as described above. Each stage is seen to possess its own set of conditions which requires the appropriate management responses. There is no one style of management which would favour the conducting of all three stages, the dissimilarities being too great. For example, management must support creativity and tolerate the finding of 'blind alleys' during the invention stage. Yet in development all research must be clearly defined and tight controls must be applied. Thus the ability to manage innovation must also be a test of the ability of management to change attitudes to match changing circumstances. To use the words of Basil and Cook, such management must be 'change responsive'.[108]

### *2.4.2 Invention And Innovation: Summary*

Product innovation does not necessarily presuppose invention. However, when this is the case the transition from one to the other can be a complex process. A useful simplification is to consider this transition as comprising a few distinct and sequential stages. A common simplification, and one adopted by Utterback,[70] is to describe the innovation process as comprising the three stages of: Invention, Development, and Adoption/Diffusion.

*Invention:* Invention is described as being the first of three sequential stages which comprise the innovation process. It is a stage which places emphasis on creativity and it is as a consequence of its association with creativity that the invention stage can present particular management difficulties. Holt recognises that this is a stage which cannot be managed directly.[87] It is nonetheless a stage which can be stimulated, and there are a number of techniques which are reported to improve the quality of creativity.[84]

*Development:* This represents a stage of high expenditure and financial commitment - the stage where the company takes an invention and prepares it for commercial launch.[89] All development work has commercial objectives and any costs must be recoverable during commercialisation. A number of management planning techniques are available to assist the review and control of a project through this stage.

*Adoption/Diffusion:* This is the final stage in the innovation process. It involves the decision on whether to adopt (or reject) an innovation into the existing company operations. This is a decision which has many influencing factors. Mansfield describes a relationship between receptivity to innovation and company size, as well as to the predicted profitability of the innovation.[101] Economic crisis is another motivating factor. March and Simon report an increased propensity to innovate by those companies whose market share, or financial performance, is in decline.[104]

It is apparent that the above three stages describe fundamentally different facets of the innovation process. The implications arising from these differences must be recognised by management. For example, the disciplined managerial approach to development would indeed be ill suited to the creative environment of invention.

The attempts to product innovate at Geest could all be classified according to one or other of the above three stages. Examination will be made of the 'appropriateness' of the management at Geest and the symptoms and effects of inappropriate management will be investigated.

### *2.5.0 Market Factors*

A contrasting feature of the three attempts to introduce new products at Geest is the dissimilarity in the age of the recipient market. This is an important difference, not least, because the established market can provide a source of information on which to base marketing and design decisions, in contrast to the younger market which can provide no such information.

Market factors are reported as the primary stimuli influencing the rate of industrial innovation. Utterback[109] in a study of the proportions of innovations stimulated by market needs and technological opportunities has noted that:

> "From 60 to 80 per cent of important innovations in a large number of fields have been made in response to market demands and needs."[110]

Most of these innovations according to Abernathy and Townsend[111] will be concerned with the introduction of new products. In a study of technological innovation in the UK manufacturing industries, Townsend et. al.,[112] came to the same conclusion. According to Townsend, product innovations comprise 77-79% of all manufacturing industry's innovations. Process innovations were found to comprise 16-17%, materials 3-4%, and others 2%. However, by their very nature these findings generalise the situation across a number of industries. For every industry the ratios of the occurrence of the above types of innovation will be governed by characteristics specific to that industry.[113] In this respect the stage of development of the particular industry has been reported as a key variable.

According to Abernathy and Townsend:

> "The most likely form of successful innovation, the typical barriers and enabling conditions, and appropriate management skills all tend to depend upon the stage of development which the recipient process has reached."[114]

Likewise Rothwell commenting on characteristics associated with the evolution of an industry suggests that:

> "...the type of innovations typically produced by large and small firms at different stages in the industry cycle might also vary ie. product or process innovations."[115]

This association between product and process innovation and the stage of industrial development of a market is found to be a recurrent theme in the literature on industrial innovation. The market conditions favourable for each of the above two types of industrial innovation are also reported.

Product innovations are associated with the young, more dynamic market environments, where market characteristics favour product diffentiation through specification and performance.[116] In this type of market the efficiency of the production process is not so critical and different manufacturing processes may exist concurrently.

Process innovation is identified with the large mature markets where it is argued conditions favour competition through product price minimising action.[117] Such action can lead to increasing investment in production plant and in the appearance of technological interdependence between product and production process. This effect can, in itself, reduce the likelihood of further major product innovations.[118]

### 2.5.1 *Models Of Industrial Innovation*

Theoretical models to account for the variation in the ratio of product to process innovation within an industrial market have been proposed. In one such model, by Utterback and Abernathy, the authors describe common characteristics in the evolutionary cycle of an industry, figure 2.1. The basis of this model is that:

> "...the characteristics of the innovative process and of a firm's innovative attempts will vary systematically with differences in the firm's environment and its strategy for competition and growth, and with the state of development of process technology used by a firm and by its competitors."[119]

Though depicting a chronological progression, timescales, or rates of progression, have no place in this model except, that is, in a retrospective sense and only then in relation to the specific market in question.

The above model distinguishes between product lines in a dynamic 'fluid' state of technological development and those in a 'mature' state. According to the authors, while in the fluid state firms are identified as exhibiting high rates of product innovation, small size, informal organisational structure and entrepreneurial spirit. Competitive action is based on product performance maximisation rather than price. In comparison, as a product line matures its products become characterised by a high degree of standardisation as the manufacturing firms turn towards mass production. Competition is then based on the pre-eminence of price minimisation. The onset of this stage, according to Adams,[1] elevates the importance of process innovation in contrast to product innovation.

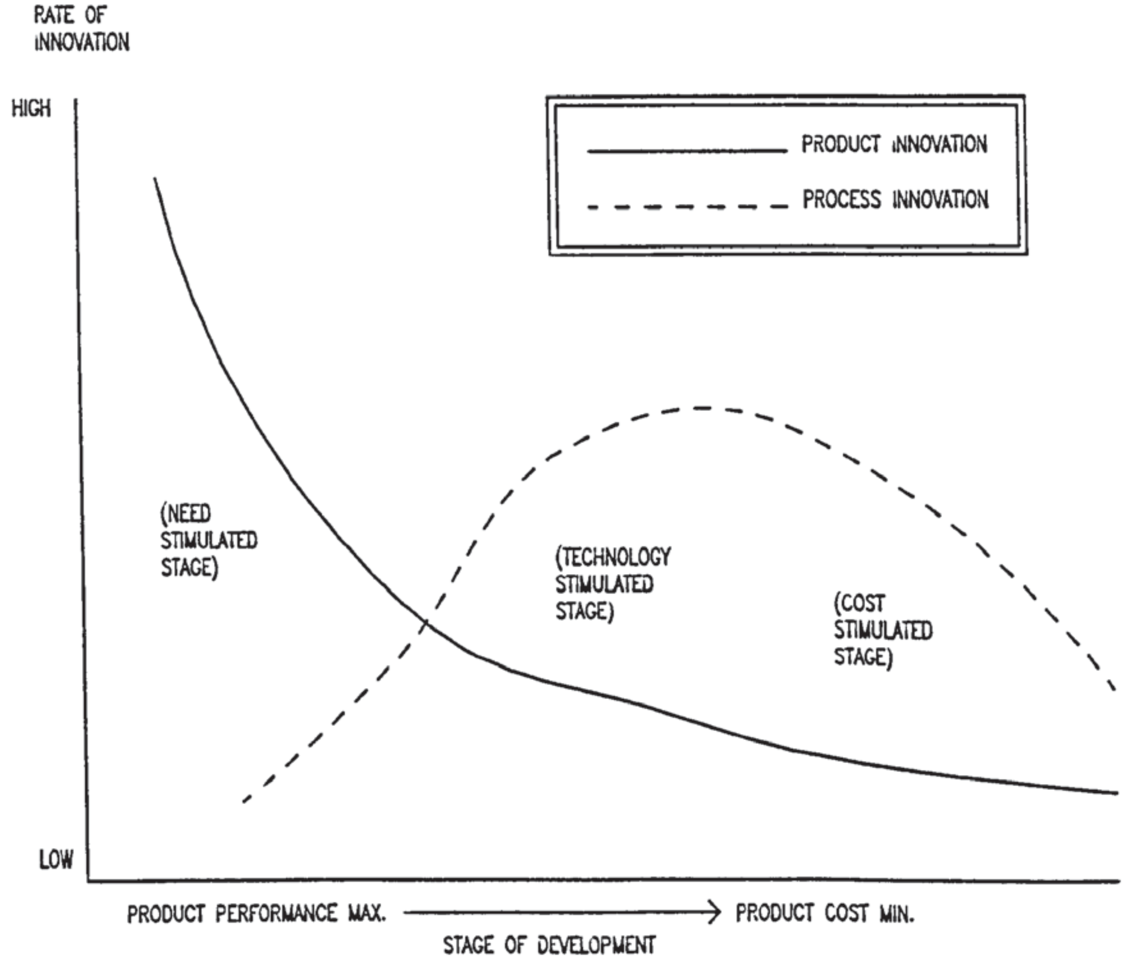


FIGURE 2.1
INNOVATION AND STAGE OF INDUSTRIAL DEVELOPMENT

Source: Adapted from Utterback and Abernathy.[118]

Freeman et. al.,[120] describe a fundamentally similar model. According to Freeman there are essentially two classes of innovation, which he terms 'entrepreneurial' innovation and 'managed' innovation. In the former new technologies emerge, coupled to new scientific developments, which are largely outside existing companies and market structures. Risk-taking entrepreneurs recognise the 'techno-economic' opportunities thus offered and, via. radical innovation, foster the growth of new industries and the emergence of major new product groups. As with the Utterback and Abernathy model, Freeman recognises that it is during this phase, of the industrial evolutionary cycle, that dynamic new and fast growing firms play key roles as innovators. Freeman also describes a similar industrial ageing process. As the technology and the market matures the average firm size increases and inventive activity becomes increasingly 'managed'. Within firms the organisation becomes bureaucratic and is structured along functional lines.[1] Finally, as the industry and its technology reach maturity the possibilities for major product innovations diminish. At the same time the market requirements become increasingly well specified and competing products are designed around similar specifications. A result is that price becomes a more significant factor in competition. Thus development efforts become increasingly directed towards process efficiency improvements.

Both these models report a similar phenomenon. The idea of a pattern inherent to all technological innovation has also been studied by Sahal.[121]

While Sahal's analysis accords with the above two models, it goes further. Specifically it describes two important consequences arising from these models:

"In its essence, the process of technological development invariably leads to a certain pattern of design. The pattern in turn governs the possibilities of further development. We find therefore that a great many innovations in any given area depend on exploiting the potential of an essentially invariant pattern of machine design by degree. Some such basic design may be likened to a guidepost indicating the general direction of technical progress."[122]

"In a nutshell, the proposed principle of technological guideposts is illustrative of a very general phenomenon. It is that evolutionary processes tend to be both self-generating and self-constraining. The implication of this for the management of R&D activity is evident: It is possible to assess the technological innovation potential of a new technique in advance."[123]

Sahal's argument is that while the concept of evolutionary development with respect to innovation is universal the evolutionary development of a particular innovation is a function of its inherent potential. A consequence of this is that innovations will follow evolutionary patterns which are, at the same, time both unique and yet similar.

A premise of all the above models is that the likely complexity of product innovation, to be found in any market, is a function of the stage of development of the industry serving that market which is, in turn, a function of the development of the market itself. The fact that the types of products to be found within markets are considered to follow a predictable evolutionary pattern does indicate the presence of constraints on the type of innovations adopted by the market. Essentially a market as it develops is characterised by the adoption of those products which provide a better fit with the market needs. Therefore the constraint on the market accepting a new product is that it meets such an objective which, in turn, would suggest the need for innovation in the mature market to have a strong marketing input.

In proposing the above models it is argued that the relative complexity of product innovation shifts as the market being served matures. The models describe a transition from radical innovation to style changes/minor improvements. To enable debate on the significance of this transition there is a need to adopt a classification system which will account for the transition stages. Heany provides an account of a 'spectrum' of degrees of innovation activity.[124] His classification of innovation activity is conducted with reference to the innovating company. Heany's degrees of product innovation are given in a descending order of complexity, as follows:

Major innovation
Start-up business
New products
Product improvements
Product line extensions
Style changes

This idea of dissimilar types of product innovation is not unique and classification schemes are to be found in the works of both Rothwell and Zegveld,[125] and White.[126]

It is thus argued that the type of innovation appropriate to a given market is dependent upon the stage reached in its evolution. However, the type of product innovation appropriate to a particular firm is reported to vary in relation to its size. The basis for this comment is that certain characteristics associated with company size are reported to favour the conducting of one particular complexity of innovation over the other. This relationship accounts for the differences in the characteristics of the typical companies found competing in any two markets. According to Adams[127] the small firm, when innovating, has the following advantages:

1) Flexibility.
2) Rapidity of response to market change.
3) Entrepreneurial environment.

By comparison large firms are reported by others as offering the following advantages:[128,129]

1) The financial ability to invest in the more expensive innovative activities.
2) The ability to scale up production quickly.
3) The ability to reach a wider market.

Rothwell provides a detailed comparison of the advantages and disadvantages associated with firm size.[130] According to Rothwell the comparative advantage, in performing innovation activity, lies with neither size of firm. Instead both size of firms are reported as making valuable contributions towards innovative activity. In this respect Rothwell also suggested that the: "...large and small firms are a necessary complement to each other...".[131] Each responds to this task in a way which best capitalises on the distinct characteristics of these two groups, a situation which Rothwell describes as 'dynamic complementarity'.[132] In a joint publication Rothwell and Zegveld[51] conclude that the small firms enjoy a number of human resources, in innovation, while the larger firms benefit from resources related to advantages of scale.

Freeman[133] studied the occurrence of different types of innovation with reference to firm size. With the exception of one industry, namely 'paper and board', he reports that the large firms (>200 employees) monopolise all innovations in the capital-intensive industries. On the other hand he found that small firms (<200 employees) innovated in industries where the entry costs were low. He concluded both sizes of firms satisfied different requirements as regards innovative activity. Scherer makes a similar comment:

> "No single firm size is uniquely conducive to technological progress. There is room for firms of all sizes. What we want, therefore may be a diversity of sizes, each with its own special advantages and disadvantages."[134]

To expand on this subject there are essentially two financial factors which positively discriminate against the market presence of the smaller firm. Firstly, is the required cost of entry for a given market. Secondly, is the cost of remaining in that market.

The required cost of entry to a given market, at any time, is termed the financial threshold. Mueller and Tilton[128] suggests that the financial threshold for entry to a given market will vary and is dependent upon the stage of development of the industry serving that market. The evolution of a market has been reported as progressing from primarily product innovation to primarily process innovation, and finally, to a combination of both. Thus while an industry is serving a market in the early stages of evolution the financial threshold will be dictated principally by factors associated with the technological sophistication of the product. As the market matures, and product specifications standardise it is reported that the competing firms will invest increasingly large sums on the development of improved production processes. According to Freeman such action by one will force all competing companies to do likewise and once a company enters a market it must innovate at a rate comparable with its competitors, if it wishes to remain competitive.[135] One consequence of such competition is to raise the financial threshold required for entry to that market. Thus the situation as regards new entrants to a market is straightforward; market evolution biases against the appearance of the smaller company.

To remain in an evolving market a company must innovate at a rate at least comparable with its competitors and all companies must innovate at a rate sufficient to maintain a competitive and up to date product range. Achieving this requires that two preconditions be met. Firstly, that the firm has access to the appropriate expertise. Secondly, that it has access to adequate finances. What is appropriate and adequate can only be quantified with respect to the competitive nature of the particular environment. This presents the concept of the R&D threshold, namely, the annual financial commitment required by a firm to remain competitive in a given market. Freeman makes the comment that below this: "...'threshold' level of R&D expenditure it will normally be impossible to develop new products with lead times short enough to survive."[136] This level is an absolute value set by characteristics of the market. According to Freeman if the 'threshold' is too high for the particular firm then it must either go out of this particular market, or, it must combine with other firms in order to reach the required critical mass.[137] On the international scale this effect has been reported to have forced the rationalisation of national industries. Thus the required annual investment in new products is to a large part dictated by the type of product and by the competitive composition of the market. In any event it is an absolute value and consequently must be matched or bettered by all existing companies in that market. At the company level the ability to fund such a commitment is a measure of financial size. Thus this concept describes a relationship which mitigates in favour of the continued presence of the larger company. In remain competitive.[135] One consequence of such competition is to raise the financial threshold required for entry to that market. Thus the situation as regards new entrants to a market is straightforward; market evolution biases against the appearance of the smaller company.

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> "It appears undeniable, at least in the broad sense, that the state of technology is a determinant of market structure through its definition of the minimum efficient scale of production."[138]

All innovative policies which operate to raise the financial threshold required for entry to, or continuation in, a given market differentiate in favour of the larger firm.

However this differential advantage extends only in so far as it affects the practicality of certain companies introducing specific innovations. In general the actual ability to innovate seems to be independent of firm size and the larger firms do not develop a greater proportion of innovations, relative to their market share, than the smaller firm.[71,139] In a study by Utterback no relationship was found between the size of a firm and its relative ability to innovate.[140] Myers and Marquies[68] have reported similar findings. Project SAPPHO[141] which compared matched cases of successful and unsuccessful innovation also found a similar result. Though arguing that the greater the amount of resources devoted to a project the more likely it was to be a success the study could find no relationship between resources devoted and firm size.

Thus it is argued that technological sophistication and market maturity are two factors which dictate the competitive composition of a market. Both operate by constricting the innovative abilities of those companies with insufficient finances. In any event financially smaller companies do innovate and at a rate comparable with the large firm The key point is that these companies compete for the financially smaller markets. The evolutionary characteristics of the market act in such a way that through time the financially larger firms will come to predominate. This is a characteristic of the industrial process of achieving an optimal fit of existing products to the market needs. However as technology advances, to provide more design opportunities, so such markets may become obsolete - and new markets are always being formed.

The volatile conditions reportedly present at the beginning of a new market would favour the flexible and adaptable firm. It is in this area that the small firm, possessing such characteristics can operate to achieve rapid growth. Small firms are often reported as capitalising on such conditions. To quote Collier:

> "Instant pictures were developed by Polaroid, not by Eastman Kodak or Ansco. Transistors were first put on the market by Texas Instruments, not by RCA or General Electric who dominated the vacuum tube market, and xerography as a basis for copying, was pioneered by Haloid, now Xerox, not by Addressograph - Multigraph or Eastman Kodak, who dominated the copying field."[142]

The companies conducting these innovations were at that time quite small. Innovations of the above degree do not fit on the model of an evolutionary development of a market. Instead they can be found at the ends of such models operating to terminate, or initiate, the evolutionary pattern.

The conditions surrounding the occurrence of such innovation will now be examined.

### 2.5.2 *Radical Innovation*

An innovation which displaces existing techniques or technologies is termed radical, and according to Hill and Utterback:

> "...is one which can create new businesses and transform or destroy existing businesses. Substantial portions of the capital stock will essentially be swept away and replaced."[143]

Threshold barriers apply only as long as a market is content with the product being offered. There is always the possibility that a firm, of any size, may introduce into the market a new product or process which employs an inherently more effective technology. Examples of this include the introduction of the transistor, xeroxography, and automobiles. Such innovations will cause considerable disruption to the evolutionary development of a market and for this reason are less likely to be actively sought by companies with a vested interest in maintaining an established market. According to Freeman et. al.,[120] the likelihood is that the displacement of an established product or process will come either from small new firms or from firms operating outside the existing technology. To support this Freeman notes that none of the synthetic materials were invented, developed, or innovated by either the suppliers or fabricators of the natural materials and metals for which they were largely substituted.[144] This reluctance of the established firm to undergo change in response to the competitive introduction of products based on inherently more effective technology is not surprising. The established company facing competition from such products may argue that it has sound financial reasons for backing its established product. For example, the company is likely to have made a considerable commitment to the product, both in terms of financial investment and operating knowledge, equally it may not possess the resources, social or financial, necessary to allow the adoption of the new technology. Nevertheless, such a company should recognise the consequences of the path it is choosing to follow. To quote Allio and Sheehan:

> "The risk of technological commitment is that the needs of the customer to satisfy a particular function are de-emphasised."(145)

A company must never forget that a purchase decision is based on the ability of a product to satisfy the customer's need better than the alternatives. An OECD report highlights the danger of technological commitment for the large firm:

> "The big firm makes the bulk of its profits out of economies of scale on established products, it is therefore inclined to improve these established products rather than make radical innovations."(146)

According to Hill and Utterback it is difficult for firms producing standardised products in high volume to respond to the challenges of major technological or market change.(147) Firms that do respond tend to do so by redoubling creative effort and investing in what is well known. However for these companies the liklihood is that the conditions of competition will have changed. In this respect, after the introduction of a radical innovation to a market, Hill and Utterback suggest that:

> "The emphasis in competition will shift to product change and away from cost and quality, while, at the same time, prices may drop with extraordinary rapidity and many new options and performance dimensions may be available to users."(148)

This argument accords with the earlier model of the evolving development of products within a market. Radical innovation forms the basis for a new cycle and at this stage of development the nature of competition is different from that reported in a mature market.

### 2.5.3 *Technology Push - Market Pull*

A simplification arising from the above discussion would be to describe product innovation as an activity comprising essentially two forms; radical innovation and evolutionary innovation. These two forms are distingushed with respect to the nature of their origins, namely:

1) Radical innovations arise through the opportunities presented by advances in technology.

2) Evolutionary innovations are introduced in response to the commercial advantages to be gained by the improved matching of existing technology to the needs of the market.

A similar method of account of innovative activity is reported in the literature, and while the actual classifications are as above it is common practice to title both so as to reflect their dissimilar origins.[149] Cooper describes the two types of innovation as:

> "...market pull: where the new product idea originates in the marketplace (eg. from the salesforce or a customer; via market research; etc.)
>
> ...technology push: where the impetus for the new product comes from a laboratory discovery or the availability of a new technology."[150]

While the idea of the classification of all innovations into two forms lacks the subtlety of the Abernathy, Freeman, and Sahal model, it is nevertheless intended as an account of the same phenomenon. In classifiying innovations, according to these two forms, researchers have found that the majority of successful innovations were the result of market pull. To quote Voss:

"...it has become almost an unwritten law that more successful innovations arise from need pull than from technology push."[151]

Rothwell provides another example:

"The majority of successful innovations (on average, about 75% of successful innovations) arise in response to the recognition of a need of one sort or another (need-pull) as opposed to the recognition of a new technical potential (technology-push)."[152]

However the above statements are open to misinterpretation, that is, these figures fail to take account of the considerable difference in the actual rate of occurrence of these two types of innovation. For example, what is less frequently reported is that the majority of failures are also conducted in response to market pull.[153] In fact what these statements do reflect is that the majority of innovations are conducted in response to market pull situations. Utterback describes this situation as follows:

"Market factors appear to be the primary influence on innovation. From 60 to 80 percent of important innovations in a large number of fields have been in response to market demands and needs."[70]

This he concluded from the findings of eight studies of the proportion of innovations stimulated by market needs and by technological opportunity. Given the character of the earlier models, which better emphasise the role of market pull, this situation is not altogether surprising. Nevertheless in a comparison of the likely outcome of individual projects Cooper has reported that, as regards a successful outcome, market pull projects do fare "marginally better" than technology push:

"Our conclusion is that whether a product is market pull or technology push does not differentiate all that well between success and failures (although market pull fared marginally better)."[153]

Finkin, quoting that 80% of all successful innovations are conducted in response to market needs, does give good reason as to why market pull should fare better that technology push. Finkin argues in favour of companies pursuing a market pull approach towards innovation:

> "This is the most reliable way to succeed in new products, for it means lessened business risk - lessened because there is less chance that the fully developed product cannot be successfully sold."[154]

The above classification of innovation activity is a considerable generality. In taking such an approach the authors are choosing to ignore the existence of a chronological (evolutionary) pattern to the development of products for existing markets. Nevertheless, the resulting simplicity, of only recognising two classes, does allow for valuable comparison. Comparative research has indicated the presence of a considerable bias in favour of the conducting of market pull innovations. Research also indicates that such innovations are likely to be (marginally) more successful.

Such findings are not incompatible with the ideas contained in the Utterback and Abernathy model. In particular they serve to quantify the prevalence of market pull over technology push a situation which is implicit in the earlier models. Both approaches are accounts of the same phenomena and both are complementary in their findings.

### *2.5.4 Industrial Product Innovation: Summary*

A model is presented which explains the changes in the characteristics of product innovation occuring within a market as a function of the age of the industry serving that market. According to this model at the beginning of a new market, competitive action is based around improved product specification and performance, and, as the market evolves this is replaced by competitive action based around price differentials. This model is proposed by Utterback and Abernathy,[118] and similar accounts of the 'evolutionary development' are reported by Freeman[120] and by Sahal.[121] All three of the above authors describe a transition from major to minor product innovation as the industry providing the products evolves.

This transition does carry financial implications. Studies by both Freeman[135] and Mueller and Tilton[128] suggest that the relative cost of conducting product innovation in a given market will rise as the industry serving that market evolves - a consequence of, what Abernathy et. al.,[118] describe as the 'technological interdependence' between product and process innovation. The transition also has implications for competition. In comparative studies by Rothwell[130] the author comments that the smaller companies, with skills in R&D, are better suited to competition for the younger and more dynamic markets whereas the more mature companies, with skills in production and distribution, are better suited to compete for the mature markets.

The implications of the above is that there is a clear benefit if a company can, prior to innovating, conduct an internal audit of its skills to ensure that they are compatible with those of benefit to the innovation (given the age of the recipient market).

During the two year period of industrial study Geest pursued innovation in a number of markets. These markets were of different ages. In this thesis the implications of the age of the market will be examined.

### *2.6.0 Aspects Of The Review Of Literature*

The review of literature has described four dissimilar aspects of product innovation. The first of these provides an introduction and description of the need for innovation. The latter three are included because of their significance as regards the attempts, by Geest, to innovate. It is these latter three aspects which provide a theoretical framework around which examination of product innovation activity will be conducted and in this respect the preceding review of literature has presented the following arguments:

1) The introduction of product innovation is contrary to the purpose of the more immediate business interests and, in consequence, there is an argument for separating innovation from the immediate business interests. It is also argued that this level of separation is a function of the complexity of the innovation sought.

2) Product innovation can be considered as a process comprising three stages: invention, development, and adoption/diffusion. The characteristics of management favourable to each stage are reported different.

3) As an industry evolves (to serve a market) it does so while following a predictable pattern of product innovation. This pattern describes a transition from major innovation through to minor innovation.

It is in chapter six and seven that each of the above three arguments will be examined.

*CHAPTER THREE*

*RADICAL PRODUCT INNOVATION*

CONTENTS:

### *3.0.0 Outline Of Chapter*

This chapter describes an attempt at radical product innovation within Geest Industrial Group. The writer had responsibility for the conducting of this innovation under the supervision of the managing director. To attempt this innovation was ambitious - it involved the development of an entirely new product which had no equivalent in the marketplace and whose technology was likely to be far removed from that found within Geest. The project was abandoned five months after its start, following the departure of the managing director.

### *3.1.0 Introduction*

In October 1982 Geest Industrial Group recruited the writer on a fixed term (three year) industrial studentship to design and develop a new product. This project remit is reproduced as appendix B. Geest gave the proposed new product the title of the 'low cost intelligent truck'. The technology applicable to such a product suggested a radical departure from the company's existing technological base. One of the main features of this product was to be the development of the automated guidance facility - a 'black box' which when fitted to a suitably adapted electric truck would provide a degree of autonomy to its travel. No decision had been taken regarding the technology of the 'black box' design, though the writer's first degree in electronics was a contributing factor in his selection. The reason for this electronics bias may be a result of the project's origins. Management at Geest first became interested in the possibility of automated guidance through commercial contacts with a firm already participating in the IHD scheme. In 1980 an electronics components firm (company X) had employed three IHD students to work on the development of an electronically controlled wire guided electric vehicle. Aware of this work, Geest management saw advantage in being able to offer the facility of automated guidance for their own range of electric trucks and expressed interest in collaborating on the vehicle guidance aspect. This did not, in the event, happen, although Geest did receive design documents from company X.

### 3.2.0 Objectives

The October 1982 project remit, see appendix B, called for the development of a low cost intelligent truck intended for use in small manufacturing or warehouse units. The word 'intelligent' made reference to the design requirement that the truck be able to negotiate a route under its own guidance and without the need for operator assistance. As such, the sophistication of the truck was intended to provide a: "...halfway house between the computer control, wire guided truck and a man pushing a pallet from location A to location B."

Marketing research was undertaken in order to further develop the product/performance specification contained in the project remit. There were two objectives to this, firstly, to acquire information on technologies available for vehicle guidance, and secondly, to acquire information to allow determination of suitable markets for the truck. On the second objective, it was a stated intention not to produce a direct competitor for the existing automated guided vehicle (AGV) market. Nevertheless the product would have certain operational similarities to AGV installations and so details on the products and suppliers to this market were also of interest.

### 3.2.1 Sources Of Information

Marketing research was conducted from Geest offices in Boston, from Aston University, and during visits to specialist centres such as the National Material Handling Centre (NMHC),Cranfield.

From the above three locations the writer had access to the following sources of information:

| | |
|---|---|
| *a) Journal Articles* | *b) Company Literature* |
| *c) Conference Publications* | *d) Government Information* |
| *e) On-line Literature Searches* | *f) On-site Visits* |

*a) Journal Articles.*

This involved a review of present and past issues of 'material handling' journals (eg. 'Storage Handling Distribution', 'Material Handling News'), in order to gain familiarity with the types of equipment used in the material handling environment and to study the application and operating environment of automated guided vehicle installations. Useful information was found.[1,2,3] This review of trade literature revealed five companies supplying AGV systems to the UK market, table 3.1.

TABLE 3.1: UK SUPPLIERS OF AGV SYSTEMS.

| COMPANY: | PRINCIPAL PRODUCT RANGE |
|---|---|
| Rolatruck Ltd. | driverless truck (wire guided), order picker, stackers, reach trucks, pallet trucks. |
| Babcock Fata Ltd. | driverless trucks (wire guided), conveyor sorting systems, order pickers, stackers, robot welders. |
| Jungheinrich (GB) Ltd. | driverless trucks (wire guided), order pickers, stackers, fork lift trucks, reach trucks, pallet trucks. |
| Malthouse Hunter Ltd. | driverless trucks (wire or optically guided), electric trucks, platform trucks, sack trucks. |
| Wagner Indumat Systems Ltd. | driverless trucks (wire guided), order pickers (wire guided). |

The installation cost of an AGV system is difficult to determine as it varies as a function of the technical requirements and on-site details.

However, it will be expensive. For example, an on-board automatic guidance facility for use in one vehicle will cost £5000+ with the installation of the wire guidepath an extra £7-10/m, and then there is the cost of the operating software, commissioning, etc.[4] An indication of an order-of-costs is provided by a major manufacturer of AGV systems:

> "...a simple floor installation and one AGV with automatic pick-up and put-down could be installed for approximately £25 000."[5]

AGV systems are criticised on cost and inflexibility, and the UK has a poor rate of adoption as compared with other european countries:

> "Britain has about 70 automated warehouses but of these no more than 30 are really advanced."[6]

This slow rate of adoption is not through a lack of availability. The AGV has been available in the UK for some 20 years,[7] indeed personal communication with an employee of Thorn-EMI (in the 1960s one of only two British manufacturers) suggests the first UK installation occurred as early as 1959.

*b) Company Literature.*

Company literature was sought on AGV systems in order to identify the potential for a transfer of technology to the truck. The managing director of Geest produced a set of sales literature from one supplier. A review of the literature held in the trade section of the NMHC Cranfield provided another set. As a company employee the writer made a telephone request for sales literature from two other AGV suppliers. Neither company was prepared to forward information, though, given the opportunity they both would instruct a sales representative to call. Another request, this time as a student, also met with no success.

*c) Conference Publications.*

During discussion with the librarian at the NMHC Cranfield, the writers attention was drawn to a 1981 conference publication on AGVs, prepared by the Industrial Fluidics Society Ltd.[8]

The conference was the first of what is an annual event, held with the aim of promoting discussion on the subject of AGVs. Papers contained in the 1981 conference proceedings included submissions by AGV manufacturers, distributors, users, and academic researchers. Its content was essentially technical, and potentially of benefit to the design of the intelligent truck. Reference is made to this document in the following (technical) section.

*d) Government Information.*

*Company Accounts:* To determine the financial condition of the five companies supplying AGVs to the UK market (to enable comparison with Geest) the writer obtained microfiche copies of their annual accounts.[9] Comparison reveals three of the four companies for which accounts information was available, were financially considerably larger than Geest. See appendix C.

*Business Monitor:* The market size for types of products can sometimes be obtained from statistics contained in Business Monitor. In this, the section which deals with AGVs is PQ337. However, examination of the product classification system revealed AGV details to be incorporated with other product types, making any statistical analysis impossible.

> "Industrial Tractors (including electronically controlled driverless tractors):
> Internal combustion
> Electric "[10]

*e) On-line Literature Search.*

An on-line literature search was conducted at Aston University library in an attempt to identify vehicle guidance techniques not currently used on the existing industrial AGV systems, but with potential application for the intelligent truck. This search helped to identify several techniques which are reviewed in the following section.

*f) On-site Visits.*

On-site visits were arranged in order that the writer might gain an insight into the type of working environment intended for the truck. Such visits serve two purposes in that they:

1) Increase information on existing techniques and technologies. This assists with the identification of potential applications and market segments which might be of interest to this project.

2) Allow discussion on potential applications with people involved with this market. This encourages the cross-flow of ideas, and thus assists in identifying the desirable characteristics of such a product.

In arranging these on-site interviews it was the intention that the writer observe the techniques of material handling in the industry and warehousing environment. A list of suitable companies was compiled from information at hand. This comprised the sales record of the Geest electric vehicle and a 1982 edition of Kelly's Directory.[11] A telephone call was made to each company explaining the nature of the study and the type of assistance required. Details of any agreements reached were confirmed in writing.

This approach resulted in interviews being granted at the following six sites:

| | |
|---|---|
| Woolworths | - Rochdale |
| Kays | - Worcester |
| Geest | - Spalding |
| Crabtree | - Birmingham |
| Halfords | - Redditch |
| Pedigree Pet Foods | - Melton Mowbray |

Each interview took the same form, and started with an informal discussion of the company's material handling operations followed by a tour of the site. The operational details of each site is given in appendix D. The following points were noted at these interviews:

1) Unease existed towards the idea of installing any new and unproven material handling process.

2) In applications where the material handling operation comprised a number of distinct processes, the overall effectiveness of the operation was dictated both by the efficiency of the individual processes and by the level of integration achieved between these processes.

3) All companies stressed the importance of being able to maintain a flow of materials. The amount of attention given to specific material handling activities was seen to be related to the importance of the role played by that activity in the overall nature of company operations.

4) In the movement of goods there does appear to be a performance gap between the AGV system and the equivalent manual operation. A market entry into this gap with some hybrid of the above two techniques could be commercially viable.

5) The outlined characteristics of the intelligent truck did favour its operation in certain roles within factories/warehouses. In particular its method of loading/off-loading with a previous defining of routes would possibly support its operation in the following:

   a) Loading/off-loading bays. An area characterised by irregular though intensive movements of goods from and to specific locations.

   b) Place and put operations. For operations which are characterised by infrequent though regular movement of goods.

   c) The transfer of goods between remote buildings on a single site. A system of manual loading and off-loading with automatic transfer to destinations would prevent the need for fixed hardware or operator escorts.

### *3.2.2 Summary And Conclusions*

The low cost intelligent truck lacks a precedent and as a result the marketing research had two basic aims, firstly, to establish the availability of suitable technology, and secondly, to establish the viability of the truck concept in the marketplace.

The truck proposed certain operational characteristics having some similarity to that provided by the existing AGV systems. The latter could prove a useful source of design information, they could also provide a source of competition. The UK suppliers of AGVs were companies financially larger than Geest, furthermore, their product ranges comprised mainly powered products with which the intelligent truck concept would have greater synergy. Thus any competition with established AGV suppliers was undesirable, the option was to identify a market niche, one whose physical characteristics were inappropriate to the application of the AGV concept.

The determination of the viability of the intelligent truck was being pursued through a series of on-site visits. These visits served to introduce the concept to the managers of factory-warehouse complexes and thus enabled dialogue on potential applications.

### *3.3.0 AGV Guidance Techniques*

The low cost intelligent truck project, see appendix B, proposed the design of an electric vehicle with a control system sophisticated enough to:

> "...enable the vehicle to be sent by an operative to some other part of a factory or warehouse..."

Realisation of the intelligent truck presents two distinct design problems. Firstly is the design of the trucks electrical and mechanical framework. Secondly, and more complex, is the design of the trucks intelligent control system incorporating the automated guidance facility. The automated guidance facility would be the innovative feature in the truck design and it presented the area of greatest technological uncertainty.

The design of a suitable control system and in particular the guidance facility would prove to be complex and time consuming. This being so, there was a need to appreciate the nature of the problem faced. The intention was initially to study only the guidance facility, and only when this aspect was understood would the study area be widened, to include the design of a suitable vehicle. Existing techniques used for AGV guidance were reviewed to assess their potential for transfer.

An automated guided vehicle (AGV) system can be considered as comprising two elements, a vehicle and a guidepath. In operation the vehicle follows a guidepath by continually monitoring and adjusting its position with respect to this path. Usually the vehicle guidepath is formed from either buried electric cables or a track which is painted or taped onto the floor surface. With the former, the buried cables are installed as a series of closed loops, the actual number of loops being dependant upon the complexity of the intended vehicle route. In operation each loop is injected with a signal of different frequency. The cables 'leak' this signal which is then detected by an overhead vehicle. With this approach a vehicle is programmed to follow that sequence of cable frequencies which correspond to the desired vehicle route. This technique is commonly referred to as 'wire guidance'. For the latter technique the vehicle guidepath is provided by a track placed on the floor surface. This track is formed from a fluorescent dye which can be applied directly to the floor surface, or supplied in the form of an impregnated tape and bonded to the floor surface. The operation is based on optical rather than electrical technology with a vehicle illuminating the fluorescent dye as it passes overhead.

Despite differences in the technology of the guidepath, all automated guided vehicles navigate in a similar way, they define their position with reference to the guidepath. To provide the necessary information on position a vehicle is fitted with two sensors, which are designed and positioned so as to react to the proximity of the guidepath. In normal operation these sensors would lie either side of the guidepath and equidistant from it. It is through monitoring the output of both sensors that a vehicle is able to detect any deviation from the guidepath. When this occurs this 'detection' then forms the basis for an instruction to take corrective action, and re-establish the equidistant state.

All current commercially available guided vehicles navigate by means of a guidepath. However, there is one system commercially available which provides for a vehicle to perform a pre-defined deviation from its guidepath. This system, manufactured in Sweden, sells in the UK under the trade name 'Carrago'. In operation, its vehicles have the provision to use either of two distinct guidance techniques - wire guidance or an on-board odometric facility. The latter gives a vehicle the freedom to operate remote from the guidepath to travel up to 20m.

### *3.3.1 The Intelligent Truck*

The present guidance techniques require that any desired route be pre-defined by some form of hardware. As outlined these techniques rely on either buried wires or tracks placed on the floor surface. However the need for this hardware is inconvenient to the customer particularly from the points of view of installation cost and route flexibility. One of the objectives set for this project was to design a guidance system which did not require a path to be pre-defined in hardware but rather could be reproduced from information contained in the vehicle software. For a vehicle to reproduce a route there is a requirement that it has the capacity to orientate itself relative to some fixed origin. A number of technologies have been suggested for such an application including inertial aids, odometry, and map correlation.[12] Though these, and other techniques were known to offer potential, the complexity surrounding their technology and application made any serious comparative assessment impossible.

The writer considered that the best approach would be for the supervisory team to reach a consensus on the desired area of study. To stimulate discussion amongst the team members, the writer produced and distributed a paper containing suggestions on the application of dissimilar technologies to the guidance concept. A copy of this paper can be found in appendix E. The outcome of the management team meeting of the 17th January 1983 was a stated preference for a point-to-point navigation system. With this approach a series of beacons, each comprising a receiver and a transmitter, would occupy defined locations and a vehicle would navigate by orientating itself relative to the nearest beacon, thus a truck could hypothetically 'swing' between adjacent beacons. Such a concept meets the aims set by Geest - it would not involve investment in fixed hardware, it would be flexible and it would be expandable. The operational characteristics were not easy to visualise, difficulties lying both with the need to accurately define position to enable the safe operation of the vehicles and in the need to establish communications between vehicle and beacon.

A literature search was conducted by Aston University library to establish if any vehicle navigation techniques existed which made use of beacons or other comparable forms of remote sensing to determine position. This search produced 22 references, of which 9 were considered to be of relevance to this study. The techniques covered in these 9 references ranged from radio triangulation systems[13] to on-board dead reckoning systems.[14] Of particular interest was a technique which utilised a point-to-point beacon concept, a close range guidance system with the trade name SEFAN.[15] SEFAN was developed, under licence, by the electronics company ITT as part of a West German army contract. Its purpose is to provide close range navigation details to military vehicles operating in unfamiliar or obscured environments. The system described comprised a beacon and a vehicle mounted analyser. In operation the vehicle mounted analyser computes navigational details using the differences in phase between transmitted and received signals. This method of analysis, using phase difference, is reported to provide information on location to an extremely high degree of resolution. The principles behind this technique appeared to have potential for the truck project and indicated an area worth further study.

The effective operation of this system or any other based on similar approach would ultimately be dependant upon the ability of the truck to establish two-way communications in its operating environment. The most likely means of communication between truck and beacon was considered to lie with electromagnetic propagation. With this approach some focusing of the signals may be required in order to prevent distortion of the transmission.

### *3.3.2 Summary And Conclusions*

Realisation of the guidance aspect of the intelligent truck was likely to prove the project's most complex technical requirement. Commercially available AGV systems have certain performance similarities and the operation of their guidance systems were reviewed. This aspect was found to be inappropriate because of its dependance on fixed hardware, and the technology in its present form offered little potential for adaptation. The intelligent truck was intended to be able to reproduce a route without the AGV's need for fixed hardware. Brainstorming provided a range of potential solutions to the guidance aspect. This resulted in the selection of a solution based on a system whereby a truck is able to compute navigation details through contact with a beacon (comprising receiver - transmitter) occupying a pre-defined location. A search of the literature on vehicle guidance techniques produced details on a established system with the trade name SEFAN. The operation of SEFAN involved a vehicle communicating with a remotely sited beacon in order that it be able to compute details of position while travelling in obscured or unfamiliar environments. The technnology used in SEFAN appeared to have potential for application to the intelligent truck and was worth further and detailed investigation.

### *3.4.0 The Research Environment*

Within Geest Industrial Group, the engineering drawing office had responsibility for coordinating all R&D activity. This involved supporting at the same time, with the same resources, both long term and the more immediate company product development programmes. Integrating these two activities led to friction, the source of which is outlined below.

Short term development projects occurred frequently. A consequence primarily of Material Handling division's sales policy that they offer a 'custom' design facility. Customers for this service ranged from individuals requesting minor variations to an existing product, to the large organisations seeking tenders for a specific product design and order quantity. Sales were continually asking for an improved response by engineering to their 'custom' enquiries and argued that the time taken from the receipt of a customer enquiry to the receipt of product cost estimates from the engineering drawing office was too slow and that cost estimates were frequently too high to be competitive. On the other hand, the engineering drawing office were frequently critical of sales for passing on information which was vague and unsubstantive.

Both immediate and long term development work took place in one drawing office and to the detriment of the latter, ie. the six years (1977-1983) the company took to develop the subsequently aborted small electric truck. In this case the company's draughtsman with responsibilities for the development of this product had commented to the writer that the delay to this project was the direct result of effort being diverted to assist with more immediate drawing office projects.

Initially the writer was allocated a desk and a drawing board in the engineering drawing office. Within this office all staff duties were highly disciplined. Office time keeping was strictly observed and telephone calls required authorisation. The drawing office staff were not allowed visits to exhibitions, manufacturer suppliers, or customers. The following are four factors which worked against the conducting of the intelligent truck project in this environment:

1) The drawing office staff observed strict time keeping, and yet the writer's condition of employment as prepared by the company specified different starting/finishing times.

2) The writer required frequent access to a telephone and secretarial support, and continually had to request authorisation for these basic services.

3) Suspicion was attached to the writer's presence and purpose in the drawing office. Management never officially informed office staff of the writer's role in the office.

4) The writer was interrupted with requests for assistance with the more immediate design problems of the drawing office, eg. the redesign of the pallet truck handle.

The drawing office environment was unsupportive of the development of the intelligent truck project and, on request, a move was made to a vacant office within the factory. No explanation was asked for by management regarding this move. Working from this office provided relief from the day to day business. However, even with physical separation there was disruption to the intelligent truck project - the origins of which lay with the management of the project. The managing director had recruited the writer on the project remit as agreed with IHD, yet only two months into this project he instructed the writer to assist the engineering drawing office to conduct field trials on a new product. This duty was to be managed in addition to any commitment towards the intelligent truck project - and subsequently effort was diverted from the latter. The field trials revealed serious problems with the design of this new product and the eventual outcome of which was the abandonment of the new product, and the compilation of a report (10th January 1983) detailing the technical requirements of a replacement product and describing a suitable market strategy. A copy of this report is provides as appendix F. All this took a disproportionate amount of the writer's time.

At the start of the intelligent truck project the managing director requested that a weekly progress meeting be held. These meetings were, typically, of thirty minutes duration, during which time the writer advised on progress and outlined future plans. After a few such meetings the writer was instructed to submit travel itineraries for the coming week. In January 1983 a request for a research budget was rejected. At a project team meeting on the 4th March 1983 it was stated that there would be no definitive budget for the project. All finance required for this project, for any item however small would require the managing director's pre-approval. At this project team meeting it was also agreed that a greater monitoring of the project was desired.

The above situation remained only until the 'resignation' of the managing director on the 7th March 1983.

However, by this stage the writer was having doubts about the commercial validity of the intelligent truck project. The intended product was incompatible with the existing company operation. On the one hand research into the truck design was moving towards the application of sophisticated control and communications theory, while the more immediate company business was concerned with the manufacture and selling of low technology material handling products, such as wheel barrows, sack trucks, and safety steps. There was a lack of product synergy, and given the complex nature of the intelligent truck this could easily give rise to a number of potentially serious problems. On the appointment of the engineering manager to the position of industrial supervisor, the writer took the opportunity to express his concerns in a memo. See appendix G. There were five main points of concern:

1) *Lack of technical back-up from the company.*
   With all its skills being in metalworking the present workforce would be ill-equipped to provide the quality of after sales technical support which might reasonably be expected by a company following its purchase of the intelligent truck. New skills in electronics and control theory would be required of the workforce.

2) *Lack of servicing facilities.*
   The workforce has no expertise in the servicing of sophisticated material handling equipment and even if the truck used bought-in-components there remained the need to be able to diagnose component failure. A servicing capability would be required.

3) *Lack of electronics credibility.*
   Geest is not a company which is normally associated with

sophisticated, and powered, material handling equipment, and so the company has no market credibility in the supply of such products.

4) *Lack of financial resources.*

Geest has not the financial resources equal to the suppliers of AGV systems. The ability to be able to finance the development of the intelligent truck and thereafter bear the cost of commercialisation, and possible competition, is questionable.

5) *Lack of company test facilities.*

The company lacked the electronic test facilities which would be required to develop the intelligent truck. The university would provide some assistance, however, the sophisticated nature of the product was such that a considerable financial commitment by Geest would be required at an early stage in the project.

Concern was also expressed over the practice of diverting the writer's effort onto the more immediate company business. In April 1983, a meeting was held to discuss the practicality of pursuing this particular innovation, at which it was agreed that the low cost intelligent truck project should be abandoned.

*CHAPTER FOUR*

*NEW PRODUCT DEVELOPMENT*

CONTENTS:

# NEW PRODUCT DEVELOPMENT

## *4.0.0 Outline Of Chapter*

This chapter describes an attempt at new product development. The April 1983 project remit called for the development of a range of small electric trucks to replace the company's existing models. It was intended to segment the electric truck market and then use a combination of currently available technologies to produce a better fit for a suitable market segment - an approach made possible by the mature state of the electric truck industry. To this end the writer researched both the size of this market, and the technical design of the market-leader products. The development work described in this chapter took place between the months of April to November 1983, during which time the writer was a member of the engineering division hierarchy, and answerable to the engineering manager. In November 1983, certain events occurring within the company resulted in a redefinition of the writer's remit, and while the electric truck project continued after November, it did so under a different organisational structure and under a different set of priorities.

#### *4.1.0 Introduction*

Following the abandonment of the intelligent truck project in March 1983, it was agreed at a project team meeting in April 1983 to accept the writer's recommendation (see appendix G) to commence work on the development of a new range of small electric trucks:

> "...to concentrate effort on the development of the existing electric vehicles, and establishing a framework within Geest to optimise production and sales of these vehicles."

This was a more credible objective, and one of considerable importance to Geest. Introduced in 1958 the existing models were close to the end of their life cycle - as demonstrated by the decline in annual sales. See figure 4.1. The type of market applications of interest to the company meant that any trucks would be of a rating of at most a few H.P. and so the project was referred to as the 'small electric truck' programme. This project involved the development of a new product. See appendix H. Unlike the writer's previous project the low cost intelligent truck, a market did already exist for small electric trucks. As such, development of this type of product involved less uncertainty and less risk.

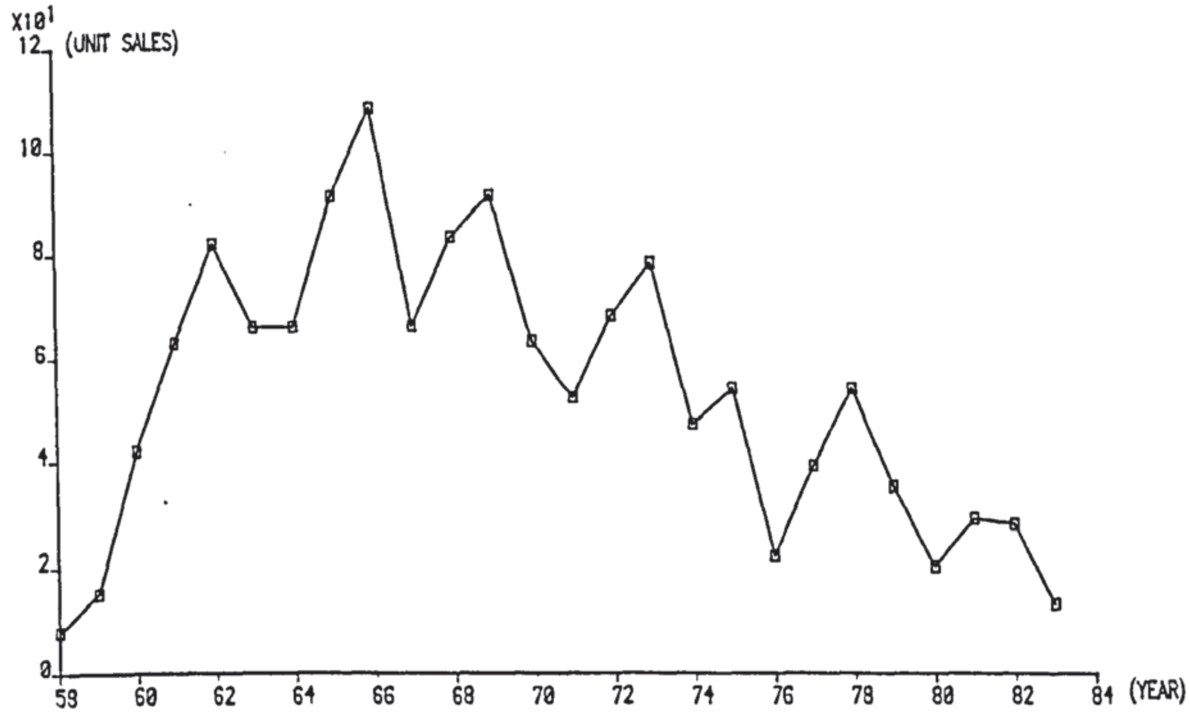


FIGURE 4.1
ANNUAL SALES OF GEEST ELECTRIC TRUCKS

Source: Geest internal document.

### *4.2.0 Collection Of Information*

Marketing research was conducted to provide information on the existing electric truck market thus enabling a suitable product/market strategy to be prepared. Information was obtained from the same three locations as used in the intelligent truck project, namely:

University of Aston, Birmingham.
Cranfield Institute of Technology, Bedford.
Geest Industrial Group, Boston.

Using these three locations information was collected from the following sources:

*a) Trade Journals*
*b) Specialist Publications*
*c) Company Sales Literature*
*d) Trade Associations*
*e) Government Publications*
*f) Internal Sales Data*
*g) Postal Questionnaires*

*a) Trade Journals.*

Trade journals were reviewed to identify those companies supplying electric trucks to the markets of interest to Geest as outlined in the project remit (see appendix H), that is: "...hospitals, warehouses, factories etc..." The two trade journals, 'Storage Handling Distribution' and 'Material Handling News', both held at the NMHC Cranfield, covered areas appropriate to this study and were particularly useful. Reference was also made to the Electric Vehicle Association (EVA) publication 'Electric Vehicles Quarterly' - a magazine to which

Geest subscribed.

*Product Portfolio.* From the trade journals the writer was particularly interested in identifying those companies whose product portfolios suggested a strong commitment to the electric truck market and whose product advertising presented them with a high profile in the markets of interest to Geest. Such companies were more likely to produce an aggressive response to a new product launch by Geest. Analysis of trade journal advertisments and subsequently product sales literature suggested the following four companies as providing competing products:

| | |
|---|---|
| Harbilt Electric Vehicles Ltd. | Petbow Environmental Products Ltd. |
| J. Bradshaw and Son Ltd. | Lansing Bagnall Ltd. |

Harbilt: This company's product portfolio is comprised entirely of electric trucks. These trucks consist of variations on two basic designs, namely, the tow-tug and the platform truck design.

Petbow: This company's product range comprises, in total, five electric trucks. These trucks were either of the tow-tug or platform truck design.

J. Bradshaw: This company provided an import/assembly operation for a range of trucks manufactured by the American company T. Dunn. This product range comprised both electric and diesel powered trucks of tow-tug and platform truck designs. The electric powered versions of the latter, though similar to the Geest product, were larger and more powerful.

Lansing Bagnall: This company produces a wide range of sophisticated powered material handling equipment. At the lower end of its product range is found electric tow-tugs.

Tow-tugs are included in the above description of competitor products. This is because the tow-tug is, in a number of respects, complementary to the platform truck, for example, both incorporate electric motors and both assist with the transportation of materials. The principle difference between the two is that a tow-tug is designed to pull a train of trolleys each capable of carrying material, while the platform truck itself carries the material. The tow-tug can transport a greater load per journey, however, it can also cost 2-3 times the price of a platform truck.

*Product Price.* Information on product prices was not freely available in any trade journal and product literature when requested would often arrive without any price list. The writer found that such information could only be obtained by making specific requests to the manufacturers.

For electric trucks of a design similar to the present Geest range, product selling prices were as follows:

Geest £2300. (current model)

Petbow £2200.

Harbilt £2100.

The tow-tugs supplied by Petbow, Harbilt, and Lansing Bagnall each sell for around £6000 - the exact price depending on the particular requirements of the truck.

*b) Specialist Publications.*

This refers to those publications produced by companies and organisations in which they provide statistical details on their operations, eg:

Railway market - British Railways Annual Report

Hospital market - The Hospital and Health Services Yearbook

*c) Company Sales Literature.*

Sales literature describing the types of small electric trucks presently available was obtained without much difficulty. The writer used three approaches, concurrently, in order that this exercise be conducted quickly:

1) Photocopies of sales literature were collected from the 'trade literature' section of the NMHC Cranfield.

2) The completion of pre-paid enquiry forms contained in the two magazines - 'Storage Handling Distribution' and 'Material Handling News'.

3) Telephone requests for product information were made to a number of companies.

*Sales Approach.* The sales literature showed each company in this industry to have a similar approach to selling. Each company advertised functionally similar products. Product sales literature emphasised the technical characteristics of trucks with any reference to specific market applications occupying only a small section of sales literature. A list of markets refered to is given in table 4.1.

TABLE 4.1: SEGMENTATION IN THE ELECTRIC TRUCK MARKET.

| MARKET/COMPANY | J. BRADSHAW | PETBOW | HARBILT | LANSING BAGNALL |
|---|---|---|---|---|
| Engineering | * | * | * | |
| Hospitals | * | * | * | * |
| Warehousing | * | * | | |
| Parts Depots | * | | | |
| Airports | * | * | * | * |
| Railway Stations | * | | | * |
| Factories | * | | | |
| Freight Terminals | * | * | | |
| Radio/Television | * | | | |
| Security Patrols | * | | | |
| Universities | * | * | | |
| Parks/Gardens | * | * | | |
| Horticulture | * | | | |
| Schools | | * | | |
| Libraries | | * | | |
| Industry | | * | | |
| Supermarkets | | * | | |
| Military | | * | | |

From this list the writer attempted to identify the major customers. The largest markets in terms of numbers of establishments was to be found in the warehousing and industry sectors (>300 000).[1] By its very nature this market was also likely to account for the largest number of electric truck sales. However a difficulty with this market is its size, that is, the number of establishments would make the task of reaching potential customers extremely difficult.

Two markets were studied in detail.

The railway market contained a fewer number of establishments. There are some 2369 railway stations in the UK, 693 of which are also used for the movement of parcels.[2] Telephone calls made to BR stations requesting information on their procurement policy, on the purchasing of electric trucks led to the writer being referred to a BR purchasing office in Derby. An on-site interview was arranged with one of the staff. During this interview the centralised purchasing process of BR was explained. The interviewee also mentioned that BR's total UK annual demand for electric trucks was presently of the order of 30-50 tow-tugs.

The hospital market comprises 2655 establishments.[3] The method of analysis of this market will be discussed in detail later in this chapter. Briefly, telephone calls were made to several hospitals to establish the persons responsible for the purchase and usage of electric trucks. Following the response, a questionnaire on truck usage was prepared and posted to 367 hospitals. From this questionnaire the population of electric trucks in the hospital market was estimated at:

Platform trucks: 1994 units.
Tow-tugs: 2299 units.

*d) Trade Associations.*

The EVA had recently conducted a survey into the populations of specific types of electric truck in the UK. See figure 4.2.[4] However the broad categorisation of types of electric trucks made its findings of little use. The interviewee knew of no other sources of information, trade reports, market research reports, etc., which might be of any value. He did suggest making contact with the librarian at the NMHC Cranfield. The writer did so, but the librarian was likewise unaware of the existence of any information on market size.

*e) Government Publications.*

This proved a useful source of financial data. Copies of the annual accounts were obtained for all those companies identified from the review of trade journals as major suppliers of electric trucks. Reference was also made to Business Monitor statistics.

Source: Electric vehicle association.

*Market Size*. Information on market size was difficult to obtain. A review of back issues of material handling journals provided no information on size, neither did contact with the librarian at the NMHC, Cranfield, nor with the EVA, London. Indeed the latter two were not even aware of the existence of such data. Business monitor PQ337 provides statistical information on mechanical handling equipment. In this, the products of interest are included under the heading:

> "Powered industrial trucks and tractors:
> pallet trucks, elevating and fixed platform
> trucks and stillage trucks
> rider controlled
> pedestrian controlled"[5]

The UK annual sales in 1982 for this product group was given at £4-5M/annum. Business monitor statistics, though useful, were found to contain two deficiencies, firstly, they do not claim to include all UK product sales, and secondly, compilation was by product group.

Accurate information on market size was important and more detail was provided from an examination of the annual accounts of the four major suppliers to this market, viz:[6]

Harbilt

J. Bradshaw

Lansing Bagnall

Petbow

The annual accounts of 'Harbilt' and 'J. Bradshaw' show the 1983 company turnovers as:

Harbilt £1.6M.

J. Bradshaw £1.9M.

Though Petbow had been trading since 1980 they had submitted no accounts to Companies House, however the writer discovered (by chance) this company's stand at an N.E.C. exhibition. This stand was manned by the company's only sales representative, and during discussions on sales volume the writer was informed that the company annual sales were in the region of £250 000. Petbow ceased trading in 1985.

The type of products of interest to this project comprised only a small part of the Lansing Bagnall product portfolio. They represented the bottom end in terms of complexity and cost, and their contribution to turnover could not be estimated. As such the four major suppliers to this market accounted for a combined turnover of £3.75m+, the upper level depending on the contribution from Lansing Bagnall. From this and from the Business Monitor statistics, the writer concluded, in the absence of more accurate information, that the total UK market value for small platform trucks and tow-tugs was in the region of £5-10M.

*f) Internal Sales Data.*

In December 1982, the writer was put in charge of managing the sales records for the company's existing range of electric trucks. This record contained delivery details on every electric truck ever sold by Geest. From this record every truck manufactured could be uniquely identified in terms of:

1) The customer.
2) The date of order.
3) The date of receipt.
4) The model purchased.
5) The modifications required.

The information contained on the customer does indicate the presence of two distinct markets. See figure 4.3.

*Buyer Characteristics.* Product sales, classified by month, to both the industrial and hospital market were studied in an attempt to identify any buying patterns. No pattern was identified for the monthly sales to the industrial market.

Details on the sales to the hospital market were studied for the years 1973-1982. This revealed the existence of an annual cycle in buying activity. The study showed that on average the monthly demand over the period January-April was three times that of any of the months May-December, table 4.2.

TABLE 4.2: HOSPITAL SALES OF THE GEEST ELECTRIC TRUCK.

| FINANCIAL YEAR ENDS | HOSPITAL ORDERS TOTAL | DEC/MAR | % SALES DEC/MAR |
|---|---|---|---|
| April 73 | 14 | 9 | 65 |
| April 74 | 15 | 7 | 47 |
| April 75 | 20 | 17 | 85 |
| April 76 | 18 | 6 | 33 |
| April 77 | 8 | 8 | 100 |
| April 78 | 17 | 13 | 76 |
| April 79 | 29 | 13 | 45 |
| April 80 | 3 | 0 | 0 |
| April 81 | 13 | 11 | 85 |
| April 82 | 17 | 10 | 59 |
| | 154 | 94 | 61 |

The reason for this pattern was that electric trucks were often only purchased if the hospital had sufficient spare finance available towards the end of the financial year, as a failure to spend this money would have resulted in a reduced allocation for the coming year.

Aston University

Illustration removed for copyright restrictions

Source: Geest internal document.

*g) Postal Questionnaire.*

Postal questionnaires were used to gather information on the two occasions described below.

*The Industrial Market.* A postal questionnaire was conducted to establish why the annual sales to the industrial market of the Geest electric platform truck were in sharp decline. There were two obvious explanations for this decline:

1) The platform truck was the victim of a more effective substitute product.
2) Customers were remaining with the platform truck but were switching to competitor models.

A questionnaire was prepared and addressed to a total of 108 companies, whose names were selected from the Geest electric truck sales record of 15/20 years ago. The selection of this period was a compromise - it had to be sufficiently long so that replacement products were likely to have been purchased, however, too long and the company might be out of business. A copy of the questionnaire is shown in appendix I.

Of the 108 questionnaires distributed, a total of 45 completed returns were received. The latter number excludes 6 returns marked 'out of business'. A high percentage of the respondents (40%) still operated the Geest electric platform truck. Of those remaining respondents only 4% had switched to an equivalent competitor model, the rest no longer used a platform truck.

The analysis of the questionnaire returns revealed the following usage of powered trucks, table 4.3.

TABLE 4.3: INDUSTRIAL USAGE OF POWERED TRUCKS.

| Product In Use: | % Of Respondents |
|---|---|
| Fork Lift Truck | 58 |
| Electric Pallet Truck | 13 |
| Electric Platform Truck (other than Geest) | 9 |
| Electric Tow-Tug | 9 |
| Diesel/Petrol Platform Truck | 0 |
| Diesel/Petrol Tow-Tug | 0 |

What this questionnaire does serve to show is that the decline in Geest sales was not as a result of past users of the Geest truck switching to some equivalent competitor model. If the decline in the sales of the Geest truck is as a result of a substitute product then, within the scope of the questionnaire, that product is the fork lift truck.

A listing of the replies obtained from this questionnaire is given in appendix J.

*The Hospital Market.* The hospital market had made significant purchases of the Geest electric platform truck. The writer was informed by Geest Material Handling division that all purchases of hospital equipment are the responsibility of the respective hospital supplies divisions. While true this fact is misleading - supplies divisions exist solely to administer the processing of purchase requests initiated elsewhere within the hospital. In the case of electric trucks such requests were invariably initiated by the hospital portering staff. Head porters at three different hospitals were interviewed. These interviews had two objectives, firstly, to obtain information on the types of electric trucks in use, and secondly, to investigate the hospital purchasing process.

Hospital purchasing procedure dictates that a head porter can authorise single tender action up to a limit a £100. Above this limit, requests for purchases must be routed through 'supplies division'. The latter approach favours competitive tender action, however, it is not compulsary and given reasonable grounds (eg, performance specification) head porters can specify the equipment of their choice. These three interviews also supported the impression (gathered from the steady level of Geest electric truck sales to this market) that the hospital market made considerable use of electric trucks. A postal questionnaire would be used to quantify the level of usage. See appendix K.

There are some 2655 hospitals in the UK. Individual hospitals do vary considerably in size, measured by the number of beds, and this variable must influence the operation of these hospitals. For example, it might be expected that powered trucks will be found in use in greater numbers in the larger hospitals - where there is a corresponding need to move greater volumes of materials (this was found to be the case). Thus the design of the questionnaire took account of any influences arising from differences in hospital sizes. In fact four questionnaires were designed and distributed (differing in terms of the layout of the reply boxes) to correspond to four categories of hospital size, table 4.4.

TABLE 4.4: DISTRIBUTION OF POSTAL QUESTIONNAIRE TO HOSPITAL MARKET.

| HOSPITAL SIZE(beds) | QUESTIONNAIRES | REPLIES | %REPLIES |
|---|---|---|---|
| 0-50 | 94 | 30 | 32 |
| 50-250 | 102 | 62 | 61 |
| 250-500 | 81 | 38 | 47 |
| 500+ | 90 | 48 | 53 |
| TOTALS: | 367 | 178 | 49 |

The questionnaire returns, when analyzed, presented the following data on truck populations, table 4.5.

TABLE 4.5: ESTIMATED HOSPITAL USAGE OF ELECTRIC TRUCKS.

| TYPE OF ELECTRIC TRUCK | ESTIMATED POPULATION |
|---|---|
| Electric Platform Truck | 1994 |
| Electric Tow-Tug | 2299 |
| Diesel/Petrol Platform Truck | 324 |
| Diesel/Petrol Tow-Tug | 227 |
| Fork Lift Truck | 429 |

A more detailed breakdown of the postal questionnaire, by hospital size, is given in appendix L.

### *4.2.1 Summary And Conclusions*

The project remit of April 1983, calling for the development of a range of small electric platform trucks, was modified in the light of marketing information. Market research revealed the presence of a complementary product - a product whose design was not dissimilar to the platform truck, and whose purpose was to transport comparable (if larger) quantities of materials. This complementary product is the electric tow-tug. Synergy would result from the addition of such a product to a future Geest electric truck range. However the decision to include such a product could only be taken if there existed a market demand - this would need to be determined.

A study was conducted to determine the size of the UK market for platform trucks and tow-tugs:

1) Advertisments and articles in past issues of material handling trade journals were reviewed to determine the major retailers of both types of product. This review identified the four companies: Petbow, J. Bradshaw, Harbilt, and Lansing Bagnall. Three of these companies produce a combined turnover of £3.75M. Figures for the sales of tow-tugs by Lansing Bagnall were unavailable. However, it is assumed

that these sales will not be significantly dissimilar to those sales levels achieved by the other three companies.

2) Business monitor, whose statistics had certain shortcomings, indicated sales of platform trucks and tow-tugs of some £4-5M/annum.

Given both the above figures, and with the absence of other information, an order of magnitude for the UK market was put at £5-10M/annum.

Geest sell electric platform trucks to two distinct markets - industry and hospitals. The annual level of Geest sales to the industrial market had been in sharp decline since the 1960's. The reason for this decline was not known. It was not, however, due to the uptake of competitor models, the response from a questionnaire to this market indicated this fact.

The hospital market had made substantial purchases of the Geest platform truck. The number of hospitals within the UK is considerable, comprising 2655 establishments. A questionnaire on electric truck usage was prepared and distributed to 367 establishments - individually selected to take consideration of the differences that exist in physical sizes. Analysis of the returns revealed a substantial installed base of both platform trucks (1994 units) and tow-tugs (2299 units). From these figures an estimate can be made of the likely replacement demand, certain assumptions must first be made:

1) Annual purchases of electric trucks by the hospital market are nearly constant, for example, despite the obsolescent design of the Geest truck the recent purchases by the hospital market show only a 4% decline in annual sales.

2) Electric trucks in use in the hospital market will come up for replacement every 15 years.
3) There is no adoption of substitute products.

Given a platform truck retails for some £2 500 and the tow-tug for some £6 000, then the annual replacement demand from the hospital market can be estimated in the region £1-1.2M. This is a substantial market segment - given a UK market estimated at £5-10M and sales of Geest electric trucks, in 1982, of less than £40 000. It is also a market with which Geest have considerable contact, and from which Geest gain a considerable number of product sales. Because of these factors the hospital market was selected as an area of particular importance in a future product launch.

A product range comprising tow-tugs and platform trucks would be developed to meet the needs of the hospital market, and designs would pay attention to the aspects of manouverability, speed, and health and safety.

Product pricing, an important consideration in a mature market was not a pre-eminent consideration as the hospital purchasing procedures does allow for product selection on the basis of performance considerations. Pricing is nevertheless an important aspect, however it is only one aspect and its consideration would have to be weighed against the more fundamental requirement to better satisfy the needs of the hospital market. Specific details of the proposed product range, eg, number of models, design requirements and pricing, would come from further and more detailed investigation.

*4.3.0 The Existing Geest Electric Truck Designs*

The technical objective of this project was to provide a range of small electric trucks whose performance characteristics better fitted the needs of the hospital market. These needs were determined through reference to the acceptability of the available products, which included the Geest design. It was not the intention to introduce a radically new product. Instead it was intended to produce a 'better fit' product through a recombination of current designs and technology.

An indication of the desired performance requirements of the hospital market was obtained from discussion with users of the existing Geest (0.25 H.P. pedestrian) electric trucks, in a number of hospitals. The following comments were received during on-site visits.

Criticisms of the Geest model were made on the following points:

1) Instability. One of the models in the range became unstable when loaded. This was a consequence of a wheel configuration which gave it the stability of a three wheeler rather than that of a four wheeler.

2) Poor braking when loaded. Braking action was effected by a manual system whereby an operator squeezes a lever and this force is transferred to an expanding caliper set mounted on each of the front two wheels. This technique was criticised as inadequate for stopping a fully laden truck (850 kg) in an emergency.

3) Insufficient motor power. The motor used on all Geest trucks was a

0.25 H.P. traction motor. This rating was considerably less than the 1 H.P. of competitor models, and was insufficient to enable a fully laden truck to negotiate steep inclines.

The latter two criticisms were accentuated by the hospital environment. The hospitals visited were found to contain a considerable number of ramps and other steep inclines which a Geest truck would have difficulty in negotiating.

Features considered to be desirable in the existing Geest design were:

1) Quiet truck operation. A major source of noise in electric trucks comes from the operation of the reduction gearing connecting the truck electric motor and the drive wheels. In competitor designs this mechanism is exposed, whereas in the Geest design it is enclosed and immersed in an oil bath.

2) Vehicle manoeuverability. Manoeuverability is a function of truck size and steering ability. The Geest design was more manoeuverable than similar competitor models because of its smaller frame also in operation its steering arm projected less distance from the truck.

3) Speed control. There is a safety requirement that trucks operating inside a hospital must travel at low speeds. The design speed of the Geest trucks was acceptable to the hospital market, whereas engineering modifications were required to reduce the speed of competitor models to acceptable levels.

### *4.3.1 The Proposed Geest Electric Truck Designs*

Technical information on the tow-tug and the platform truck was obtained from the following sources:

1) Inspection of competitor equipment at trade shows.
2) Inspection of competitor equipment in hospital premises.
3) Discussions with electric truck component suppliers.
4) Review of competitor product sales literature.

From this information the technical designs of the Geest trucks were prepared. Designs were developed around five sub-assemblies:

*a) Electric Drive Unit*
*b) Mechanical Drive Unit*
*c) Vehicle Speed Control Unit*
*d) Steering Mechanism*
*e) Chassis*

*a) Electric Drive Unit.* This unit comprises three components, *batteries*, *charger* and *motor*.

*Batteries.* No obvious alternatives emerged to traction type batteries. These are specifically designed for use with electric trucks. Their internal construction is such that they can withstand a greater frequency of charge-discharge cycling than can conventional designs. This being so these batteries typically come with a 3/4 year manufacturers guarantee as compared to the 'conventional' battery guarantee of 1 year. In financial terms, for the same rating of battery a traction design will cost approximately three times that of a conventional design.

*Charger.* All trucks would come complete with a suitably rated battery charger. These chargers would be incorporated as an integral part of the truck design. This decision was taken on three counts:

1) The cost to Geest would be in the region of £80-100 and this compared favourably with the purchase of a stand alone charger of a similar rating, which would typically cost a truck user £250 (excluding installation and wiring costs).

2) Charger selection is dependant upon the duty of the truck battery pack, and for an optimum charge rate must be matched to the battery specification. In this respect existing stand-alone battery charging units could restrict the user to compatible trucks when re-ordering. A replacement vehicle complete with a built-in battery charger would go some way to negate such arguments.

3) The facility of an incorporated battery charger already existed on a competitor model.

*Motor.* Electric motors designed for use in electric trucks are termed traction motors. Such motors are of a heavier and bulkier construction than conventional motors of a similar rating. The reason for this is that traction motors are designed to operate under sustained overload conditions, tolerate the frequent stop/start operations and survive being subject to periods of high starting/stall currents. All traction motors are compound wound. That is, with some compromise they combine the high starting torque characteristics of series motors with the speed control of parallel motors.

For reasons of reliability, and the lack of a credible alternative, traction motors would be used in a future electric truck design. For the same duty a traction motor will cost four times that of a conventional motor.

*b) Mechanical Drive Unit.* This unit comprises the ***reduction gearing, differential gear,*** and ***brakes.***

*Reduction Gearing.* Torque is produced by the truck's electric motor, which typically rotates at around 2500 RPM. Reduction gearing is used to convert this rotational speed to a value more appropriate for transmission to the truck drive wheels. Noise resulting from the movement of electric trucks can frequently be attributed to the operation of this gear reduction unit. Two distinct techniques are used. One technique makes use of an enclosed worm reduction unit immersed in an oil bath. The alternative is to use an exposed chain and sprocket mechanism. The latter is inherently noisier and was criticised by a head porter in one hospital for having a tendency to drip oil and so present a health and safety hazard. Discussions with head porters indicated a preference for a quieter drive unit. The writer therefore decided to remain with the technique of an immersed worm reduction unit as presently used in the Geest trucks.

*Differential Gear.* In order to transfer power from the reduction gears to both front wheels and allow manoeuvrability the existing Geest range uses a technique with the trade name 'Tractamatic'. In essence, this comprises two pairs of meshing dogs, which interlock to transfer power from the reduction gear to each drive wheel. Apply power and the dogs engage, remove the power and the dogs disengage. On turning a corner this mechanism is designed such that the appropriate dogs slip to devices and the other uses solid state electronics.

Traditional electrical control relies on a contactor and wire resistance combination. The contactor is installed so that the wire resistance can either be connected in series with the motor or disconnected entirely. When connected, a percentage of the power which would normally go to the motor is instead dissipated in the wire resistance thus resulting in a reduced motor speed. This technique is used on the current (1958) Geest range.

Solid state control of motor power relies on the switching characteristics of thyristors or transistors. These devices effectively act as a gate and when connected into a circuit allow power to flow only when a control voltage is applied. In operation one of these devices connects between a truck's batteries and its motor. The on/off switching of the control voltage to these devices can take place very quickly. Thus by adjusting the ratio of its on-to-off time the average power passed by the device to the motor can be readily managed. In practice electronic control of the on/off duration of the switching device is translated into an average power level and, at the motor, into a specific truck speed.

Both techniques of speed control are in use in currently available trucks:

Electric control - Geest

- J. Bradshaw

Electronic control - Harbilt

- Petbow

The writer chose to use an electronic speed controller in future designs for the following reasons:

1) Electronic speed controllers could be purchased as a ready assembled item, whereas the electrical controller involved a labour intensive assembly operation. Company policy was that labour should not be timed, thus it was impossible to accurately cost the company's existing electrical controller. The electronic controller could be purchased for £108.

2) The electronic option has the facility to allow the operator to use the motor action to smoothly brake the truck. This action is not possible with the electrical speed controller.

3) The electronic option allowed the operator greater control over the truck speed.

4) To control the motor power the electronics approach is inherently more efficient than the electrical approach.

*d) Steering.* Ackermann steering is used in electric trucks. This method of steering, also used in automobiles was designed to prevent the scuffing of adjacent tyres due to differences in angular distances involved when turning corners.

Study of competitor designs showed that this steering arrangement is controlled by one of two mechanisms.

For platform truck designs, steering is achieved by means of a tiller-type action translated to the Ackerman arrangement. Tow-tug designs were found to use rack and pinion action.

Both these techniques are in widespread use, and as such were considered suitable for use in future Geest designs.

*e) Chassis.* The present range of small electric trucks make use of both metal and glass-fibre for the chassis construction. Discussions with hospital head porters did not indicate any market preference. Material for the chassis fabrication would be selected nearer the time of a product launch and would be dependant upon cost and aesthetic qualities both of which influence, and are influenced by, the chassis design.

The above information a) - e) formed the basis of a product 'draft' specification and enabled the selection of suitable makes of equipment, table 4.6.

TABLE 4.6: COMPONENT SELECTION FOR THE SMALL ELECTRIC TRUCK.

| Component | Type | Supplier | Cost(£) |
|---|---|---|---|
| Speed controller | Transistor | Cableform | 108 |
| Batteries | Traction | Oldham | 58x4 |
| Battery charger | Electronic | Westinghouse | 130 |
| Instruments | Hour run | Curtis | 10 |
| | Batt(fuel) gauge | Curtis | 48 |
| Mains plug | Earth leakage | B+R | 30 |
| Electric motor | Traction | Electro dynamic construction co. | 280 |
| Brakes | Electro-mechanical (drum/disc) | Neco | 60/120 |
| Wheels/tyres | Semi-solid | Watts | 15x4 |
| Seat | Plastic | Sears manf. co. | 40 |

<u>To Be Decided:</u>
Hand controller
Axle/differential
Steering mechanism
Chassis

Copies of the product draft specification and its associated costings are given in appendix M and appendix N. The product draft specification comprised details on four electric trucks - a tow-tug and a platform truck both in a ride-on and a pedestrian version. Detail on these four trucks was compiled only to facilitate discussion, there was no implication that this would be the adopted product range. The technical details for the four trucks was based on satisfying the perceived requirements of the market. Product prices were included and in each case the price quoted was either comparable with or slightly less than the price of comparable competitor models. The four electric trucks were costed according to their component requirements with a separate allowance for assembly. The cost of the trucks compared favourably with the selling price, table 4.7.

TABLE 4.7: ESTIMATED BUILD COST / SELLING PRICE OF TRUCK RANGE.

| VEHICLE | ESTIMATED COST(£) | SELLING PRICE(£) |
|---|---|---|
| Tow-Tug: | | |
| Ride-on | 2 800 | 5 200 |
| Pedestrian | 2 050 | 3 800 |
| Platform Truck: | | |
| Ride-on | 2 300 | 3 600 |
| Pedestrian | 1 220 | 2 200 |

### *4.3.2 Summary And Conclusions*

The technical objective was to provide a range of electric trucks with characteristics which would better match the particular needs of the hospital market. For example, in this market the electric trucks are often operated indoors and therefore noise, manouverability, and health and safety, become important considerations. However, these are not considerations particularly relevant to other markets, and they are common areas of neglect in commercially available products. As a consequence the existing Geest electric platform truck was still purchased by the hospital market even though important aspects of its performance were criticised for being inadequate. There is a number of areas where considerable improvements could readily be made to the performance of the existing electric trucks. A new combination of commercially available components would produce a better-fit product. Cost details were noted and the margin between cost and estimated selling price was considerable which suggests a good profit margin.

*4.4.0 The Research Environment*

The appointment of a general manager to replace the managing director in March 1983 had an impact on the company's innovation activity. On his appointment the general manager emphasised the need for the company to pay greater attention to the introduction of new products and in a April 1983 budget review document (prepared by Industrial Group for Geest Holdings) his comment on product development was that:

> "...we cannot afford not to afford any expenditure as indicated in the budget."(7)

There followed an increase in the level of support given to the company's innovation activity. For example, the engineering drawing office had authorisation to recruit two draughtsmen, one of whom was assigned full time to the design of a new product for F.W. Pettit division. Manufacturing staff numbers increased through the recruitment of a materials controller and an undergraduate, both of whom became involved in attempts to improve the company's manufacturing processes.

In the electric truck project, the writer found that product/market decisions could be taken more quickly than before, without the need for continual justifications to top management. This allowed the freedom to explore new avenues as they appeared and to modify theories and concepts in line with the information available. The financial constraints imposed on the writer during the first period were eased and the writer was now allowed access to a source of limited funding through the company petty cash system. While the writer still had no official budget, there was a move to make provision for one in the 1984 budget. This will be explained in more detail below.

During this period the general manager requested that the engineering manager prepare a division budget submission for 1984. This budget was to recommend the action necessary to counter the company's mounting losses. Though the responsibility for preparing this budget lay with engineering its recommendations were to be based on sales division forecasts. The budget produced by engineering is shown as appendix O. Its recommendation was that the company increase its product development activity, the focus of which would be the enhancement of the company's existing product range througn modifications and product line additions. In the budget the electric vehicle programme was to be allocated funding of £30 600, this figure having been agreed on during discussions between the engineering manager and the writer. This figure was based on costs submitted by the writer which allowed for the design and prototype evaluation of three models in the coming year. In fact, in October 1983 when this budget was prepared, the writer had insufficient information from which to reach a decision on the number of models to be included in a future product launch. The engineering manager suggested budgeting for three models simply because this was the number of models produced by a previous and aborted small electric truck programme. In the event the recommendations contained in this budget submission were never implemented. In the month of its submission occurred a management restructure and most of the support was lost.

## *CHAPTER FIVE*

## *PRODUCT LINE ACQUISITION*

CONTENTS:

PRODUCT LINE ACQUISITION

### *5.0.0 Outline Of Chapter*

In November 1983 the company management hierarchy was reorganised. The manufacturing hierarchy was restructured as was product development. A consequence of the latter restructuring was to transfer all supervision and control to the general manager. The role of product development within the company was expanded and given a new direction. Hereafter, it was to concentrate on the feasibility of introducing manufactured goods into the company's product range. This period of industrial research was brought to a halt by the closure of Geest Industrial Group on the 11th July 1984.

### *5.1.0 Introduction*

The resignation of the engineering manager, who also acted as industrial supervisor, was announced in November 1983. In the same month the general manager stated that it was now his objective to increase the company's rate of new product launches and he intended a reorganisation of the company product development activity and a redefinition of the writer's remit. The small electric truck project would remain, though it was considered too narrow a remit. Rather than focus on the one product the suggestion was that the company would benefit more if the writer's experience were applied across a range of products, specifically the writer would now be expected to work in co-operation with the other sales divisions to expand their product ranges. See appendix P. The new industrial remit was formally agreed at a meeting on the 10th February and the general manager accepted the position of main industrial supervisor.

## MARKETING RESEARCH

### 5.2.0 *Introduction*

Development work on the small electric truck project continued and there was now the additional requirement to assist the development of the product portfolios of both sales divisions. With this arrangement the writer was involved in the following four projects:

Small pedestrian electric trucks.

Potato harvester equipment.

Pallet stacking equipment.

Straw incorporation equipment.

The marketing research required in the study of the above involved investigation of material handling and agricultural aspects.

Prior to conducting any research for F.W. Pettit Division the writer met with the divisional sales manager to discussed possible sources of marketing research information. This resulted in a visit to the library at the National College of Agricultural Engineering (NCAE), Silsoe. This library performs a similar function to the NMHC library at Cranfield, and contains a considerable quantity of information on both the academic and practical aspects of agriculture. Access to these two 'specialist' libraries provided a source of up to date information on the two principle business areas of Geest Industrial Group, viz: material's handling and agriculture.

The majority of marketing research was conducted from the four locations:

1) Aston University, Birmingham.
2) Geest Industrial Group, Boston.
3) Library, NMHC Cranfield.
4) Library, NCAE Silsoe.

### *5.2.1 The Small Electric Truck Project*

A continuation of the design work started in the previous period. Previous research indicated that the hospital market made considerable use of electric trucks. In particular, two designs were popular - the tow-tug and the platform truck. Hospital porter staff were interviewed to establish their likes and dislikes regarding the presently available truck designs. The purpose of this interview did require the head porters to be familiar with the operation of electric trucks and so hospital selection was on the basis of information contained in the earlier questionnaire returns.

Points to emerge from these interviews reinforced earlier comment, ie:

1) The need to provide the customer with a reliable back up service.
2) The need for ease of maintenance and quick fault diagnosis.
3) The need for good truck stability and manouverability.
4) The need for a slower running speed than presently provided on most models.
5) The need for the truck to be able negotiate steep gradients when laden.

A 'draft' specification for the electric truck existed. See appendix M. This specification served two purposes. Firstly, the information it contained had allowed estimation on the size and cost of components.

Secondly, it now enabled the production of preliminary engineering drawings. Thus the desired performance specification as understood by the writer, see appendix M, could now be resubmitted along with the preliminary drawings, see appendix Q, to the hospital porter staff for their comment.

### *5.2.2 The Potato Harvester Market*

In May 1981 Geest Industrial Group through F.W. Pettit division acquired the UK exclusive right to purchase for resale a range of potato harvesting and planting equipment supplied by the German company - Hassia A.J. Troster GmbH & Co. By December 1983 the sales performance of this equipment was causing concern, table 5.1.

TABLE 5.1: ORDERS RECEIVED/FORECAST FOR HASSIA POTATO EQUIPMENT.

| YEAR | FORECAST(£,000) | ACTUAL(£,000) |
|---|---|---|
| 1981 | N/A | 43 |
| 1982 | 665 | 312 |
| 1983 | 667 | 332 |
| 1984[a] | 130 | 112 |

[a] as at March 1984

The UK market was considered by Geest management as healthy, yet the Hassia annual sales figures were in decline, and as a consequence of this decline the product profit margins were increasingly being sacrificed in an attempt to stimulate demand through the offer of a greater customer discount. Within the Hassia product range it was the decline in the orders received for the harvesting equipment that required explanation, table 5.2.

TABLE 5.2: ORDERS RECEIVED FOR HASSIA HARVESTERS.

| YEAR | ORDERS RECEIVED(units) |
|---|---|
| 1981[a] | 16 |
| 1982 | 22 |
| 1983 | 15 |
| 1984[b] | 0 |

[a] May/December
[b] January/March

In January 1984 the general manager proposed a commercial analysis of its Hassia harvester range. The objectives of which were to be as follows:

1) To determine the financial history of this product since its acquisition.
2) To investigate the reason for the decline in sales.
3) To make recommendations on a future product strategy.

The harvester market was unfamiliar, so in order to gain familiarity one week was spent in Edinburgh accompanying F.W. Pettit's Scottish sales representative during visits to agricultural retailers.

A number of important points were to arise from this visit:

1) The working life of a potato harvester is between 8-12 years.
2) The abuse given to machines means that there is no secondhand market.
3) The UK demand for harvesters is supplied by less than fifteen makes of machine.
4) Harvesters are only in use for a short period each year. Nevertheless product reliability is paramount, and a purchase decision is based, in part, on the quality of the back-up service.
5) The largest share of the UK market is held by a make of German machine (Grimme), imported by a Boston firm.

6) There is no strong buyer loyality.

7) The technical performance of the F.W. Pettit machine (Hassia) was considered by retailers of competitor products to be as good as anything presently on the market.

A meeting was arranged with the F.W. Pettit sales manager, and, regarding this market, it was agreed that the company suffered from a lack of marketing information. One effect of which was that the Pettit strategy for this product range, see appendix R, had as its basis an erroneous belief concerning the state of the market:

> "Potato harvester sales show an increase of 33.3% over the 1979 sales figures..."
>
> "The potato harvester market is continuing to grow and shows no signs of decreasing."

The 33.3% is statistically correct, however, the later statement was incorrect. Regression analysis of the UK sales figures for the past ten years indicate a market contraction of >2%/annum. See figure 5.1.[1] There are two other factors which would support this finding, namely, similar levels of decline can be found in the GB land area allocation to potato crop production,[2] and in the annual turnover levels (adjusted for inflation) of the major UK supplier of harvesting equipment. The NCAE library provided a useful source of marketing information. Details on the potato market were also obtained from the following sources:

1) Customs and Excise. Details on the import and export figures for potato harvesting equipment.

2) Potato Marketing Board. Details on the annual crop yield and land allocated to the growing of potatoes.

3) Registrar of Companies. Details on company accounts information.

Aston University

Illustration removed for copyright restrictions

Source: Agricultural engineering association.

4) Agricultural Engineering Association. Details on the monthly delivery of potato harvesters, as supplied by the returns of the major UK distributors. (Statistical information restricted to member companies)

Investigation of the Hassia franchise was completed in March 1984, and a report submitted to management.[3] The 'summary of conclusions' is given as appendix S. Its findings argue that F.W. Pettit division has not the resources to provide a viable sales and after sales service to the UK market and it was attempting to do so with an operation comprising probably less than one fifth the resources of its main competitor. A strategy was proposed to deploy the company resources more effectively. Market research indicated that coverage of a defined geographical area could reach a disproportionate percentage of the buyer market. For example, Lincolnshire which accounts for <5% of England land surface area, in turn represents >15% of the potato crop growing area. Given Pettit's limited resources, the objective was to reach the maximum number of potential buyers while still maintaining a geographically manageable area. To achieve this the Scottish and Welsh operations, accounting for 35% of the GB land area and 17% of GB harvester sales, were to close and the sales operation in England restricted to two locations, selected such that a coverage of 39% of the land area in England would reach 72% of the English buyer market, table 5.3.[4]

TABLE 5.3: ESTIMATED PERCENTAGE DEMAND CONCENTRATIONS FOR POTATO EQUIPMENT IN ENGLAND.

| EASTERN REGION COUNTY | %DEMAND[a] | %AREA[b] | WESTERN REGION COUNTY | %DEMAND[a] | %AREA[b] |
|---|---|---|---|---|---|
| Humberside | 5.5 | 2.7 | Lancs. | 4.0 | 2.4 |
| S. Yorks. | 1.5 | 1.2 | Cheshire | 3.3 | 1.8 |
| Notts. | 2.9 | 1.7 | Staffs. | 3.1 | 2.1 |
| Lincs. | 15.9 | 4.6 | Warwks. | 2.2 | 1.5 |
| Leics. | 1.3 | 2.0 | Hereford/Worcs. | 4.0 | 3.0 |
| Cambs. | 8.2 | 2.6 | Salop | 4.2 | 2.7 |
| Norfolk | 8.1 | 4.2 | | 20.8 | 13.5 |
| Beds. | 0.8 | 1.0 | | | |
| Suffolk | 2.7 | 2.9 | | | |
| Essex | 4.3 | 2.8 | | | |
| | 51.2 | 25.7 | | | |

[a]measure of the county holdings(>8Ha.) as a percentage of total holdings(>8Ha.).
[b]measure of the land area of the county as a percentage of the total land area of England.

It was possible that such a 'retrenchment' strategy may not be favoured by the suppliers of the Hassia equipment. In which case F.W. Pettit had no option but to withdraw from this market.

The information collected for this exercise and its assessment were presented to both the general, and the divisional, manager. A number of management meetings were subsequently held to discuss the implications of this report with respect to the future operation of the franchise. The outcome was for F.W. Pettit to divest of its Hassia franchise.

### *5.2.3 The Pallet Stacker Market*

This represented a possible area of diversification for Material Handling division. A study of this market was requested to assess its value and, if appropriate, to propose a suitable market entry strategy. The request was made by the divisional sales manager who considered this type of product to be compatible with the present product range and to represent a growth market. The latter reasoned from the observation that an increasing number of companies were now selling these types of products. To study this market the following three information sources were used:

1) Registrar of companies.
2) Customs and Excise statistics.
3) Company literature.

The investigation of this market revealed it as comprising two distinct product segments. One segment comprising manual stackers the other powered stackers. Such segmentation of the market contributed towards the analysis of the total market. Another factor favouring this segmentation was that the major suppliers of manual stackers were manufacturers, while the suppliers of powered stackers tended to be factors for products imported from Italy.

The above segmentation was used to estimate the UK market.

*Manual stackers.* To estimate the size of the market for manual stackers the writer made use of company accounts information. Major suppliers were considered to be those frequently advertising and whose products were frequently found within industry. By taking note of the annual turnover and stock level of a major supplier to this market the UK market size was estimated to be of the order £0.5M.

*Powered stackers.* A detailed investigation of the literature on this market revealed the presence of only one UK manufacturer. The major 'material handling' mail order firms carried the same make of imported models. It was appropriate that to estimate the size of the powered stacker market use was made of Customs & Excise import data, figure 5.2.[5] This indicates a UK market for powered stackers of £1-3M. An analysis of the historical data provided for both the above product segments indicated a growth rate of around 15% per annum.

The product portfolios of the companies selling these types of products, as well as the markets being targeted, indicated that adoption of this product would be appropriate. It was the intention that the manual stackers would be supplied by a UK manufacturer (Easi-Lift Ltd.) while the powered stackers would be supplied by an overseas source. Regarding the latter the writer wrote to ten manufacturers of powered pallet stackers in Italy, in Italian !, stating Geest's interest in purchasing for resale a suitable range of products. Product details on the Italian companies were obtained from information contained in market intelligence report on the European fork lift market.

### *5.2.4 Straw Incorporation Equipment*

F.W. Pettit division considered straw incorporation equipment to be a potentially worthwhile area for diversification. The divisional manager requested an exercise be conducted to determine a viable entry strategy. The request for this study was made primarily in response to the possibility of legislation being introduced which would ban, or, lead to an increase in the maximum fine (£100) presently payable on conviction of illegally conducting straw burning. This product would be new to the company. It is true that the range of disc harrows sold by the company did perform 'straw incorporation', a feature inherent in the harrow operation, however, this was not the primary function of the company's harrows, and was not the reason for their purchase. A consequence of the company closure was that only a few weeks were available to research this project.

Source: Customs and excise.

### *5.2.5 Summary And Conclusions*

In an attempt to stimulate the rate of product innovation the company hierarchy was restructured. The focus of attention also switched to the study of the adoption stage of innovation. The writer's remit was redefined to reflect the importance now being attached to the benefit of acquiring 'new' manufactured products for resale. The role of marketing was essential given this approach, as it would provide the information on which to decide to adopt/reject a 'new' product. The small electric truck continued and three additional projects were started. Requests for consideration of a number of projects were rejected for fear of diverting the effort required to conduct accepted projects.

### *5.3.0 The Small Electric Truck Project*

Of the four projects conducted in this period, December 1983 to July 1984, only the small electric truck project required any design work. During this period the writer concentrated on the design of the bodyshell and the associated framework to be technically realisable and sufficiently detailed for issue to the intended market.

The desired technical performance of the truck range was established earlier in discussions between the writer and head porters. The study of existing truck designs at exhibitions and on customer premises, coupled with a review of related equipment, had provided sufficient information to allow selection of suitable types of components. However, deciding the aesthetics of the truck range presented more of a problem. An option would be to produce a range of truck designs and issue these to potential customers for comment. In this it was not the intention that a particular design be selected or rejected, but rather that each design stimulate discussion and thus lead to a redesign and a reissue. It was through this process that it was hoped to reach optimum truck designs.

In April 1984 a draughtsman was seconded from the engineering drawing office to work full time to this project. This draughtsman prepared the outline designs of the truck range which are shown as appendix Q. The designs are dimensioned such that there is adequate space available for incorporation of the required components.

### *5.4.0 The Research Environment*

A major influence on management decision making throughout the period December 1983 to July 1984 was the continuing deterioration in the company's financial condition. Managers were given updates on this situation at the monthly management meetings.

As with the previous five years, the 1983 financial accounts showed the company to have incurred losses, in this case amounting to some £457 645 on a £3 213 819 turnover. This was compounded by the fact that throughout the first half of 1984 the company continued trading at a loss. See appendix T. As a means of resolving this situation, new products were proposed. The general manager had received a copy of the 1984 engineering division budget submission which called for minor innovations aimed at enhancing the company's existing products and product ranges. However, no new innovation activity resulted nor for that matter did it lead to the curtailment of any existing work. Rather than implement this budget, or even seek alternatives on its theme, the general manager sought a quite different approach, and all innovation exercises started in this period were concerned with the adoption for resale of manufactured products.

The company hierarchy was reorganised in November 1983. This move was designed in part to obviate irregularities resulting from the May consolidation of the company's manufacturing activity. In the event two manufacturing posts were abolished, and a new position of works manager created. In addition the new post of special projects co-ordinator was created and the writer, product development engineer, was repositioned within the management hierarchy. See appendix U. Both positions were concerned with managing product innovation and had representation on the company management committee and were answerable, along with the engineering drawing office manager, directly to the general manager. In practice, their creation represented a widening of the company hierarchy and a broadening of the general manager's span of control. Both new positions were organisationally and managerially separate from the immediate business activity. Nevertheless their presence at the regular monthly management meetings reduce opportunity for alienation and at the same time served to indicate the level of importance being attached to these roles. One position, was given the title of special projects co-ordinator, see appendix V, formalised 21st February 1984, and would assume the responsibilities for the introduction of new products which spanned both the company's sales divisions and in particular for those products which due to their technical or marketing complexity were likely to require considerable managerial attention and long term commitment. The general manager was to allocate projects of a suitable character. In the event, for the period of its creation the special project co-ordinator was concerned with the introduction to the company of a range of petrol driven agricultural carriers manufactured in Taiwan. The creation of the second position primarily represented a redefinition of the duties of the writer, formalised 14th February 1984, the associated responsibilities widened to include product development support to both company sales divisions. See appendix P. It was proposed by the general manager that the writer should:

> "...become involved in a broader range of product development exercises. In particular he will assist Divisional Managers with the commercial evaluation of business development strategies."

This assistance was in considerable demand. So much so that several requests had to be rejected, lest they hinder work on accepted projects.

Table 5.4 contains a list of the projects submitted for consideration:

TABLE 5.4: LIST OF PROJECTS SUBMITTED FOR ASSESSMENT.

| PROPOSAL | MONTH SUBMITTED | RESPONSE |
|---|---|---|
| Small Electric Truck(MH) | **** | Continuation |
| Potato Harvesters(FWP) | January | Accepted |
| Sillage(FWP) | March | Rejected |
| Agricultural Trucks(SPC) | April | Rejected |
| Pallet Stackers(MH) | May | Accepted |
| Straw Incorporation(FWP) | May | Accepted |
| Castors & Wheels(MH) | June | Rejected |

Key: FWP=F.W. Pettit Division.
MH=Material Handling Division.
SPC=Special Project Co-ordinator.

However, although new means existed to encourage and promote innovative activity, the resulting efforts within the company were neither concentrated nor co-ordinated. In this respect the innovation programmes of both the engineering drawing office and the special project co-ordinator had serious shortcomings. For example:

1) The engineering drawing office had allocated considerable staff time to the development of a new disc harrow which when completed would complement the company's existing range of harrows. However, cursory research of this market, which arose from investigations into the straw incorporation market, showed the total UK disc harrow market to be contracting at around 20%/annum with sales in 1983 of approximately 1100 units/annum. See figure 5.3.[6] From the contents of journal articles and a discussion held with the head librarian at NCAE Silsoe, it was apparent that the harrow market was experiencing a process shift in favour of the use of power-take-off (PTO) equipment.

2) The introduction of the Taiwan petrol driven agricultural carriers by the special project co-ordinator contained shortcomings in marketing research.

Source: Agricultural engineering association.

Based on the recommendations of the special projects co-ordinator the general manager provisionally agreed to the importation of 180 units at a cost of some £150 000. These products were being adopted without any declared market strategy, and marketing research comprised a comparison of competitor costs and the on-site trial and evaluation of the product. During a visit to the statistics library at Warwick University some research was conducted into the size of the agricultural carrier market. This suggested the likelihood of a very small market for this type of product, a finding reinforced by the knowledge that the sales of equivalent vehicles by a major competitor (J. Bradshaw), as identified by the special projects co-ordinator, typically ran at around one unit per month.

The 180 vehicles ordered by the company were due to arrive in consignments. The first consignment reached the company in February imported under an ambiguous import classification. The special project co-ordinator's February 1984 (monthly) report to the management team contained the comment:

> "From all the headings within the C&E tariff guide the Wu trucks can only properly match the description given for works trucks. This was not known at the time the invoice was raised and on this the units are described as Agricultural Carts."[7]

This error was again reported in the March (monthly) report:

> "Before the next consignment is shipped a meeting with our shipping agents will be held to ensure that for the future we are not held at risk by declaring the units in an incorrect C&E category"[8]

Three months later, on their arrival in the UK, the second consignment was impounded by Customs and Excise officials on the suspicion of an attempt to defraud HM Government by evading customs duty.

Thus in restructuring the company the objective of the general manager had been to produce an environment capable of providing support for innovative activities. From the writer's own experience the resulting structure was capable of this. However, while the new environment supported innovation it did lack the means to distinguish between effective and ineffective types.

# *CHAPTER SIX*

## *ANALYSIS AND DISCUSSION*

CONTENTS:

# ANALYSIS AND DISCUSSION

## *6.0.0 Outline Of Chapter*

This chapter examines aspects of Geest's product innovation activity during the period October 1982 to July 1984. It presents an analysis of the innovation activity as described in the preceding three chapters and follows the same structure, viz;

6.2.0 - Radical product innovation.

6.3.0 - New product development.

6.4.0 - Product line acquisition.

Analysis of each of the three attempts to conduct innovation is concluded with an assessment of the viability of the company's approach.

### *6.1.0 Introduction*

Unacceptable financial losses were the cause of Geest Industrial Group's voluntary liquidation in July 1984. Reference to the company's annual accounts show the majority of these losses were attributable to a poor trading performance - losses being incurred primarily as a result of insufficient profit margin on the sale of products. A response to such a situation is to introduce new and more profitable products. The preceeding three chapters have contained descriptions of three attempts to introduce new products. In each case the marketing and technical functions were described together with the corresponding organisation and management arrangements. An examination of the viability of these three attempts to innovate is now conducted, in comparison with the experiences reported in the literature.

### *6.2.0 Introduction*

The low cost intelligent truck project, see appendix B, centered on the design of an automated guidance system for use in a small electric truck. This was intended to overcome the need for a predefined fixed guidepath. The proposal was that a truck should have the capability to be taught a desired route and be able to reproduce that route as and when required. As will be explained, the low cost intelligent truck project was an attempt at radical innovation. This project ran from October 1982 until its abandonment in March 1983 and was conducted under the supervision of the managing director.

### *6.2.1 The Low Cost Intelligent Truck*

The idea for the Geest intelligent truck project arose as a result of commercial contact with an electronic components firm. During discussions this firm had mentioned that they shortly intended to diversify into the AGV market and were pursuing the development of a new product, a product whose operation was to be based around the application of the 'established' AGV technique of wire guidance - a fixed vehicle guidepath comprising intersecting loops of buried cable. The idea of automated vehicle guidance appealed to the management of Geest.

Ideas form the starting point of the innovation process. The origin of this project is not unusual and supports the findings of Myers and Marquis,[1] and Mueller,[2] in that the idea for this project arose as a result of information received from a source outwith the company. This information was translated by Geest into a proposal to create a new concept in the transportation of materials, namely, automated guidance without the need for a fixed guidepath. This operating concept was novel, and so there was a need in the first instance to establish its feasibility - to invent.[3] The low cost intelligent truck was only an idea - it had no guaranteed market and would rely for its operation on technology not yet integrated. Such characteristics help to describe the type of innovation being sought. The origins of this idea do not fit with the market pull model: "...where the new product idea originates in the marketplace..."[4] Rather its origins describe more the technology push model with the intention at Geest being to capitalise on: "...laboratory discovery or the availability of a new technology."[4] This innovation was radical as opposed to evolutionary - its purpose lacking a precedent. It sought to capitalise on the 'techno-economic' opportunities presented by advances in technology. It is true that the intelligent truck would have certain operational similarity with the established AGV systems, however, it was not the intention to produce a competitor product.

Thus the low cost intelligent truck project began at the invention stage. Its origin displays the stimulus of a technology push project in the pursuit of radical innovation. In the review of literature it is demonstrated that the presence of both factors have important implications for the conduct of innovation. In the remainder of this section the consequences of the presence of these factors is examined for the *technical*, *marketing*, and *organisation and management* aspects of the intelligent truck project.

*Technical Research*

As a design project the low cost intelligent truck was considered as comprising two parts:

1) The truck mechanics.

2) The guidance/navigation system.

Such an approach makes sense as it serves to separate dissimilar design problems and, in so doing, reduces their design to more manageable elements. To quote Utterback on problem solving:

> "The idea or problem defined...must be divided into subproblems amenable to solution."[5]

Of these two design problems it was the design of the guidance/navigation system which was likely to be the more radical and also present the greater complexity. Consequently all design effort was concentrated on the assessment of the feasibility of this aspect of the intelligent truck. Any solution would involve creativity, which to quote Cannon (citing Usher):

> "...requires a notion of a sequence of acts of insight which leads to a cumulative synthesis of many items that were originally independent..."[6]

There are numerous aids available to stimulate the creative input at the invention stage[7] and from a review of such techniques the use of brainstorming was selected as being appropriate. The technique of brainstorming is based on free/intuitive association and deferred judgement:[8,9]

> "The purpose of brainstorming is to generate within a short time a large quantity of ideas, among which there will be some fit for future use."[10]

In an effort to prepare ideas which might then usefully be combined to form a worthwhile invention, and prior to the brainstorming exercise, a review was conducted of the current literature on automated vehicle guidance/navigation systems. This review included both the operation of existing AGV systems as well as a review of technical papers detailing potential approaches to automated truck guidance systems. The brainstorming exercise produced 16 proposals on automated guidance/navigation techniques. See appendix E. All 16 proposals were submitted to the project supervisory team for comment, discussion around which led to the preference for a beacon type system. A common cause for rejection of the other techniques was the likelihood of damage or disturbance to any navigation aids sited at a low level. The theory of operation of the beacon system was straightforward. In operation a beacon (comprising receiver - transmitter) would be interrogated by any truck in the vicinity and the response would contain the necessary information to allow the vehicle to compute its location and orientation relative to the position of the beacon. Such computation for example, might make use of 'period' and 'wavelength' characteristics contained in the beacon response. Comparison was drawn between the operation of the intelligent truck and its beacons, and, the nature of the route selection process when commuting between stations on an underground rail network, ie. a series of point-to-point journeys. See appendix W.

The proposal on the operation of the intelligent truck was still very much a concept, and so research was conducted to substantiate, or otherwise, its validity. A review of literature was conducted on the subject of automated vehicle guidance and of remote sensing using beacons. The aim in this was to establish if any ideas/techniques were available on navigation/guidance which could be usefully applied to assist the invention stage of this project. This search provided 22 references - and highlighted the operation of a navigation system with the trade name of SEFAN. SEFAN was interesting because it made use of remotely sited beacons. Communications between vehicle and beacon was through electromagnetic propagation and navigational details were computed using characteristics of time and wavelength.

The ideas employed in SEFAN would have been pursued further but for the abandonment of the low cost intelligent truck project in March 1983.

*Marketing Research*

There was no evidence of the management at Geest having conducted any market research prior to the formal adoption of this project in October 1982. This disregard for marketing is a feature of the technology push project which, according to Cooper, tends to emphasise the role of R&D at the expense of marketing which is, conversely, emphasised in the market pull project. To quote Finkin on the technology push project:

> "Technology push results when the driving force of the effort is the perceived potential of the technology itself. Marketing's role is secondary..."[11]

Nevertheless, although the project's origins lie in technical opportunity, there is little commercial sense in developing a product which has no market. The invention stage is the testing ground - it must validate, or otherwise, the idea and in so doing overcome any shortcomings. Creative solutions are required at the invention stage; solutions which are technically feasible and commercially viable. To quote Holt:

> "Creativity is that thinking which results in the production of ideas that are both novel and worthwhile."[12]

Thus while the role of the market is secondary in the technology push project, its input is nevertheless important if the project is to be worthwhile. On this point the project remit, see appendix B, did contain the suggestion that a market would be found in the: "...small manufacturing or warehousing units." While there was no research material to substantiate this suggestion, it was not without merit:

1) In suggesting the smaller establishments as potential users of the intelligent truck the project remit was keeping well clear of the preserve of the existing AGV. The latter with their need for considerable financial investment prove viable only in the larger establishments.

2) The small manufacturing or warehouse units were those markets currently served by Geest and this association would provide for some measure of synergy.

The writer was unfamiliar with the current material handling technology and similarly had no knowledge of the material handling techniques currently in use in factories/warehouses. To gain a familiarity and to investigate the potential application for the intelligent truck concept a number of on-site interviews were arranged. In order to facilitate dialogue around existing techniques/technologies the writer, beforehand, visited NMHC Cranfield to review the relevant material handling literature. From November 1982 to January 1983 a total of six on-site interviews were arranged. These interviews pointed to particular areas of application of the intelligent truck within the factory/warehouse environment, namely:

1) Loading/off-loading bay applications.
2) Place and put operations.
3) Transportation of materials between physically remote sites.

As already mentioned, the opportunity to further examine the application of the intelligent truck in these areas was curtailed by the abandonment of this project in March 1983.

*Organisation And Management*

The management of innovation, and in particular the management of radical innovation, should be conducted separately from the management of routine business activity. This is an approach widely reported and favoured by Galbraith,[13] Ward,[14] and Drucker.[15] The reasons for such separation are twofold. Firstly, the purpose of innovation is fundamentally opposed to that of an operating division - whereas the former strives for change so the latter strives for stability. Secondly, in a situation where these two activities are conducted simultaneously the tendency is for the immediate business interests to take precedence over the innovation effort.[16]

As regards the low cost intelligent truck project the level of organisational and managerial separation from the immediate business interests was as absolute as practical. The writer was answerable directly, and only, to the managing director. However, while this project had organisational and managerial separation it did not have physical separation - and this led to difficulties. Furthermore, to its detriment, the continuity of this project was frequently broken. In both these respects it is the management aspect which will be shown to attract criticism and there are three points of criticism:

1) It was initially the intention of Geest management that the intelligent truck project be conducted from within the engineering drawing office. This site was chosen because it had responsibility for the existing company R&D effort. It was, however, at the same time, actively involved in the day-to-day sales and manufacturing activities of the company. Such a mix of activities is not desirable. Galbraith,

Nylen, and Finkin all argue the case for separation. To quote Finkin:

> "An operating organisation always has immediate and important problems hindering its mission of "getting the stuff out the door." An attached R&D organisation, possessing manufacturing technology know-how, will be called on for immediate help with these problems. In time, the natural consequence is for this "fire fighting" to overwhelm the resources of the new product effort, which cannot be continually interrupted by short range tasks if it is to effectively execute long time horizon programs."(17)

In addition to such interruption there is yet another cause of disruption, again resulting from the close proximity and the difference of purpose of these two activities. Namely, that in having fundamentally different purposes they also promote different measures of efficiency (ie. routinisation v. exploratory) and what constitutes efficiency for one is inefficient for the other. What is witnessed in this project is that the conditions supporting the efficient running of the drawing office were in conflict with those conditions beneficial to the pursuit of innovation, namely:

a) The writer required frequent access to telephone and secretarial facilities and on each occasion had to request authorisation.
b) Informal requests were made, by others, for assistance with more immediate design problems.
c) Suspicion was attached to the writer's presence (and purpose) in the drawing office.
d) As a result of the nature of the research the writer was required to arrive/depart at irregular hours - a source of adverse comment.

The above listed actions were disruptive to the intelligent truck project and so a move was made to a vacant office within the factory area. Physical separation did not prevent subsequent interference, and from November to January effort which should have been applied to the intelligent truck project was instead diverted to assist a draughtsman conduct field trials on a new product. This 'assistance' was not insubstantial. Initially, it was a request by the managing director for the writer to assist with field evaluation trials on a new product - as a precursor to a formal new product launch. However this product received a poor reception in the various trials, and at the same time the draughtsman accepted an early retirement offer. Ultimately the writer took responsibility for this product leading to the production of a report in January 1983 proposing ideas for a product redesign and a compatible market strategy. See appendix F. The drawing office project was to be managed in addition to any on-going commitment to the intelligent truck project. Finkin earlier warned of the dangers of innovation effort becoming involved with the 'immediate and important problems'. Such involvement is said to be to the detriment of the longer time horizon project and for a while the intelligent truck project did come secondary to the more pressing problems associated with the field evaluation trials.

2) In January 1983 a request for a nominal research budget was rejected by the managing director. A position formally announced at a March 1983 project team meeting. See appendix X. Instead of a budget the writer would be required to justify all claims for expenditure however small to the managing director. It is usual to have funds allocated to a research project, indeed a cause of debate is just how the financing of such funds be calculated (ie. on turnover or profit level) and project failure is identified with the lack of funding.[18]

Delbecq and Mills argue that to deny a project a budget is to place all risk on the innovator:

> "Risks are assumed solely by the advocate; he or she must often accept under resourcing, since permission and support depend on the patronage of managers who may see the request as "outside" normal budgets, or even as a nuisance."[19]

All financing of the intelligent truck project was to be justified and financed outside the normal budgets. On the point of justifying funding, Schon highlights this as a potential area of conflict and an area where management can thwart innovative effort:

> "In order to justify investment, the subordinate must bring his ideas to the boss before they have proved themselves, and at that early stage he can never adequately defend them."[20]

The point of the above is that it is usual to provide a project with a budget. In the absence of a budget a project will fail and as regards the justification call of the managing director it is an uncertain and not an optimum approach.

3) In October 1982 the writer was instructed to meet the managing director weekly to discuss progress, and, in December 1982 it was instructed that a weekly travel itinerary be submitted. The regularity and frequency of the above meetings did impart a sense of urgency into the project. However, this approach also led to the setting of short term goals for the project, essentially goals for the coming week. This practice of fulfilling short-term goals does tend to lock the innovation into a particular path because the only changes of direction which may be considered are those with short readily identifiable targets. On the 4th March 1983 this type of control was intensified through demands for a written weekly progress report and more documentation.

This thesis argues against management imposing such 'short-term' procedures for the reason that invention is not a process which can be so managed. To quote Holt:

> "...it is not possible to order creative ideas and schedule the time of their arrival."[21]

Invention is not a process characterised by uniform chronological development and to operate procedures to examine progress as if it were is likely to lead to tension. Pressure for progress is ill suited to the creative role of the invention stage and is better suited to the development stage.

Thus is described the three points of criticism of the intelligent truck project.

The inability, or failure, of the mature company to innovate is reported to be a direct consequence of a management unwillingness to tolerate the associated level of risk.[22] Risk, however, is an integral part of product innovation. Indeed as Bessant[23] or Holt comment the particular level of risk is a variable which is dependent: "...on how radical and unfamiliar the change is for the organisation."[24] In this respect not only did the low cost intelligent truck involve a degree of risk associated with radical innovation, but it involved a higher degree as a result of its unfamiliar nature. Some managers are reported to be comfortable with risk while others are not. To qoute Nylen:

> "Success in dealing with risk reflects, in part, the varying character of new-product managers, but the underlying cause is top managements willingness to accept operation in an uncertain environment."[25]

It is the ability to manage risk and operate in conditions of uncertainty that is the measure of the quality of the entrepreneur. However, it is reported that management in the mature company is naturally risk averse. This characteristic having developed from the desire to optimise the running of existing business activity:

> "When we analyze mature businesses, we usually find that the predominant characteristic of the successful manager are those that belong to what we might call a "critical administrator", typified by the desire to increase efficiency, control and financial returns. However, a management interested in innovation must adopt many of the characteristics of the "entrepreuneur"..."[26]

The radical intelligent truck project, with its considerable element of risk, should have been associated with an entrepreneurial management approach, yet the criticisms of management described above, and summarised below, do indicate otherwise:

1) No budget approval.
2) Prior justification required for all items of expenditure.
3) Authorised disruption of this project with attention being focused on more immediate company business.
4) Progress to be acounted for at weekly meetings and from the 4th March in weekly statements.

The above list better fits the 'critical administrator' approach rather than the entrepreneurial approach. There is considerable contrast between these two types of characteristics and the corresponding pressures for change-continuity which they create in a company. In reality it would be expected that individuals, and companies, would display a mix of both characteristics. However, as Guetzkow comments: "The balance of these countervailing pressures determines the organisations climate for the innovative member."[27]

### *6.2.2 Viability Of The Innovation*

The question of the viability of the intelligent truck project is considered in two parts. First is the need to consider the choice of product. Second is the need to consider the company approach.

*The Choice of Product*

It is the inability of management to come to terms with the radical nature of this innovation that is reflected in this project. The intelligent truck was to be a sophisticated product, and different from anything previously manufactured by Geest. The company product range consisting with the one exception of the electric truck of low technology items. Such contrast carries its own implications. In manufacturing the company's skill lay with volume production and metalwork. In sales its skill lay with the volume distribution of low technology products. That is, competencies which were likely to be of little benefit during the commercialisation of the intelligent truck. This considerable incompatibility does suggest that there would be little incentive to absorb the intelligent truck project into the day-to-day business. This point was supported by the lack of company interest for the project following the resignation of the managing director on the 7th March 1983. What the above demonstrates is the lack of any synergy between the intelligent truck project and the existing company operations. Radical innovation need not lack synergy with existing operations, for example, the chemical firm Du Ponts' diversification into the synthetic fibre market with Nylon, or Pilkingtons pioneering of the float glass process. However, where such synergy is lacking, then the associated project uniqueness makes the task of innovating all the more difficult.

Therefore with respect to Geest, the company's particular skills made the intelligent truck project a more difficult form of 'radical' innovation; more difficult than it otherwise might have been if pursued by a company whose existing operations provided for a more substantial measure of synergy.

*The Approach To The Innovation*

Prior to the abandonment of the intelligent truck project both the technical and marketing functions had reached the stage of selecting and focusing in on areas considered to be of particular interest. At the same time management was diverting effort and applying restrictive controls. However, although this was the case there can be little doubt that the innovation, in principle, was desired. The managing director had sponsored the intelligent truck project and maintained throughout the position of industrial supervisor. The academic supervisors attended progress meetings and expressed support for future areas of study. The research findings associated with the progression through the invention stage were noted and discussed at supervisory team meetings, yet this desire for innovation (invention) was not being followed through into the provision of a suitable environment.

*Summary*

The intelligent truck represented radical innovation. Technical research was to create a new concept in guidance/navigation techniques, brainstorming was used as an aid to creativity, and marketing research was to locate a market. Both these functions involved the search for something new. The ability to manage effectively such a project is a measure of the quality of the entrepreneur - requiring the individual to tolerate uncertainty and manage risk. In this project the entrepreneur is absent, in his place is the critical administrator who denied the project the necessary resources.

NEW PRODUCT DEVELOPMENT

*6.3.0 Introduction*

The small pedestrian electric truck project, industrial remit agreed April 1983, was intended to provide replacements for the company's current range of electric trucks. See appendix H. The latter having remained virtually unchanged since their introduction in 1958. From 1966 to 1982 the annual sales of the current product had shown a fall of some 75% (80 units) which, in 1982, was the equivalent of a loss of revenue of some £180 000.

In the small electric truck project Geest was again pursuing product innovation, however, the approach was dissimilar from the earlier 'intelligent truck' project and for three reasons. Firstly, it involved the design of a product for a currently served market. Secondly, the market for this product was being served by an established industry. Thirdly, as a consequence of the managing director's resignation in March 1983, this project was conducted under the management of a different industrial supervisor.

*6.3.1 The Small Electric Truck Project*

It is reported by Utterback and Abernathy,[28] Sahal,[29] and Freeman[30] that an industry serving a market will evolve in a predictable fashion, and that the characteristics of product innovation in that industry will also follow a pattern. The above authors describe a transition from radical product innovation to minor product innovation as an industry evolves. They also comment that the competitive conditions in the young market favours the small entrepreneurial company, while the conditions in the more mature market favours the larger bureaucratic company.

The fact that Geest had entered the electric truck market in 1958 would suggest this industry to be at, or approaching, its maturity. There are several other factors to support this viewpoint. Firstly, the electric platform truck has a well established market. The writer's survey of the hospital market revealed an installed base of some 2000 units, with a larger base suspected in the industry/warehouse sector. Secondly, there is considerable standardisation on the type of design to be found in this industry. Thirdly, for all practical purposes this industry is dominated by four companies. Fourthly, the commercialisation of the small electric truck concept first took place in the 1920's.[31] Given the presence of a maturing industry then according to the model of Utterback and Abernathy, Sahal and Freeman, any subsequent product innovation ought to be minor, eg. style changes. However it is important to note that this minor innovation is defined with reference to the current state of development of the industry as a whole and in this respect the development of the Geest electric truck had failed to keep pace with the development of the industry. It is as a consequence of this neglect that, in order to achieve the same commercial objectives in the electric truck market, there is a difference in the effort required of Geest as compared with that required of the current market leaders. Bessant makes reference to the need to consider the starting point of the innovation:

> "...it follows from our definition of innovation that the degree of newness will be an important factor...Obviously this will be a relative quantity depending upon the organisation involved: what may be a radical departure for one may be little more than a logical progression for another."[23]

However the presence of a maturing electric truck industry did have important implications on the pursuit of innovation at Geest. In that the innovation while ostensibly a new product, was in the position to benefit from the current design of the market leader products. The writer could, with justification, design a new product using the techniques/technology of the current market leaders, this information was readily accessible and the designs in an established market were unlikly to see much change in the near future. It is this approach which leads the writer to comment that the 'new product' innovation at Geest was not as difficult as it might otherwise have been if say it were to be pursued in a younger and more dynamic market. The point of the above is that the effort required of a company to innovate is a function of the level of change which must be managed by the company in order to successfully establish a product in a given market and with respect to a given product this function is dependant on two separate criteria, namely:

1) The current stage of development of the industry and, following from this, the characteristics of subsequent product innovation likely to be found in that industry.

2) The difference which exists between the current stage of industrial development and the corresponding stage of development within the innovating company.

The presence of two separate criteria is significant. There are numerous models which describe the dissimilarity in the types of innovation activity and give account of the effect of the latter - while failing to take any account of the former. Such models are describing product innovation with respect to the condition of the company, and not of the industry, and the limitations of such an approach ought to be recognised. Any classification system such as that proposed by Heany,[32] or Rothwell and Zegveld,[33] which fails to take account of the implications of the stage of evolutionary development of an industry must necessarily be of limited use. A consequence of this omission is that such classification systems are unable to discriminate between the same 'type' of innovation conducted at different stages of evolution of an industry. For example, Heany in his classification makes no allowance for the fact that 'new product' innovation would be considerably more risky and uncertain if conducted in the dynamic environment which surrounds a young industry, than if it were conducted, as above, in a maturing industry. This omission has particular significance if intra-industry comparisons are to be made and the writer would argue that for such purposes, innovations must be further defined according to the stage of evolutionary development of the respective industry or recipient market.

Evolutionary innovations are conducted in response to the commercial advantages to be gained by improved matching of existing technology to the needs of the market and they therefore represent a focusing of design effort - it is the industry operating in a market-pull situation.

The electric truck industry was in, or approaching, maturity, and, it is appropriate that the industrial remit for this project contains no mention of technology; no reference to the technical design of the replacement trucks. See appendix H. Instead this remit places emphasis on the importance of incorporating into the truck the types of performance characteristics considered by the market to be desirable:

> "The nature of (the existing Geest electric truck) sales would indicate that a market still exists in hospitals, warehouses, factories, etc. for a truck with suitable operational characteristics. It is, therefore, desirable to identify these characteristics and, if considered economical, incorporate them in the range of redesigned trucks."

As such, the design approach of this project was wholly compatible with a mature market situation.

This project, did not involve an invention stage. There are three reasons for this:

1) The design concept of the small electric platform truck is straightforward and well proven.
2) The electric truck industry is in (or approaching) maturity and the competing companies are thus unlikely to attempt to radically alter current designs.
3) There was no call in the project remit for the writer to invent an electric truck.

Instead of inventing a new product the design of the Geest truck would rely on available technology, interconnected so as to provide a product whose characteristics are a 'better-fit' with the recipient market needs - this project involved the development, as opposed to the invention, of a new product.

The fact that the small electric truck project involved development work, and was to respond to a market-pull situation in a maturing market does have a significance for the conducting of the project. The consequence of these factors for the *marketing* and *technical* functions, and for the *organisation and management* aspect are now discussed.

*Marketing Research*

To quote Ward:

> "Reduced to a minimum, the function of marketing research...is to help decision makers in resolving: what to make and how to sell it."[34]

In the market-pull project, as opposed to the technology-push, this function is all the more critical - as it is the market research findings which form the basis around which subsequent design and commercialisation decisions will be taken. On the subject of conducting marketing research Ward describes six approaches as follows:

1) Literature searches.
2) Statistical analysis.
3) Postal questionnaires.
4) Telephone interviews.
5) Direct interviews.
6) Designed seminars.

For the electric truck project all the above, with the exception of item 6), were research techniques employed at some stage.

While researching the electric platform truck the existence of a competing and complementary product, namely the tow-tug, was noted. The tow-tug was found to be operating in the same environment as the electric platform truck. The design and the operation of both these products are similar and it was also an integral part of the product ranges of retailers of the electric platform truck. For these reasons the tow-tug design was added to the designs proposed in the project remit.

The approach to the research of the electric truck market was one of market segmentation followed by market targeting. The reason for this will be explained. A review of competitor sales literature, and of Geest sales records, suggests a market for the electric truck which is widespread and heterogeneous. The existing suppliers of the electric truck, including Geest, all sell to the UK market and each company has in theory the opportunity to compete for every sale. The disadvantages in this approach is that all markets do not have the same needs nor do they have similar levels of demand and a decision to cover all markets can lead to a dilution of effort. The option is to segment the market, to quote Kotler:

> "An organisation that decides to operate in some market...recognises that it normally cannot serve all the customers in that market...Some competitors will be in a better position to effectively serve particular customer segments of the market. The firm, instead of competing everywhere, sometimes against superior odds, should identify those parts of the market that are the most attractive and that it could serve the most effectively."[35]

Thus segmentation enables a focusing of effort which can provide for a differential sales advantage at commercialisation:

> "Segmentation analysis is the key to establishing a brand or product on the market by more effectively meeting the needs of more tightly defined, closer knit groups."[36]

Littler suggests that four criteria need be satisfied if segmentation is to prove a worthwhile marketing strategy:[37]

1) The ability to identify individual members of the market segment.
2) The ability to reach effectively the market segment.
3) The ability to quantify the market size.
4) The market size should be substantial enough to make segmentation worthwhile.

There are valid arguments both for and against segmentation/targeting and its adoption requires careful judgement.[38] In the electric truck project the writer, after the examination of a number of market segments, concluded that a worthwhile differential advantage could be obtained through the technique of segmentation. In a review of market segments using the market research techniques listed by Ward it was the response from the hospital market which proved the most interesting. This market presented three points of advantage to Geest:

1) It was an established user of the Geest electric truck and although this market found fault with the truck, they were also dissatisfied with competitor models. That is, this was a market with user specific needs which were not being met, eg:
   a) Speed: requirement for trucks to travel at a pedestrian pace.
   b) Manouverability: for movement in confined areas.
   c) Consideration of noise and hygiene aspects.

2) This was a market segment familiar and accessible to Geest. The hospital market is a major customer of Geest Material Handling division.

3) This was a market segment which made substantial use of the electric truck with an installed base estimated in the region of 2000 tow-tugs and 2000 platform trucks.

The characteristics of the hospital market suggested that a considerable penetration could be achieved with a product which better fitted its needs. With an annual demand for electric trucks estimated from questionnaire returns to be valued at some £1/1.2M this market is substantial, it meets the four criteria for segmentation set by Littler and was selected as the target market.

Marketing research was disrupted in November with the resignation of the engineering manager who provided industrial supervision. The project did continue after this period though it did so under a different set of priorities.

*Technical Research*

There is no commercial advantage in inventing for its own sake and to quote De Bono:

> "In business a powerful source of ideas is copying."[39]

The electric truck project proposed the development of a tow-tug design and a platform truck design. In both cases the components for these designs were selected from amongst those components commercially available, which effectively encompassed all the components to be found in competitor models.

The incorporation of existing techniques and technology is valid given the circumstances of this project. The electric truck was first commercialised in the 1920's and the truck concept and its market are now well established. In serving an established market the current industry is unlikely to introduce radical alternatives or alterations to the established design concepts. The latter being defined with respect to the current stage of development of the industry. On this point the design of the current Geest product, introduced in 1958, was outdated and a number of its components were obsolete. Thus the design of a new product (representing style changes in the marketplace) could only arise from an appreciation of the current state of the technology of the electric truck industry. As a consequence of the levels of advertising it was quickly established that the manufacturers of electric trucks obtain the majority of components from independent component suppliers. Thus the development of the Geest electric trucks would involve a selection amongst the available component design options, selection being on the basis of a better fit with the market needs. Thereafter it would be necessary simply to design a suitable bodyshell around these components.

The intended marketplace for the Geest electric trucks, and importantly the technical needs of this market were established by marketing research. Satisfying these needs using commercially available technology led to the selection of a suitable set of components.

In November, due to events within the company, the development work on this project was interrupted, though not suspended.

*Organisation And Management*

In March 1983, following the resignation of the managing director, the writer's position was incorporated into the engineering division hierarchy and the engineering manager was appointed as industrial supervisor. In this situation there was neither organisational nor managerial separation from the immediate company business.

Within a hierarchical structure, McTavish[40] argues that highly innovative activities may be constrained, and consequently innovation in such circumstances is said to be appropriate only when it has a close association with the principle activity of the host hierarchy. However, the small electric truck project was not unfamiliar in that it was an attempt to re-establish Geest in the maturing electric truck industry and in this respect the decision to conduct this project within the hierarchy of Geest engineering division was consistent with the recommendations of the literature. One consequence of working within an established hierarchy was to define formally the writer's role within the company. This provided a measure of support and protection for the truck project. Essentially the project benefited from a 'formal licence', Souder described this phenomenon as follows:

> "Individuals who have a clear licence and mandate to carry out a particular function will normally do it with a greater degree of effectiveness and air of profesionalism than those who do not...A formal licence is also a visible record of authority that promotes recognition, respect and confidence. This is especially important for the individual entrepreneur, since he must obtain the cooperation of many other persons who are preoccupied with their own assignments."(41)

The benefit of a formal licence with which to conduct this project is recognisable in the description of events. Thus:

1) A few weeks into this project the writer was transferred from a factory office, occupied during the low cost intelligent truck project, to a newly furnished office within the general administration complex.

2) This project was not subject to restrictive cash constraints. Instead a source of limited funding was available through the company petty cash and justification was not required on small levels of expenditure.

3) In November 1983 the engineering manager in preparing the divisional budget for the coming year included provision for the sum of £30 600 for the small electric truck project.

The development of this project was not interfered with and it was an integral part of the engineering division. Furthermore, it was allowed, or was in the process of being allocated those resources necessary to enable progression to commercialisation. A point of criticism may be made of management, namely, this project was in the development stage - a stage of problem solving and a stage where work is undertaken for definite commercial objectives, yet there was a lack of management control. Management made no call for timetables or for financial appraisal. Such omissions need not be to the detriment of the actual progression of the project, given it has sufficient resources allocated, however, it does conflict with the recommendations in the literature that tight and detailed control be maintained over development work.

The literature is reported as suggesting that projects having a close association with current business interests ought to be appropriate for conducting within an established hierarchy. The events of this project would add support to that viewpoint.

### *6.3.2 Viability Of The Innovation*

The question of the viability of the innovation is considered in two parts. First is the choice of product, and second, is the company approach.

#### *Choice Of Product*

The small electric truck project was intended to provide replacements for an existing company product and consequently the project had synergy with the existing company operations. The project describes a mature company innovating in a mature market - a situation in which the skills of the former in manufacturing and sales are exactly those best suited to capitalise on the situation of the latter. The UK market for electric trucks is well established, though it is small (£5-10M) and the 'few' dominant companies were found to be of a financial size comparable to that of Geest. Production processes - a key factor in determining the cost of entry to a market, being primarily assembly operations, were less capital intensive than might otherwise have been expected from a mature market.

*Approach To This Project*

This project was conducted and managed from within the engineering hierarchy. The close association with an existing hierarchy presented no problems for this project - primarily because it was low risk and had close association with existing business interests. The electric truck project represented evolutionary innovation in a maturing market and the marketing approach was one of market segmentation and targeting. The hospital market was selected as a target market, it was a large user of electric trucks and a market with which Geest were familiar. The marketing function first drew attention to this market and subsequently helped define its needs while the technical function involved the gathering together of a suitable set of components.

*Summary*

This project was not a high risk innovation but rather represented evolutionary innovation in a maturing market. The existence of an established market for this product provided a valuable source of marketing and technical information around which to design the products. This project, had a close association with existing products and its management within an existing company hierarchy was conducted without presenting any difficulties for the project. There were few management controls applied to the development of this project - a consequence of neglect or possibly in recognition of the relatively straightforward nature of this project. In conclusion, as a low risk development project it was provided with an environment within which it could be suitably conducted.

## PRODUCT LINE ACQUISITIONS

### *6.4.0 Introduction*

Geest Industrial Group's management hierarchy was reorganised in December 1983. This was the first reorganisation since, both, the consolidation of the manufacturing activities in May 1983 and the resignation of the engineering manager (industrial supervisor) in November 1983. While it was conducted in order to facilitate rationalisation of the company's manufacturing function it also introduced a change in the company approach to product innovation. Henceforth the principal task of the writer was to conduct examinations of the viability of the incorporation of selected ranges of manufactured products within the two sales division's portfolios, that is, to consider the adoption/diffusion stage of product innovation. See appendix P. The small electric truck project was allowed to continue though as a consequence of the refocus of the writer's remit it did so on a reduced priority.

The conduct of product innovation in this period was dissimilar from that of the preceeding two periods, and on three counts. Firstly, it involved the adoption/diffusion stage. Secondly, it involved a series of innovation exercises. Thirdly, innovation was conducted under the supervision of the general manager.

### *6.4.1 Product Innovation Activity*

A principal distinguishing feature of this period is the attention given to the adoption/diffusion or commercialisation stage of product innovation. This attention was deliberate, a consequence of a change of strategy. The origin of which can be linked to the appointment of a general manager in March 1983, and the fact that by March 1983 Geest Industrial Group had returned five consecutive years of losses and had lost the favour of the parent company. See appendix A.

Barring the actual removal of the loss making aspects (ie. through a closure of the operation) then it is only through innovation that a company can recover from this disadvantageous position. March and Simon report a positive relationship between an increased support for innovation and a decline in financial performance.(42) Basil and Cook similarly argue that inadequate performance is a strong motivator:

> "Most organisations initiate change only in crisis, and often then only when it is a case of survival."(43)

It was not inappropriate, therefore, that in April 1983, in the month following his appointment, the general manager stated that the company could no longer afford to neglect product innovation:

> "My March 17th proposals included a statement on our product development policy, which is basically that we cannot afford not to afford any expenditure as indicated in the budget."(44)

Thus in attaching emphasis to the role of product innovation the general manager was displaying a characteristic management response to a worsening financial situation. Product innovation is a means of securing profit and was sought after by the general manager. However, his approach in this was not one which involved defending and re-establishing existing products instead this aspect was intentionally disregarded, as is explained.

In September 1983 the engineering manager was instructed to prepare a 1984 budget submission, the focus of which was to be the role expected of product development. Submitted in November this budget highlighted two areas for attention, firstly, it recommended the need for value analysis and related product improvement exercises (to enhance the existing product range) and secondly, it called for resources to be allocated to extending the current product ranges. Both proposals have a strong logic. According to McTavish[40] an operating division is organisationally and managerially best suited to host those innovations which have a close association with its primary function. Furthermore such innovations are in a good position to capitalise on the current knowledge/skills of the company, to quote Andrews:

> "Revitalisation of existing products has the immense advantage of enabling the company to exploit its existing assets to the maximum."[45]

However, the engineering division budget recommendations were never implemented. Instead the general manager decided to pursue innovation through the introduction of manufactured products 'new' to the company. Under the circumstances such a strategy has considerable risk attached, in that to ignore the existing operations was to leave them loss making. In fact, through January - July 1984 the existing operations generated losses in excess of £300 000. This neglect of existing operations is also in conflict with the recommendations of the literature on innovation, which argues that of primary concern is the need to secure the profitability of the current business operations and thereafter to expand with the addition of 'new' products. To quote Smith et. al:

"A growing corporation must defend it current profitable businesses by introducing improved products and processes into its current markets. Growth can be further enhanced by successful innovations with new products and processes which extend its business/market scope..."[46]

This decision to ignore the development of existing products and instead to focus on the acquisition of new products implicitly carries the need to manage and organise for a greater 'newness'[23] of innovation. To quote McTavish:[47]

"It is true that some companies can successfully exploit a given market situation for long time periods with relatively little change in organisational structure or management style. But a commitment to new products and markets presents rather a different challenge and dynamic change is unavoidable."

"Top management ability to foster and manage change thus emerges as centrally important to successful new product development."

In the 'dynamic change' at Geest the writer and the engineering drawing office manager were separated from the engineering hierarchy and made answerable direct to the general manager. A new position termed 'special project co-ordinator' was created with the aim of managing the more complex innovations and the special project co-ordinator was also answerable direct to the general manager. Given that the goal of all this was the introduction of 'new' products then the approach, to separate innovative effort, is compatible with the literature. Furthermore the actual ability of the company to conduct management 'style' change, from a hierarchial structure to a more 'open' structure as the company refocuses attention from 'defensive' innovation to 'offensive' innovation is itself significant, and is a characteristic which McTavish[40] and Booz. Allen and Hamilton[48] have recently argued in favour of - the ability of management to change its structure to meet changed circumstances.

Thus in December 1983 the general manager decided on a course of action which was to ignore the development of existing products and instead to pursue the adoption of 'new' products. Such a strategy is not favoured in the literature because of its neglect of the need to maintain a competitive product range. Nevertheless his creation of a suitable organisation from which to conduct this type of innovation was a significant achievement. By itself it is not enough and the realisation of its purpose is also dependant on the quality of its management.

*Managing The Product Innovation*

As has been mentioned, the restructure of December 1983 considerably altered the management of product innovation within Geest. Prior to this restructure, product innovation was conducted both by the engineering drawing office and by the writer: both working on separate projects and both located within the engineering hierarchy. See appendix U. The adopted structure, in which the conducting of innovation is autonomous is more favourable to entrepreneurship and to the conducting of a higher complexity of innovation. It is shown supporting three means of product innovation:

1) The writer. (remit formalised 14th February 1984)
2) The engineering drawing office. (remit unchanged)
3) The special project co-ordinator. (remit formalised 21st February)

1) The writer:

> "...will become involved in a broad range of product development exercises. In particular he will assist Divisional Managers with the commercial evaluation of business development strategies."
>
> (appendix P)

During the period December 1983 - July 1984 the writer was involved in a total of four product development exercises, namely:

a) The small electric truck project. (Material Handling Division)

b) The potato harvesting equipment. (F.W. Pettit Division)

c) The pallet stacker market. (Material Handling Division)

d) The straw incorporation market. (F.W. Pettit Division)

Item a) was a continuation from the previous period and items b) - d) were initiated in this period and represented the 'commercial evaluation of business development strategies' to assist divisional managers.

A market for each of the above listed products does exist and the approach to the evaluation of commercial viability involved market segmentation and targeting and in each case for the same reasons, ie. differential advantage and better satisfying the needs of the customer.

a) The small electric truck market: As already described segmentation of this market was by end user. The hospital users were selected as the target market and various bodyshell designs were prepared and issued to this market for comment.

b) The Hassia harvester equipment: The supply of potato harvesters in the UK is dominated by the one company R. Pearson Ltd. with some 75% of the market. Segmentation of this market was on geographical factors, viz. coverage of <5% of the land area of England can represent >15% of the buyer demand.

c) The pallet stacker market: The market for this product is young and growing. Segmentation of the market was on product sophistication ie. manual - powered equipment.

d) The straw incorporation market: Insufficient research was conducted in the time available and so segmentation could not be defined.

While conducting the above four exercises there was never any mention of budgeting or other means of financing the research, and petty cash was freely used in all cases.

2) The engineering drawing office: The drawing office continued with the development of a disc harrow (started in summer 1983) to complement the company's existing product range.

3) The special project co-ordinator:

> "The importance of new projects in our future plans will have become increasingly clear to everybody in recent months. Our 1983 results and prospects for 1984 can leave nobody in any doubt that we have to find new opportunities, as well as making better use of existing ones. The conflict of priorities between those two requirements was the reason for putting Mr. X in charge of the Wu project, so that other managers could concentrate on their present responsibilities. I have decided that the time has come to formalise the arrangements by establishing Mr. X as special project co-ordinator reporting to me."
>
> (appendix V)

This description of the formal creation of the special project co-ordinator position was announced on 21st February 1984. The special project co-ordinator was primarily concerned with managing the introduction, into the UK of a range of agricultural carriers from Taiwan.

The review of literature indicates that when in crisis a company will accelerate its innovation activities and events within Geest would support this view, viz: the creation of an organisation structure to assist the company conduct innovation and the approach of concentrating innovative effort at the commercialisation stage.

It is argued by Smith et. al., that to accelerate innovative effort can be risky, that 'crash programmes do indeed crash'. There are however no fundamental reasons why such programmes should fare any worse than other innovation programmes, though Smith does cite over optimistic management with a: "...down playing of unfavourable results..."[49]

By concentrating on the adoption/diffusion stage the company escaped the 'normal' commitment to the invention and development stages and thus accelerates the introduction of new products. However, adoption/diffusion does require in-house work, in particular, it does not free the company from the decision on the choice of products as assessment must still be made as to the commercial viability of pursuing the innovation - a decision all the more important with the 'resale' of goods since profit will be shared with the manufacturer of the product. Both are points noted by Andrews:

> "Joint ventures or licencing agreements enable a company to add the missing facility or strength it needs in order quickly to exploit an idea or a commercial opportunity. The main disadvantage is a fairly important one: a shared project means shared profits."[50]

In this respect difficulties may arise if commercialisation cannot be effectively prepared or justified. It may be as Smith argues, that managerial pressure for the introduction of new products is such as to override any objective assessment.[49] Indeed while the general manager was directly supervising the innovation programmes there was no standardisation in their respective approaches - there was no procedure within which which work was to be conducted or upon which progression would be objectively assessed, yet such mechanisms are required. To quote the management consultancy firm of Booz. Allen & Hamilton:

> "The key problems in the management of new products require top management attention. Responsibility for direction must rest at the highest operating level in the company. This requires a clear statement of company objectives, effective organisation, careful planning and provision for rigorous analysis and control. When these conditions are absent, problems usually result."[51]

Innovation at Geest suffered from lack of careful planning, analysis, and control. Problems were developing; for example, the engineering drawing office were continuing with the development of a product line extension in the disc harrow for a market which was contracting at some 20%/annum.[52] The special project co-ordinator launched a radical new product and provisionally committed the company to a spend of some £150 000. No market strategy, or market assessment was ever submitted to the management team to justify such a level of commitment. Likewise, the writer continued to pursue the development of the small electric trucks and there was no call for any appraisal or financial justification.

The above examples serves to highlight a danger with a misdirected commitment towards innovation. Namely, that unless the activityis adequately monitored and controlled there is the possibility that the company will optimistically support all such activity, even when reality should dictate otherwise. Rothwell explains the need for control:

> "...if management backs a loser at the outset, there is little that can be done at the operational level to retrieve the situation other than to terminate the project. This highlights...a...significant point, which is the need for a set of 'termination criteria'. Projects do, otherwise, have a tendency to continue under their own, often considerable, momentum with a consequent, and needless, waste of resources."[53]

Two problems are highlighted in this account of innovation at Geest.

Firstly, the general manager sought to promote innovation of a higher complexity than that previously pursued by the company. Although the company was suitably reorganised, there was no attempt to improve the quality of management conducting the innovation activity. Secondly, the company did not incorporate the management practices which would allow the objective assessment of innovation programmes. As a result the company's innovation programmes once started were allowed to continue even though cursory investigation did indicate the need for a more self-critical approach.

A principle criticism is that the company lacked the skills required for the effective managing of its innovation programme. The company did accelerate the pursuit of product innovation, however, it also pursued product innovation programmes for which no objective appraisal had been conducted. This gives support and cause for the earlier comment by Smith et. al., that 'crash programmes do, indeed, crash'.[49]

### *6.4.2 Viability Of The Innovation*

The question of the viability of the innovation pursued in this period is considered in two parts, firstly, the choice of product, secondly, the company approach.

#### *The Choice Of Product*

The development of the small electric truck continued and both sales managers requested the writer to study the viability of their adopting particular product ranges. The latter arrangement favours an objective assessment, and does not require the diverting of resources from the more immediate business interests of the sales divisions. In every case the projects proposed by the sales divisions had synergy with those products currently on offer. To have established this arrangement, the general manager must have recognised the valuable contribution of marketing research, and yet at this same time his decision to continue to support the development of a range of disc harrows and the importation of petrol driven carriers is questioned. Neither product range had a marketing strategy nor had marketing research been conducted in any detail.

*The Approach To The Innovation*

Reorganisation of the company hierarchy produced a more open structure which does favour entrepreneurship. This was appropriate as the types of product sought were more radical than those associated with the previous hierarchy. The focus of innovation switched to the adoption stage with the aim being to introduce new manufactured products. This approach removes any need for consideration of the invention or development stage, and as a result must accelerate the conducting of innovation. Thus the general manager had sought to accelerate the rate of product innovation and the approach adopted towards product innovation did support this aim.

*Summary*

Accelerating rates of product innovation are a reported feature of a company in crisis, and the desire of Geest to accelerate its innovation is witnessed in two areas. Firstly, the reorganisation of the management hierarchy to create a more favourable open structure. Secondly, in the emphasis placed on the adoption/diffusion stage of innovation. The number of new products under consideration did increase as a direct result of both actions, however, there is evidence of a lack of attention to the marketing research aspect.

*CHAPTER SEVEN*

*CONCLUSIONS*

<u>CONTENTS:</u>

# CONCLUSIONS

## *7.0.0 Outline Of Chapter*

A number of conclusions are drawn based on evidence contained within the body of the thesis. These conclusions are then discussed with particular emphasis being placed on the action required by management in a medium size mature company. From these a 'set of guidelines' is presented as an aide memoir for the conduct of innovation.

### *7.1.0 Introduction*

British industry has acquired the reputation of being a reluctant innnovator. The effects of this are compounded by accelerating rates of innovation worldwide and a shortening of the product life cycle. British industry must innnovate if it is to survive; its products must be of a design to match or better the current market offerings. Yet its trading record in manufactured goods shows the damaging extent to which product innovation has been neglected. There is an urgent need to improve performance in this area, and it is with this aim in mind that the concluding chapter is presented.

In chapters 3-5, factual evidence is provided to highlight the problems which befell one manufacturing company in its attempts to innovate without first adopting a coherent strategy. The analysis of these abortive attempts (chapter 6) clearly shows that such a strategy if created would have wide application in manufacturing industry, in other words it is possible to effectively manage innovation. The chapter 6 analysis leads directly to the conclusions presented in this chapter. These are presented, firstly, because they reiterate the difficulties associated with product innovation and, secondly, they show how these difficulties can be minimised, overcome, or, even, turned to advantage.

## PRODUCT INNOVATION IN THE MEDIUM SIZE MATURE COMPANY

### *7.2.0 Introduction*

The perception of innovation held by many people, including some of those in industry, is that it must be dramatic. Mention innovation to the layman and his mind will envisage the inventor. Recently with some emphasis being placed on supply-side economic theory this idea of innovation has been somewhat nurtured. A new ethos has emerged whose basis is that Britain must gain a foothold in the new embryonic 'high-tec' industries. A mechanism and benefactor is the New High Technology Business Firm. Dramatic innovation suits the internal characteristics of these firms. However, this type of innovation does not suit the characteristics of the medium size mature company. It is not a solution for the ills of this business sector - it is not even an option. The medium size mature company has inherent characteristics of size and age which mitigate against the pursuit and commercialisation of such innovation. This is because of the fundamental incompatibility between the purpose and pursuit of radical innovation and the immediate business interests. Given the character of the mature company a more compatible solution lies in the pursuit of incremental innovation. This is because it is a type of innovation which conflicts less with the immediate business interests, also it provides opportunity for the strengths of the mature company to be used to commercial advantage. It is a type of innovation whose pursuit makes sense for mature industry. It is pursued by some companies. For example, it is in evidence in the turnaround of the fortunes of the car manufacturer Jaguar, it is also a declared strategy (evolutionary change) of IBM: witness their late entry into the PC market.

It is important that the mature company recognise the fundamental dissimilarities (both in pursuit and commercialisation) between types of innovation. If the medium size mature company is to derive maximum benefit from innovation then it must reject the more radical options and instead commit resources to the pursuit of incremental innovation.

### *7.2.1 Three Aspects Of Innovation*

The review of literature concentrated on the examination of certain aspects of innovation chosen to reflect the thrust of the research fieldwork findings. Three themes emerge in the review, namely:

1) *Organisation And Management.*
2) *Stages In The Innovation Process.*
3) *The Age Of The Market.*

*Organisation And Management*

Reports of internal interference to the detriment of innovation are supported by the evidence in this thesis. This illustrates that practical handicaps are suffered even at the hands of a well-meaning and committed management. Management must provide on-going support for innovation and it must pursue a coherent strategy. It must also have the ability to maintain control of innovation while at the same time making allowance for its associated characteristics of risk and uncertainty. This is a difficult balance to achieve. Excess in the former direction and innovation will be inhibited, while excess in the latter and financial control is lost. As a means of striking a balance there is evidence for the need for separation of innovation from the more immediate business interests. Sound reasons for this are given, namely, difference in purpose and different measures of efficiency. Such separation should be present in all companies. However, its need is accentuated by the characteristic maturing of the manufacturing company, that is, in the transition from entrepreneurial management to bureaucratic management. This is because bureaucratic management is naturally risk averse and has a preference for on-going and detailed control, characteristics which are healthy in optimising the performance of the immediate business interests. However, these are characteristics not compatible with the pursuit of innovation. Nevertheless they are applied and bureaucratic interference is a cause of the failure of the mature company to innovate. Excessive bureaucratic interference in the innovation process is evident in the events described in this thesis:

1) Unqualified control of expenditure.
2) Unqualified control and monitoring of progress.
3) Diverting effort to more immediate business interests.

This interference in the innovation process was not foreseeable at the outset. The initial commitment to innovate was matched with an organisation structure which provided the maximum possible separation from the immediate business interests. Nevertheless bureaucratic practices were increasingly adopted as the innovation progressed. This demonstrates an important point, namely, the pursuit of innovation does require more than the initiation of a project, and the creation of a suitable organisation structure; it also requires an on-going commitment sufficient to counter an equivalent and inevitable tendency to introduce bureaucratic practices.

A lack of effective commitment to innovate is also witnessed in another more subtle form, namely, that the direction of effort was changed three times over a two year period and the type of innovation considered during this two year period ranged widely - from radical innovation to evolutionary innovation. No new products actually reached the stage of adoption. At best, market tests were conducted on a range of imported petrol driven carriers. What is evident is the lack of coherency of effort. As a consequence knowledge and expertise in aspects of technical design and marketing research are seen to be acquired and discarded. This however, should not be confused with the need to allow failure. The basis of the above criticism of the pursuit of innovation is that over a two year period there were three fundamental changes of direction on innovation - each inspired by something less than rational thought and not much more than management whims. For any company the consequences of such an approach are likely to be very detrimental.

An incoherent strategy on innovation is obviously wasteful of physical resources, knowledge and expertise. Further it creates an adverse psychological environment within the innovative team that tends to destroy enthusiasm and trust and, in the routine business sector, nurtures the natural opposition to innovation which maturity creates. Coherency here means the successful management of innovation based on principles and procedures given in this thesis - it means that management must forge a new synthesis from the old routine business activity and the new in-house quasi-entrepreneurial ethos which is geared to evolutionary change.

The mature company has strengths of administration, manufacturing, and distribution, and any attempt to divert resources away from such established activities will be resisted. On this basis alone there is a sound argument for the separation of innovation from the more immediate business interests. In any event, the required level of separation is a function of the 'newness', or dissimilarity, which the proposed innovation has with respect to the immediate business interests and is at its greatest with radical innovation and at its least with evolutionary innovation. In the mature company bureaucratic practices will resist efforts to create separation and this is a characteristic which does mitigate against the mature company pursuing the more radical innovation. However, from the examination of the pursuit of innovation in the mature company, there appears to be another and more fundamental reason as to why this should be the case. The argument for this is as follows. The immediate concern of the mature company is to optimise its competitive performance in the markets which it currently serves. This aim favours bureaucratic management and administration. Radical innovation has no use for such skills, and it may even render them obsolete. Likewise the bureaucratic commitment to the existing activities will, correctly, perceive any attempt at radical innovation as incompatible with its aims and a rival for resources. Given this situation, conflict is likely and the consequences will be witnessed in bureaucratic interference and thwarted innovation. This situation is evident in the attempt to pursue radical innovation, ie. the unwillingness to divert funding, the lack of support following the resignation of the managing director. As explained this conflict arises out of a fundamental difference of objectives. However, instead of attempting to manage a situation of conflict it is proposed that a situation of strength be created. The bureaucratic company has exactly the characteristics required to exploit innovation in the mature markets, ie. strengths in administration, manufacturing and distribution. Indeed, a commitment to bureaucratic practices provides the best opportunity for the evolutionary innovation to be exploited in the marketplace. Furthermore, innovation in the mature market is relatively predictable, and thus contains less risk and uncertainty than would more radical innovation, and as a consequence would be less sensitive to bureaucratic interference. In the pursuit of evolutionary innovation in the mature market there is evidence in this thesis of its relative acceptability to the mature company. Thus a recommendation for the mature company is to conduct innovation so as to exploit its bureaucratic strengths. This need present no shortage of opportunity for the mature company, just as new markets are always being formed so it is the case that young markets are evolving into maturity.

In summary, management must maintain an on-going commitment to innovate, also it must display coherency in its efforts. The type of innovation pursued is also seen to be important. Innovation of a less radical form is more appropriate to the characteristics of the mature company - both in terms of its pursuit and its subsequent exploitation.

*Models Of Product Innovation*

A simple three stage model of the product innovation process was tested in this thesis and found to be adequate for the purpose of describing the dissimilarity between the three attempts to innovate. Numerous conceptual models of the innovation process do exist, and it is true that the more complex models of the innovation process do better describe the character of the innovation process. Nevertheless the simple model is demonstrated to be of practical value. In this respect the presence of dissimilarity in the conduct of product innovation is highlighted. Appreciation of the reasons of this dissimilarity and the implications which result from it, would benefit management's perception of the innovation process and could lead to an improvement in management's effectiveness.

Criticism of the simple model is on the basis of the self-evident truism that it does not adequately capture the interactive and interdependant character of the innovation process. However, a counter argument is that the innovation process is highly complex and unique to each product, and that its detailed study will only produce a mushrooming of potential models, each accounting for some particular dissimilarity and all without adding clarity to the process.

The simple model derives its strength from the basic similarities in the innovation process - the presence of invention, development, and adoption/diffusion, and it is not the finding of this thesis that the simple model is inadequate. The simple model was used in chapter 6, and found to be beneficial in enabling explanation of the dissimilarity in the needs of the product innovation activity as reported in chapters 3-5. The dissimilarity is considerable:

1) The invention stage of a radically new product - the search for ideas, the need for creativity, to propose and consider options with the aim to bring into being something new.

2) The development of a product for an established and evolving market - the selection of commercially available components with a close attention to the market needs and cost and performance aspects.

3) The acquisition of 'new' manufactured products with its emphasis on the adoption/diffusion stage - the role of financial justification as the pre-eminent basis for taking commercialisation decisions.

It is a finding of this thesis that more attention to the dissimilarity between these three stages, by itself, would have improved management's perception of the innovation process and may have improved the quality of management. For example, the recognition of the radical innovation as a new product in the creative stage, or the recognition of the evolutionary innovation as a new product in the disciplined and problem solving stage, would have in both circumstances aided in the understanding of the innovation's particular requirements.

The adoption of the simple model of the innovation process as a means of highlighting the inherent dissimilarity within the innovation process, and also as a means of drawing attention to the need for particular or changed requirements is supported in this thesis.

*Age Of The Industry*

The concept of the products produced by an industry evolving in a predictable pattern, through radical to minor innovation, is supported in this thesis. This pattern was found to be applicable to the markets studied and was of benefit in enabling understanding of the basis of competition in a given market. It is important that management recognise the consequences of this evolutionary behaviour of the market, namely, that the pursuit of product innovation in the mature market requires different skills as compared to the pursuit of innovation in the younger market. The former is witnessed to favour the bureaucratic strengths of the mature company whereas the latter favours entrepreneurship and flexibility.

It is evident from the review of literature that an industry can be described as being in only one of two states, either it is evolving, or it is being overthrown. Given the opportunity an industry will evolve towards a state of product standardisation and mass production. However to be able to benefit from mass production requires access to considerable financial resources as well as possesion of skills in manufacturing and distribution. A consequence is that the larger companies are the dominant competitors in the mature markets. The smaller company does have some advantage over its larger counterpart.

For example, its flexibility and speed of response make it better equipped to compete in the younger markets. The above relationship between the two sizes of firm is well documented. It is a case of matching the company's strengths to the needs of the marketplace and yet when it comes to the pursuit of innovation this relationship can be overlooked. The ability of the company to exploit an innovation subsequent to adoption is a function of its ability to compete in the recipient market. The nature of competition in a market is reported a function of the age of the market, and follows a path from performance competition to price competition.

In the new market competition is essentially on the basis of improved product performance. This requires a company to display skills of R&D and have a commitment to initiating technical change both in product and process design. However a willingness to initiate change is not a characteristic, described in the literature, of the mature company. The evidence in this thesis is also of a lack of willingness but not of ability to change.

The attempt of the mature company to pursue radical innovation in a new market is described in this thesis. Though it was unlikely that any new product would ever have reached the stage of adoption it must also be the case that any resulting benefit would have been shortlived. This is because the reluctance to commit resources, were it to continue, would have left the new product with little chance of remaining competitive in a new market committed to change. For example, to have any change of success in the new markets requires the mature company to divert resources away from the established business interests, and a commitment to the adoption of new skills and practices, all for a market whose value is unquantifiable. It requires a confidence to compete in the market where product performance and R&D are fundamental, and any established skills in manufacturing and distribution are likely to be of little benefit. In contrast, following the introduction of evolutionary innovation there is a requirement to compete on product price, and so skills are required in optimising the manufacturing and distribution aspects. The account of evolutionary innovation given in this thesis describes the situation where the innovation was intended to capitalise on established skills in both these areas. There is evidence that the introduction of comparatively modest innovation in the mature market could have generated considerable revenue and profit. The rate of change in the mature market is much slower than that associated with the new market and so it is less critical to maintain an on-going commitment to innovate. This will benefit the mature company which is shown to find on-going commitment difficult to maintain.

In summary, any desire of the medium size mature company to pursue innovation in the young market would seem misplaced. The mature company lacks the skills appropriate to the pursuit of such innovation, equally it lacks the skills which would enable it to compete in the marketplace following the commercialisation of the innovation. Instead the strengths of the mature company favour competition in the established markets, and its internal characteristics favours the pursuit of evolutionary innovation over the more radical innovation.

### *7.2.2 The Direction And Scale Of Effort*

There is accrued benefit if management can adopt an on-going commitment to innovation. The complexity of innovation is such that in its pursuit, mistakes, and failures, are inevitable. There are a number of reasons to account for this failure and a significant factor is the quality of management. In part, this aspect is determined by the psychological make-up of the individual. Innovation favours lateral thinkers. Tests are available that measure the ability of individuals to display lateral thinking and there must be some argument for the selection of management based on their performance at such tests. Given the selection and installation of suitable management, a working knowledge of the innovation process can then be provided through reference to the body of literature. Ultimately, however, management will only acquire confidence in the ability to innovate through practice - through making mistakes and learning the lessons. It is important, therefore, that the mature company does not wait until beset by some 'precipitating crisis' before pursuing innovation; for it is likely to have left it too late. The experience of Geest illustrates this fact. By the start of the low cost intelligent truck project, in October 1982, Geest no longer had the time remaining in which to make mistakes, learn from them, and optimise its efforts to innovate. Had this project been started ten years earlier when Geest was in profit, and thus financially able to tolerate the resulting failure, and learn from such failure, then the company might still be in business. With perseverance Geest could have acquired the ability to innovate successfully and this would have staved off its subsequent decline and closure.

This experience warns of the danger of the view that innovation can be conceptualised as a one-off activity, or, as a 'moment in time'. This is not so. It requires commitment over a period of time sufficient for management to be able to acrue experience from its mistakes. This learning can be costly, however, it is the investment on whose fruits the future of the mature company will depend. The time to promote innovation and awareness of innovation is when the company is doing well not when it is in decline and there is insufficient margin for error. The single greatest mistake with the innovation pursued by Geest was that it came several years too late.

The dominant use of short-term controls in the mature company is to the detriment of the pursuit of innovation. A commitment by management to such controls, to the exclusion of others, is flawed and it will cause serious damage to the outcome. If management want the business to survive long term, they must understand that managing change is their prime long term responsibility. They must understand and overcome the inertia of the bureaucracy; they must understand the nature of innovation. Innovation cannot be managed using short-term controls - it cannot be managed as if it were an integral part of the immediate concerns of the business. Both activities have fundamentally different objectives, and measures of efficiency. Separation is fundamental in order to perform both activities within the one company and in a manner which will provide for an optimal outcome for the company as a whole. However, the medium size mature company is restricted in its ability to provide separation because of its size. This is particularly the case with respect to the conditions appropriate to the pursuit of more radical innovation. It is unlikely, for example, that the medium size company will be able to divert sufficient resources to support the operation of autonomous business units or free standing management teams, or any other such options associated with the pursuit of the more radical innovations. An alternative course of action for the medium size mature company is to pursue innovation of a type which requires a lesser degree of separation from the immediate business interests and thus more easily matches the existing structure and ideology of the company.

In any event, whatever the type of innovation sought after, it is essential that the current practice to manage innovation through the application of short-term controls must be stopped. In its place should be the type of controls more in tune with the long-term aims of innovation. That is, for example:

1) The allocation of a nominal project budget. Project funding should be reviewed periodically and modified in the light of the actual expenditure incurred. This will go some way to satisfying the characteristics of the mature company for detailed control of activities. It is a means of monitoring the activity without on-going bureaucratic interference. Thus it will satisfy those members within the company committed to maintaining some measure of control; it will provide a means of monitoring, and yet provide a degree of financial autonomy for the innovator.

2) Management feel the need to be in control therefore the idea of separation as expressed in this thesis may not be attractive. Nevertheless, separation, the degree depending on the innovation, is a pre-requisite for success. It is necessary, initially, for management to consciously relinquish control in the limited sense that they must grant the innovator, at the invention stage, an agreed period during which the latter's full attention is devoted to the innovation. Thereafter management must analyse the new post-invention problems and decide whether to proceed and if so to choose the level of integration possible in the subsequent stages of the innovation process. It may well be that this kind of intermittent control rather than the traditional style is the most suitable for innovation of the evolutionary kind.

3) The greatest failure is when management unsuccessfully manages innovation; yet management must accept failure, accept mistakes by

innovators in their pursuit of innovation; that is the nature of the process. The criteria used to judge short term routine business activities cannot be used to judge innovation. The skills necessary for innovation can be learned but management must allow sufficient time for these skills to be fine-tuned. A different clock is needed at least until the commercialisation stage is reached and integration can begin.

### *7.2.3 A Commitment To Change*

This thesis has examined the management of innovation by a mature manufacturing company. Evidence is provided to support the argument that the mature company has difficulty with innovation. Explanation is associated with the company evolving into maturity and the adoption of bureaucratic management practices.

In this examination of the pursuit of innovation two debilitating symptoms are displayed by the mature company. Two symptoms which are not too dissimilar to senility:

1) Lack of commitment - witnessed in the decline of support for innovation and in the adoption of bureaucratic management practices.

2) Lack of coherency - witnessed in the desire to prematurely change the focus of innovation and the desire to change the associated organisational structure.

There is evidence to suggest that the onset of this behaviour may be directly related to the adoption of bureaucratic management practices. It is detrimental, and may be inevitable, however, there is no reason why its appearance should be fatal. The mature company may be a reluctant innovator, nevertheless, if there is appreciation for the need for innovation and a willingness to commit adequate resources then there is every possibility that innovation can be successfully managed and managed for success.

The evidence of this examination of innovation by the mature company indicates that the direction of effort to innovate must be coherent and it must focus either on the mature market or on the type of market where its bureaucratic practices in manufacturing and distribution can be fully exploited. There are two reasons for this. Firstly, the mature market is associated with evolutionary innovation. This type of innovation has less risk and uncertainty attached than has the more radical type, and thus is better suited to implementation in the mature company which has evolved to become intolerant of risk and uncertainty. Secondly, the mature market is established and thus its needs and customers are well defined, and it is possible to capitalise on innovation in such a market by using skills in manufacturing and distribution. In this respect the mature company's bureaucratic commitment to optimising these two activities is wholly compatible with the conditions of competition in the mature market. To be successful this focus of effort must be maintained over a period sufficient to enable new products to be developed and adopted. The desire for bureaucratic control in the mature company is on-going and so likewise there is need for management to display on-going commitment to innovate.

RECOMMENDATIONS

### *7.3.0 Principal Findings*

The principal findings of this thesis are presented as a set of guidelines. This presents practical advice derived from the experience of activities which took place within a mature manufacturing company. The adoption of this will reduce the risks of failure reported in this thesis, and assist the medium size mature company to utilise its strengths in the pursuit of successful innovation. The following guidelines are presented to aid the medium size company in the pursuit of innovation:

1) Management must display a continuity of commitment to innovate of a magnitude equivalent to its commitment to optimise existing business interests. Any failure to provide such a commitment will be to the detriment of innovation and ultimately will result in business failure. The symptoms of neglect will be those of bureaucratic interference eg, the unqualified application of financial control and the diverting of effort to the more immediate business interests.

2) Management must display coherency in their effort to innovate. The basis of any innovation ought to be the accumulation of data concerning aspects of marketing and technical design. This information can only be acquired if sufficient time is allowed for its collection and analysis. Thus there is the requirement to maintain over a period of time a coherency of effort as regards the particular innovations sought. Any attempt to restructure the organisation of innovation or to refocus effort will be detrimental to the coherency of the innovative effort and, in this respect,

should be resisted.

3) Management in the mature company must recognise that the conditions of competition in any market change as the industry serving that market evolves. This change is from performance competition to price competition. This is important because following the launch of an innovation the opportunitly to exploit it in the market will depend on the ability of the company to provide the skills appropriate to the conditions of competition it encounters. In this respect the mature company has skills of administration, manufacture, and distribution, and is well suited to capitalise on the conditions of competition within the mature market. However, its commitment to these skills make it ill-suited to compete for the new markets.

4) Any desire to pursue radical innovation by the mature company must be resisted. It is innovation of a form not compatible with the internal characteristics of the company. Its pursuit will create two problem areas. Firstly, the company will find the installation of a suitable organisational and managerial structure increasingly difficult to maintain over a period of time. Secondly, the company will find it requires new skills to compete in the new markets and that its existing skills are likely to be, at best, redundant and more probably obstructive.

5) It is to leave it dangerously late to seek the benefits of innovation when the company is in crisis. For one thing, management's preconception of the availability of innovation is likely to be all wrong. Management are almost certain to be preoccupied with the management of the short-term situation

vis-a-vis the crisis. The attempt to innovate is likely to be mismanaged. The time to pursue innovation is when the company is in profit and thus has the financial margin to make mistakes and bear the costs. In the pursuit of innovation management must leave sufficient time for the acquisition, and application, of the appropriate skills.

6) In the pursuit of innovation management must overcome their preoccupation with short timescales. The rigid application of such timescale is fundamental to the optimising of the immediate business interests, however, it is counterproductive when applied to the pursuit of innovation. Since to innovate is management's most important long term objective it is required to take a long-term perspective. Compromise has to be struck between the overwhelming desire of bureaucratic management to pursue a strategy based on short term results and the need of the innovator for long term commitment. The suggestion is that at the very least, financial, and organisational and managerial, separation be achieved. This could be through the adoption of the following procedures:

a) The provision of a nominal budget for the innovator, to be reviewed periodically and adjusted in the light of incurred expenditure.

b) To agree beforehand a fixed period where the innovator is not answerable to management and has only one responsibility - to the innovation.

7) Product line extensions are a form of innovation which will enable the mature company to capitalise on its established strengths of administration, manufacturing, and distribution. Changing patterns of consumer demand and new technological options in the product and

the production process make the exploitation of served markets an on-going situation. A particularly powerful marketing technique to assist in such exploitation is that of market segmentation and targeting.

8) Management must maintain a search for product line additions - new or established products of a type which can be successfully integrated into a company committed to the application of its skills of manufacture and distribution. This search for additional products is important because served markets will inevitebly fall into decline. Essentially the mature company should look for the type of product whose design is unlikely to see much change in the near future and whose market is familiar and large.

9) Management must be made to recognise the importance of conducting marketing research as a pre-cursor to innovation. In order that the mature company be able to exploit an innovation it has to be established, firstly, that the market is substantial and likely to remain so, secondly, that the product is a better-fit with the market needs than any commercially available option, and thirdly, the practicality of making sufficient impact on the market, following the launch of the innovation.

10) There is a need for account to be taken of the dissimilarity between the stages in the innovation process. To this end, the adoption of a simple model comprising three distinct and sequential stages of, invention, development, and adoption/diffusion has merit. Such a model is not unduly complex and it is applicable to all innovations.

### 7.3.1 *In Conclusion*

Writing this thesis has presented a unique opportunity to report, analyze, and review the management of product innovation by a mature company. It has also provided the opportunity to compare the experience with the academic literature to allow analysis of the effectiveness with which this innovation was pursued. As a result the conclusions of this thesis have industrial, as well as academic, foundations. The conclusions for the mature company are important enough to warrant further investigation, firstly, to determine the extent of the commitment to innovation within the mature business sector, and secondly, to contrast the financial performances of companies committed to minor innovation with similar types of companies committed to a more radical innovation. The finding that much of the energy and resources devoted to glamorous 'high-tec' radical innovation is likely to be far more profitably employed in incremental innovation is of national significance.

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# *APPENDICES*

LIST OF APPENDICES

U Changes To Geest Hierarchy On November 1983.

V Special Project Co-ordinator Industrial Remit, February 1984.

W Minutes Of Project Team Meeting, 17 January 1983.

X Minutes Of Project Team Meeting, 4 March 1983.

# APPENDIX A

## BACKGROUND DETAIL ON GEEST INDUSTRIAL GROUP

## BACKGROUND DETAIL ON GEEST INDUSTRIAL GROUP

*The Geest Organisation*

Geest Industrial Group were industrial participants in this research from October 1982 until their closure in July 1984. This was a medium size company[1] and a wholly owned subsiduary of Geest Holdings Ltd. The shares of Geest companies are ultimately controlled by Geest Holdings Ltd., an unquoted company owned and managed by the van Geest family, and which, in 1982, was the 238th. largest company, by turnover, in Britain.[2]

The 1983 edition of the Geest annual report to employees[3] shows Geest Holdings managing the three companies. See figure A.1:

Geest Industries Ltd.
Geest Computer Services Ltd.
Geest Industrial Group Ltd.

Figure A.1 is a simplification. In fact Geest Industries Ltd. acted as an umbrella company and contained the the entire produce business interests of Geest. As such it actually represents the collective operation of a number of limited companies. The most likely reason for this adopted diagrammatic arrangement is that it does clearly depict the three distinct business areas of Geest.

The principal activities of the above three limited companies and Geest Holdings, as described in their respective company accounts, are given as follows:

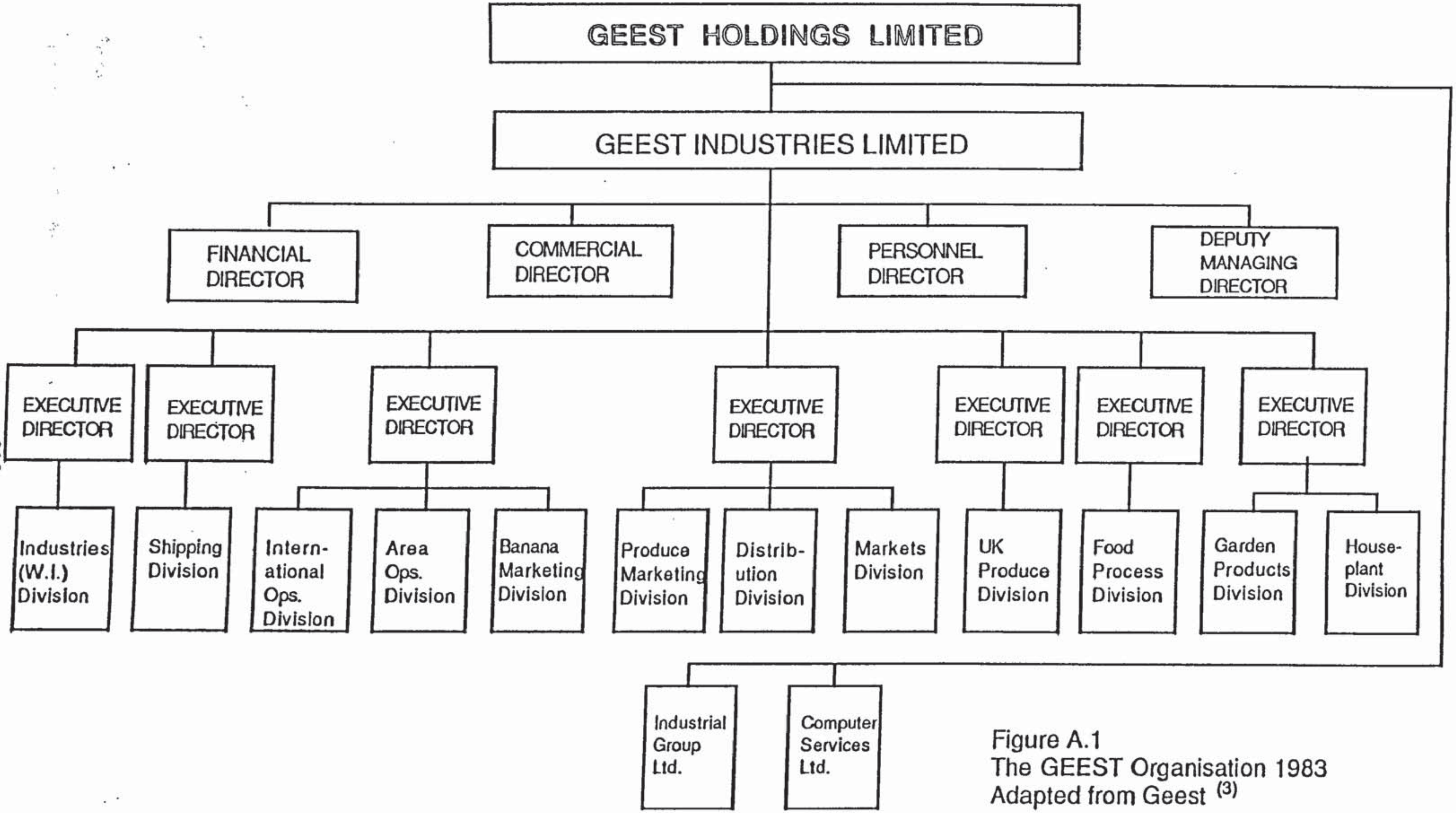


Figure A.1
The GEEST Organisation 1983
Adapted from Geest [3]

Geest Holdings (1972): The management of companies principally engaged in the shipping, importing, growing, processing, distribution and marketing of produce.

Geest Industries (1935): Engaged in the shipping, importing, growing, processing, distribution and marketing of produce.

Geest Computer Services (1976): The supply of bureau services and the sale of computer hardware and software products.

Geest Industrial Group (1936): The manufacture of industrial handling equipment, agricultural machinery and trailers.

For these four limited companies the 1982/1983 values for turnover and pre-tax profit level are given in: table A.1.[4,5,6,7]

TABLE A.1: TURNOVER AND PRE-TAX PROFIT LEVELS OF GEEST.

| | TURNOVER | | PROFIT(LOSS) | |
|---|---|---|---|---|
| | 1983 | 1982 | 1983 | 1982 |
| | £,000 | £,000 | £,000 | £,000 |
| Geest Holdings | 317 066 | 290 747 | 3 048 | 2 278 |
| Geest Industries | 171 021 | 132 256 | 1 989 | 2 388 |
| Computer Services | 6 276 | 1 149 | (332) | 36 |
| Industrial Group | 3 214 | 4 314 | (505) | (466) |

The operation of Industrial Group is seen to be a financial liability to the parent company. In addition its business interests lie outside those associated with the main Geest operation. Events leading up to the closure of Industrial Group suggest that both factors contributed to this outcome. The evidence for this is provided later.

*Geest Industrial Group*

The writer was employed by Geest Industrial Group under the SERC industrial studentship scheme from October 1982 to July 1984.

Industrial Group comprised two sales divisions and a limited company. In 1982 Industrial Group operated from three geographically distinct locations. This arrangement is shown in figure A.2. In May 1983, in response to its deteriorating financial situation the company activities were consolidated onto one eight acre site at Boston, Lincolnshire.

The business interests of Industrial Group are best described in terms of the activities of these divisions and of the company which it controls. Considered as such Industrial Group's interests were:

Geest Material Handling Division: The manufacture, distribution and sale of light material handling equipment.
The operation of 'Post Store', a mail order service for material handling and general office equipment.

F.W. Pettit Division: The manufacture and factoring, distribution and sale of agricultural machinery.

Geest Overseas Mechanisation Ltd: An export agency for Geest Industrial Group products and others, many of its orders funded by international aid agencies.

*Company Closure*

From 1978 Industrial Group had returned annual losses on a £4-5M turnover, figure A.3., and in July 1984 the company closed with the loss of some 150 jobs. In the period leading up to the closure there is

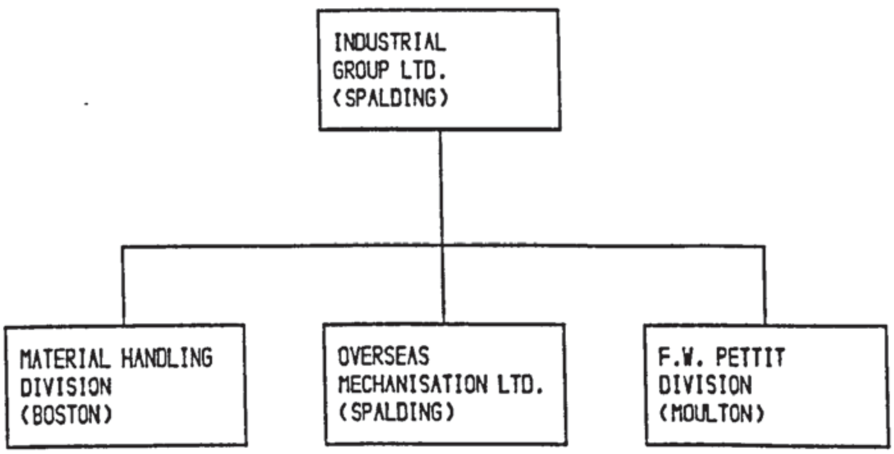


FIGURE A.2

STRUCTURE OF GEEST INDUSTRIAL GROUP LIMITED

Aston University

Illustration removed for copyright restrictions

Source: Company accounts.

evidence of a change in the attitudes of the parent company - Geest Holdings Ltd. With hindsight, it is seen that the latter was pursuing a policy of retrenchment. Evidence is found of parent company support for the continued operation of Industrial Group. In 1978 the Board of Geest Holdings had directed that:

> "for the foreseeable future, the Geest Organisation will maintain four areas of business activity:
>
> - the integrated marketing of fresh and processed fruit and vegetable products
> - the integrated marketing of horticultural and garden products
> - the manufacture and marketing of cultivation, transportation and materials handling equipment for the agricultural and distributive industries
> - the supply to the organisation and external customers of information and processing services and equipment."(8)

The third item in the above list is a specific reference to the activities of Industrial Group and as such parent company support must be assumed. However, the 1982 chairman's report on the performance of Geest Holdings contains this comment regarding future business prospects:

> "In spite of the problems we are continuing to experience with our light engineering interests and our computer services interests, I view 1982 with guarded optimism."(9)

Nevertheless, the Holding company was sufficiently concerned with 'the problems' that it sought to redefine its business objectives. The 1983 edition of the Geest Organisation annual report to employees included the following list of priorities:-

" - to make our new Geest Industries organisation successful in providing steady growth in our mainstream activities, fresh product, food processing and horticulture.

- to monitor closely the movement of cash in and out of the business.

- to examine thoroughly every operating unit, particularly inefficient areas, areas that regularly lose money and areas with old and/or outdated facilities."[10]

This redefinition of objectives was significant for Industrial Group. The 1983 listed objectives did not carry the explicit support featured in the 1978 list. It does however make reference to loss making operations and being one such operation Industrial Group could expect its activities to be 'thoroughly' examined by the parent company. A change of policy by the parent company was further suggested in a newspaper article discussing the development of the Geest Organisation. On the 8th February 1984 the management page of the Financial Times carries an review of the Geest Organisation whose introduction reads as follows:

> "Geest Holdings, Britain's largest fruit and vegetable importer and distributor, is getting back to basics. After several decades of steady expansion and diversification into activities such as light engineering and computers it has decided to concentrate on its core business of food distribution."[11]

Notes:
Geest Holdings divested of its light engineering business in 1984.
Geest Holdings divested of its computer business in 1985.

This retrenchment policy of the parent company was accompanied by the following events at Industrial Group. Firstly, the 1983 year end accounts showed the company to be still in financial difficulty, and that although all production facilities were consolidated into the Boston factory early in the period, losses from the manufacturing activity had continued to escalate.[12] Secondly, in February 1984, the announcement by the Industrial Group general manager at a monthly management meeting, that Geest Holdings was no longer willing to tolerate the continued loss making condition of Geest Industrial Group. Finally, in May 1984, the appointment by Industrial Group directors of a management consultancy firm (Cooper & Lybrand) with a remit to assess the present company operation and make recommendations as to its future development.

By 11th June 1984 the management consultants had completed their assessment and were in a position to present their findings to the Industrial Group company directors. Its conclusion, as subsequently reported by the parent company, was:

> "...that there was little prospect of Geest Industrial Group Limited being returned to profitability without a major injection of capital and resources..."[13]

On 11th July Industrial Group's general manager announced the immediate closure of the company. This announcement began by making reference to the findings of the above study:

> "The study confirms the underlying potential of the business, given substantial long term additional investment in expansion of the product range and upgrading of the manufacturing capabilities.
>
> But, the scale of that investment and the associated business risk, together with the pressing need to concentrate available resources on the mainstream produce and horticultural interests of Geest Holdings Limited has led the board to conclude that it must divest itself of the manufacturing and marketing in the United Kingdom of material handling equipment and agricultural machinery."[14]

From the above, the closure of Industrial Group can be attributed to two factors, firstly, Industrial Group was in considerable financial difficulty, and secondly, its business interests lay outside those associated with the main Geest operation.

The indications are that Geest Holdings formed the decision to divest of its non-produce business interests sometime in the period 1978-1983. This may have been taken in response to the mounting losses resulting from such business. In the event the parent company's divestment of Industrial Group had also led to its closure.

However both the divestment decision and the closure decision should not be considered as events outside the control of Industrial group. Both events, and in particular the decision to close, were taken while the company was incurring considerable losses. Had it been a more successful company a quite different outcome may have been reported. For example, in divesting of its computer interests, in January 1985, Geest Holdings Ltd. were able to sell parts of this business as going concerns.

In this sense, irrespective of the presence or action of the parent company, Industrial Group's failure must be considered to be, to a large extent, of its own making.

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*REFERENCES*

*BACKGROUND DETAIL ON GEEST INDUSTRIAL GROUP* *APPENDIX A*


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## APPENDIX B

## INDUSTRIAL REMIT - LOW COST INTELLIGENT TRUCK

OCTOBER 1982

Geest

Project Outline

## Development of small intelligent powered trucks

Geest Industrial Group produce a range of products aimed at the distribution market. Their products range from sack trucks to powered pallets.

Many of these products go into warehousing and manufacturing where a "pick and put" operation takes place. In larger installations there is now a movement towards sophisticated robotic type vehicles to carry out these tasks. These can often be very successful, but the smaller manufacturer or warehouse cannot justify or afford the expense and relative inflexibility.

The project described here would be based on a development of Geest's small and relatively simple powered truck. It is proposed that a suitable black box control be fitted, which would enable the vehicle to be sent by an operative to some other part of a completely automatic operation under central computer control. Rather this would be the half way house between the computer control, wire guided truck and a man pushing a pallet from location A to location B.

The market potential is seen to be very good provided the price and mode of operation can be got right. Ideally the vehicle would not be wire guided, but would be capable of learning the route or routes required. Loading at each end would probably be by hand and selection of the next destination would be by the operative.

The project is hence to develop a suitable control system for a small powered truck, that will enable the vehicle to move from one location to another under its own power and guidance system. This would be without the need for wire or similar guides or central computer control. This development would take place in the context of useage in small manufacturing or warehousing units.

## APPENDIX C

## TURNOVER AND PRE-TAX PROFITS FOR GEEST AND UK SUPPLIERS OF AGV SYSTEMS

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*APPENDIX D*

*DETAILS OF VISITED FACTORY/WAREHOUSE COMPLEXES*

<u>DETAILS OF VISITED FACTORY/WAREHOUSE COMPLEXES</u>

WOOLWORTH DISTRIBUTION CENTRE
ROCHDALE

1 200 STAFF (50 CLERICAL).

2 10 YEAR OLD BUILDING.

3 MATERIAL HANDLING SYSTEM COPIED FROM SWINDON (1966).

4 WOOLWORTH ORGANISATION LAYOUT-2 DISTRIBUTION CENTRES.
4 TRANCENTRES.

5 DISTRIBUTION CENTRES USE A LOW-TOW SYSTEM FOR THE TRANSPORTATION OF GOODS - TRUCKS PULLED ALONG BY A CHAIN CONTAINED IN A FLOOR TRENCH.

6 TRANCENTRES WITH HIGH VOLUME SORTING REQUIREMENTS MAKE EXTENSIVE USE OF CONVEYORS.

7 NO MODIFICATIONS PLANNED AT ROCHDALE - STAFF ARE SATISFIED WITH PRESENT SYSTEM.

8 IN WAREHOUSE THE TRUCKS ARE DISCONNECTED FROM CHAIN, LOADED AND RECONNECTED. TRUCKS ARE NOT LEFT IDLE IN WAREHOUSE AREA.

9 FORK LIFT TRUCKS USED FOR VERTICAL MOVEMENT OF GOODS.

10 GROUND LEVEL OF WAREHOUSE USED FOR ORDER PICKING ONLY (12 000 SEPARATE ITEMS).

11 HIGHER LEVELS USED FOR GOODS STORAGE.

12 WAREHOUSE ANNUAL INTAKE 18 000 PALLETS AND 2 000 000 LOOSE ITEMS.

13 WAREHOUSE DISPATCHES APPROXIMATELY 10 000 ITEMS DAILY IN 500 PALLET LOADS.

14 GOODS TURNOVER £70M./ANNUM.

KAY'S MAIL ORDER
WORCESTER

DISTRIBUTION DEPOT

1 EXTENSIVE USE OF CONVEYORS THROUGHOUT WAREHOUSE.

2 CONSIDER CONVEYOR SYSTEMS QUICKER FOR LOADING/OFF-LOADING TRUCKS, NINE BELT CONVEYORS IN USE EACH APPROXIMATELY 30m IN LENGTH.

3 OVERHEAD CONVEYOR SYSTEM (TOTE BOX) TRAVELS ALL FOUR LEVELS OF THE WAREHOUSE TO COLLECT ORDERS FOR PACKING.

4 DAILY TURNOVER 80 000 ITEMS OR 40 000 PARCELS.

5 PRESENT ARRANGEMENT LABOUR INTENSIVE, INTEND TO INTRODUCE BAR CODE RECORDERS AT GOODS ENTRY AND SO LEAD TO COMPUTERISATION OF GOODS STORAGE.

6 PROPOSE TO INCREASE USEAGE OF CONVEYORS, TO OFF-LOAD FROM INCOMING TRUCKS AND FEED DIRECTLY TO STORAGE AREAS.

7 CONSIDERABLE USE OF THE FORK LIFT TRUCK - THIS WILL REMAIN.

8 RACKING USED FOR HIGH LEVEL STORAGE.

9 STOCK HOLDING £30M.

10 TOTAL DAILY MOVEMENT OF GOODS VALUED AT £800 000.

GEEST SPALDING

DISTRIBUTION DEPOT

1 70 PERCENT TURNROUND OF GOODS DAILY.

2 ALL INTERNAL TRANSPORTATION IS BY FORK LIFT TRUCK, ONLY SIX LOCATIONS WHERE THE LIFTING OF GOODS IS REQUIRED.

3 FORK LIFT TRUCKS ARE USED FOR ALL HORIZONTAL CONVEYING OF GOODS.

4 EXAMINING POSSIBILITY OF PHASING OUT FORK LIFTS AND REPLACING WITH SCISSOR LIFTS AND HORIZONTAL TRANSPORTERS.

5 DISIMILAR CONTAINER SIZES DO NOT LEND THEMSELVES TO SECURE STACKING OR HANDLING. HENCE CONSTANT SUPERVISION A REQUIREMENT.

6 DISMISSED TRACKED AND WIRE GUIDED SYSTEMS AS TOO EXPENSIVE.

7 OPTICAL SYSTEM CONSIDERED A POSSIBILITY BUT DISMISSED ON THE FOLLOWING GROUNDS:

| | |
|---|---|
| SPACE | - POSSIBLE NAVIGATION PROBLEMS. |
| DELAYS | - REQUIREMENT TO PREVENT BOTTLENECKS WITH 70 PERCENT DAILY TURNAROUND. |
| PACKAGING | - THE TYPES OF GOODS BEING HANDLED PRESENT SPECIAL HANDLING PROBLEMS. |

8 OVERHEAD CRANE DISMISSED ON GROUNDS OF HEALTH AND SAFETY.

9 CONVEYOR UNLOADING OF TRUCKS CONSIDERED TOO SLOW AND LABOUR INTENSIVE, HENCE USE OF MANUAL SYSTEM WITH PALLETS.

10 WITH HIGH DAILY TURNAROUND OF GOODS, LOADING/OFF-LOADING TIME IS AN IMPORTANT CONSIDERATION.

CRABTREE
WALSALL

MANUFACTURER

1 TWO THOUSAND STAFF.

2 FIFTY PEOPLE EMPLOYED TO MOVE GOODS WITHIN FACTORY.

3 ALL MANUFACTURED GOODS EASILY PALLETISED.

4 USE ELEVEN FORK LIFT TRUCKS AND THREE SIDE TRUCKS.

5 FORK LIFT TRUCKS USED MAINLY WHERE HORIZONTAL AND VERTICAL MOVEMENT OF GOODS IS REQUIRED.

6 EIGHT SEPARATE STORAGE AREAS THROUGHOUT FACTORY AREA.

7 CONSIDERABLE DEGREE OF AUTOMATION IN THE PRODUCTION PROCESS.

8 PRESENT FACTORY LAYOUT DOES NOT LEND ITSELF TO THE INSTALLATION OF MODERN MATERIAL HANDLING TECHNIQUES.

9 FACTORY BUILT IN 1926.

10 FINANCIAL JUSTIFICATION REQUIRED ON ALL NEW EQUIPMENT.

11 FACTORY TURNOVER APPROXIMATELY £20M./ANNUM.

12 REGULAR SHAPED BOXES USED THROUGHOUT FACTORY TO ASSIST WITH THE TRANSPORTATION OF GOODS.

HALFORDS
REDDITCH

DISTRIBUTION DEPOT

1 STORAGE SPACE FOR 9 000 PALLETS.

2 TURNOVER 300 PALLETS PER DAY.

3 ANNUAL FINANCIAL TURNOVER £100M.

4 EXTENSIVE USE OF PALLET TRUCKS AND FORK LIFTS (ALL SIX FORK LIFT OPERATORS TO GO IN MODERNISATION)

5 BUILDING 10 YEAR OLD.

6 200 STAFF ON MATERIAL HANDLING OPERATIONS.

7 PROPOSAL TO SHED 80 STAFF AND INVEST £3.4M. IN MATERIAL HANDLING EQUIPMENT.

8 PROPOSED SYSTEM:
   (i) MANUAL PALLET TRUCKS TO OFF-LOAD GOODS FROM INCOMING TRUCKS.
   (ii) PLACE GOODS ON WIRE GUIDED AGV's.
   (iii) AGV's DELIVER TO (3 OFF) OVERHEAD COMPUTER CONTROLLED CRANES FOR STORAGE.

9 PROPOSED STORAGE AREA WILL BE UNMANNED, UNLIT, AND REQUIRE MINIMAL HEATING.

10 CONSIDERED A CONVEYOR SYSTEM TO BE TOO EXPENSIVE AND TO TAKE UP TOO MUCH ROOM.

11 BAR CODING TO BE USED FOR GOODS IDENTIFICATION.

12 PALLETS UNLOADED MANUALLY FROM DELIVERY VEHICLES, CONSIDERED CONVEYORS TO BE TOO EXPENSIVE.

13 EXAMINED (KOMATSU) FORK LIFT TRUCK BUT WERE NOT PREPARED TO INSTALL NEW AND UNPROVEN TECHNOLOGY.

14 FINANCIAL JUSTIFICATION REQUIRED FOR ALL EXPENDITURE ON MATERIAL HANDLING EQUIPMENT.

PEDIGREE PET FOODS MANUFACTURER
MELTON MOWBRAY

1 FACTORY USES STANDARD SIZE CANS THROUGHOUT.

2 THROUGHPUT OF 3MILLION CANS DAILY.

3 STAFF OF 2 000.

4 APPROXIMATELY 100 FORK LIFT TRUCKS IN USE THROUGHOUT, MAINLY FOR THE BULK MOVEMENT OF GOODS.

5 EXTENSIVE NETWORK OF CONVEYORS IN FACTORY.

6 WIRE GUIDED AGV's ARE TO BE INSTALLED IN GOODS RECIEVING BAY TO TRANSPORT DISSIMILAR MEATS TO MIXING AREA. TIME TO COMPLETION TWO YEARS.

7 ANNUAL TURNOVER OF FACTORY £280M.

8 POSSIBLE USE OF AGV SYSTEM TO TRANSPORT GOODS BETWEEN REMOTE BUILDINGS ON THE ONE SITE.

APPENDIX E

PROPOSALS ON THE INTELLIGENT TRUCK GUIDANCE ASPECT

JANUARY 1983

DETAILS OF GUIDANCE/NAVIGATION SYSTEMS

CONSIDERED FOR THE

GEEST

LOW COST INTELLIGENT TRUCK

D MENZIES

GUIDE PATHS

1. Install a narrow magnetic track in the floor.

   Through the use of high pressure injection techniques, impregnate the floor surface with a ferric compound. The track should take the form of a 50mm wide strip, impregnated to a depth of 5mm and run the entire length of required travel.

   The magnetic poles within the compound could then be aligned, or randomised, as necessary. Pole alignment could be used in two ways:-

   (i) to define direction of vehicle travel.
   (ii) to provide temporary or permanent bar type coded instructions.

   Technique dismissed:-

   (i) multidicipline technology.
   (ii) high maintainence costs.
   (iii) inflexibility.

2. Provide guide path on floor surface.

   Spray or coat vehicle routes with a plastic or other suitable compound containing ferric particles in suspension. Within the treated routes, produce, code and randomise guide paths as necessary.

   Technique dismissed:-

   (i) multidicipline technology.
   (ii) high maintainence costs.
   (iii) high installation costs.

3. Optical system following white line on floor.

   To improve contact optical path would comprise of a 50mm white strip contained within a 100mm black strip. Through the use of optical sensors a vehicle be programmed to maintain a position directly over the white strip irrespective of travelling velocity.

   The configuration could be achieved either through the use of paints or adhesive tapes.

   Bar code techniques could easily be employed, on the white/black track, provide the vehicle with on route information.

   Technique dismissed:-

   (i) maintainence costs.
   (ii) installation costs.
   (iii) inflexible.

ON BOARD MEASUREMENT

4. Odometry with two or four wheel drive.

   With onboard measurement of wheel rotation a vehicle should be able to; accurately, determine its position relative to a defined origin (starting point). So theoretically a route could be taught and reproduced as necessary.

   ...cont...

Vehicle wheel layout might be in diamond configuration, thus giving the vehicle the facility to turn on its axis.

The speed of all drive wheels would be monitored and controlled by a microprocessor/servo system. This system being used in order to prevent any uncontrolled wheel spin. Using this technique all drive wheels would be synchronised and rotated at predetermined speeds.

Since any drive wheel rotating without traction, at a predetermined speed, consumes only a fraction of its 'duty' power requirements, wheel slippage or loss of traction, could easily be detected, simply by monitoring all drive motor power requirements.

Technique dismissed:-

(i) cumulative errors.
(ii) only feasible for short and simple source/destination journeys.
(iii) start point required to be accurately defined.

5. As 4 but with defined origin and outstations.

Vehicle would have the ability to travel from station to station only through the origin. The origin could, therefore, act as a reference and so reduce navigation errors.

Portable origin could be used.

Technique dismissed:-

(i) continual requirement to pass through origin could be undesirable.
(ii) to operate this system the vehicle is required to be taken to a station, this could be inconvenient.
(iii) navigation errors could still cause problems when operating with distant stations.

6. As 5 but with bar code stickers or other passive beacons at frequent intervals. With this arrangement vehicle could continually update navigation information and so minimise errors.

Technique dismissed:-

(i) passive beacons at lowlevel subject to damage.
(ii) possible difficulties in identifying location of passive beacons.
(iii) beacon maintainence could be a problem especially with extensive systems.

7. As 4, but with vehicle as it travels along an aisle, looking sideways and counting the number of openings in racking system.

After initially being taught a route the vehicle would have the facility ot retrace route as required.

Technique dismissed:-

(i) requires permanent/fixed installations.
(ii) cumulative errors build-up.
(iii) no use in open spaces.
(iv) for exact route reproduction, the start point would have to be accurately defined.

...cont...

8. Vehicle velocity sensing using onboard laser or focussed microwave transmitter.

The vehicle would radiate forward and downward a single laser or microwave beam and by processing the reflections, using doppler techniques, the vehicle velocity would be found. The integration of velocity with respect to time would produce the required distance information.

Within limits the system could also be used to monitor vehicle turning.

The addition of wheel odometry (micro/servo) would provide useful error detection capabilities.

Technique dismissed:-

(i) possible requirement to define limits to vehicle speed (min) and turning radius (max).
(ii) complex signal processing caused by random vertical movement of vehicle.

9. Optical systems.

Technique dismissed:-

(i) too complex.
(ii) too expensive.

10. Laser/microwave range finding system.

The vehicle emits a signal in the direction of travel, and by comparing the phase of the reflected wave with that of the transmitted wave, is able to determine the distance from the reflecting surface.

When the vehicle is a prescribed distance from the reflecting surface it turns and correspondingly locks onto a new target. So all navigation is by distance only.

Technique dismissed:-

(i) health and safety problems.
(ii) requires fixed surroundings.
(iii) no control over orientation of vehicle.

## EXTERNAL BEACONS

11. Create standing wave patterns.

Establish radio or microwave standing wave patterns throughout area of vehicle operation. Initially the vehicle would have to be taught a route, thereafter the vehicle could reproduce the route as required, navigating only by means of the standing waves. Coding could be incorporated into standing wave pattern, thus allowing easy location identification.

Technique dismissed:-

(i) transmitter would require external services.
(ii) considerable reflection/interference problems.
(iii) excessive number of beacons required.

...cont...

12. Set up a string of beacons such that the vehicle effectively 'swings' from beacon to beacon.

A vehicle moves along a path continually interrogating the two closest beacons establishing:-

(i) beacon identification
(ii) relative distance information.

processing this data, the vehicle would be able to determine its position along a given route.

Technique dismissed:-

(i) no means of determining approach angle.
(ii) without any angular measurement vehicle turning presents problems.
(iii) excessive number of beacons required.

13. The vehicle electronics measure the phase difference between the received signals from several beacons and is thereby able to determine its exact position.

By comparing the phase difference between signals transmitted from two fixed beacons, the vehicle is only able to determine its position to within a given line. An exact, unique, point can only be identified if three beacons are used.

Technique dismissed:-

(i) triangulation required.
(ii) clusters of beacons required.
(iii) propagation difficulties in warehouses.

14. Use a simple beacon and complex vehicle, configuration.

The beacon would consist of a simple receiver/transmitter, with facility to respond when interrogated. Coding, for identification, could be included in beacon response.

To perform necessary distance and orientation calculations vehicle would require two onboard receivers. Direction of travel could also be established simply by the addition of odometry.

Technique dismissed:-

(i) problems occur when trying to evaluate approach angle if vehicle steers directly for the beacon.

15. To remove problems of 'approach angle definition', use a two transmitter system, with one transmitter one wavelength behind the other.

Measurement of phase difference between transmitters would provide information on vehicle approach angle, the propagnation delays providing information on distance.

Reflections could cause problems if microwave communications are used.

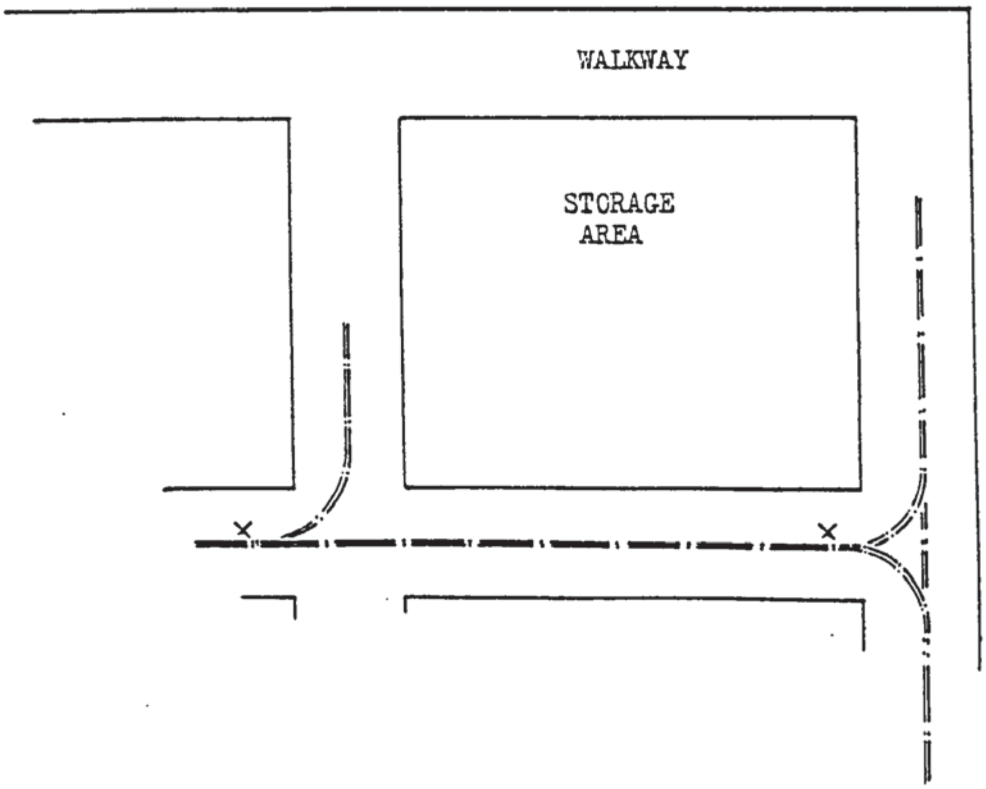
Technique dismissed:-

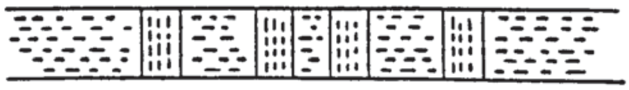
(i) vehicle location not unique.

16. As 15 except beacon turned through 90 . This allows vehicle location to be calculated without any ambiguity.

(1)

MAGNETIC GUIDE PATH
IN FLOOR



MAGNETIC PATH CONTAINING BAR-TYPE
CODED INFORMATION

NOTE: ON BOARD SIGNAL FILTERS REMOVE ANY 50$H_Z$ PICK UP.

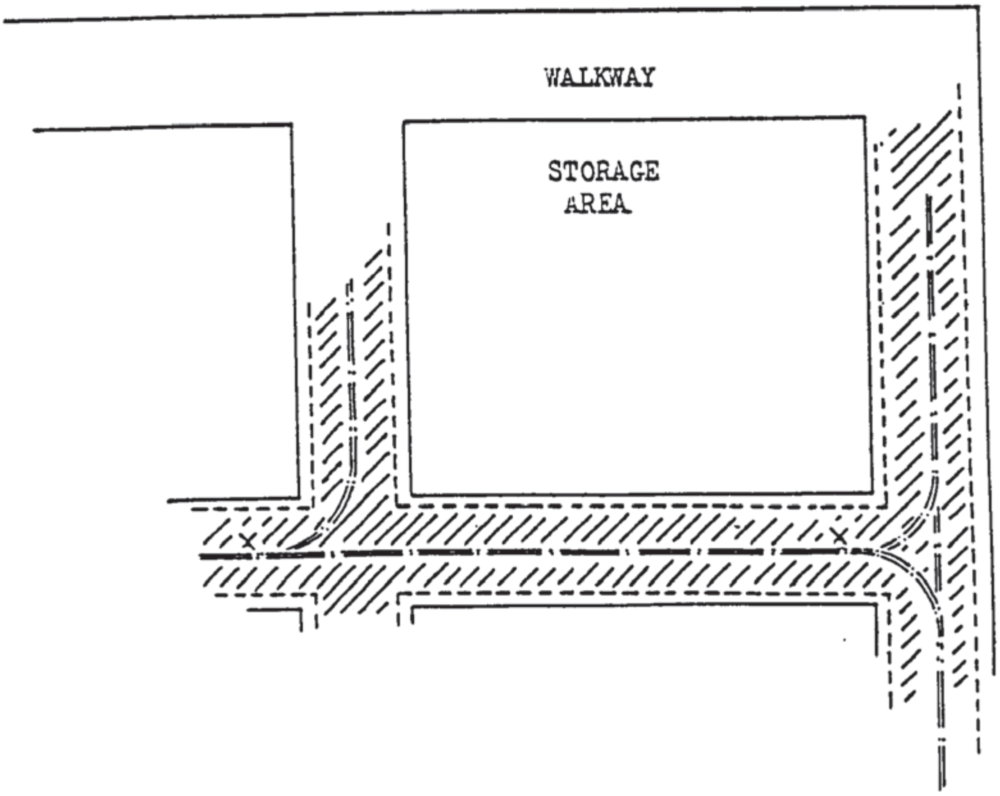
KEY:-

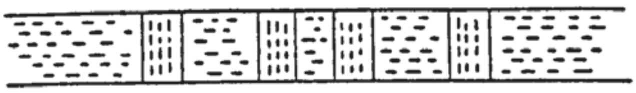
MAGNETIC PATH

X POSITION OF CODED INFORMATION

 MAGNETIC POLE ALIGNMENT

MAGNETIC GUIDE PATH
ON FLOOR SURFACE



MAGNETIC PATH CONTAINING BAR-TYPE
CODED INFORMATION

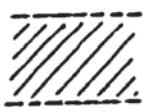
NOTE: ON BOARD SIGNAL FILTERS REMOVE ANY 50$H_Z$ PICK UP

KEY:-

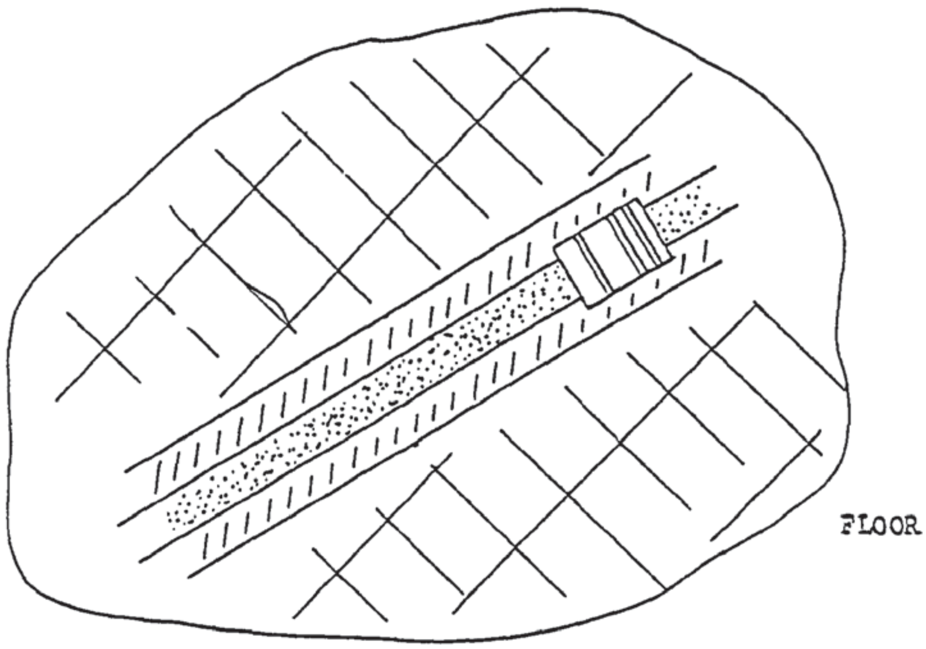
MAGNETIC PATH

× POSITION OF BAR CODED INFORMATION

 MAGNETIC POLE ALIGNMENT

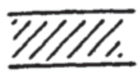
 FERRIC COMPOUND IN SUSPENSION

CHEMICAL GUIDE PATH
ON FLOOR SURFACE



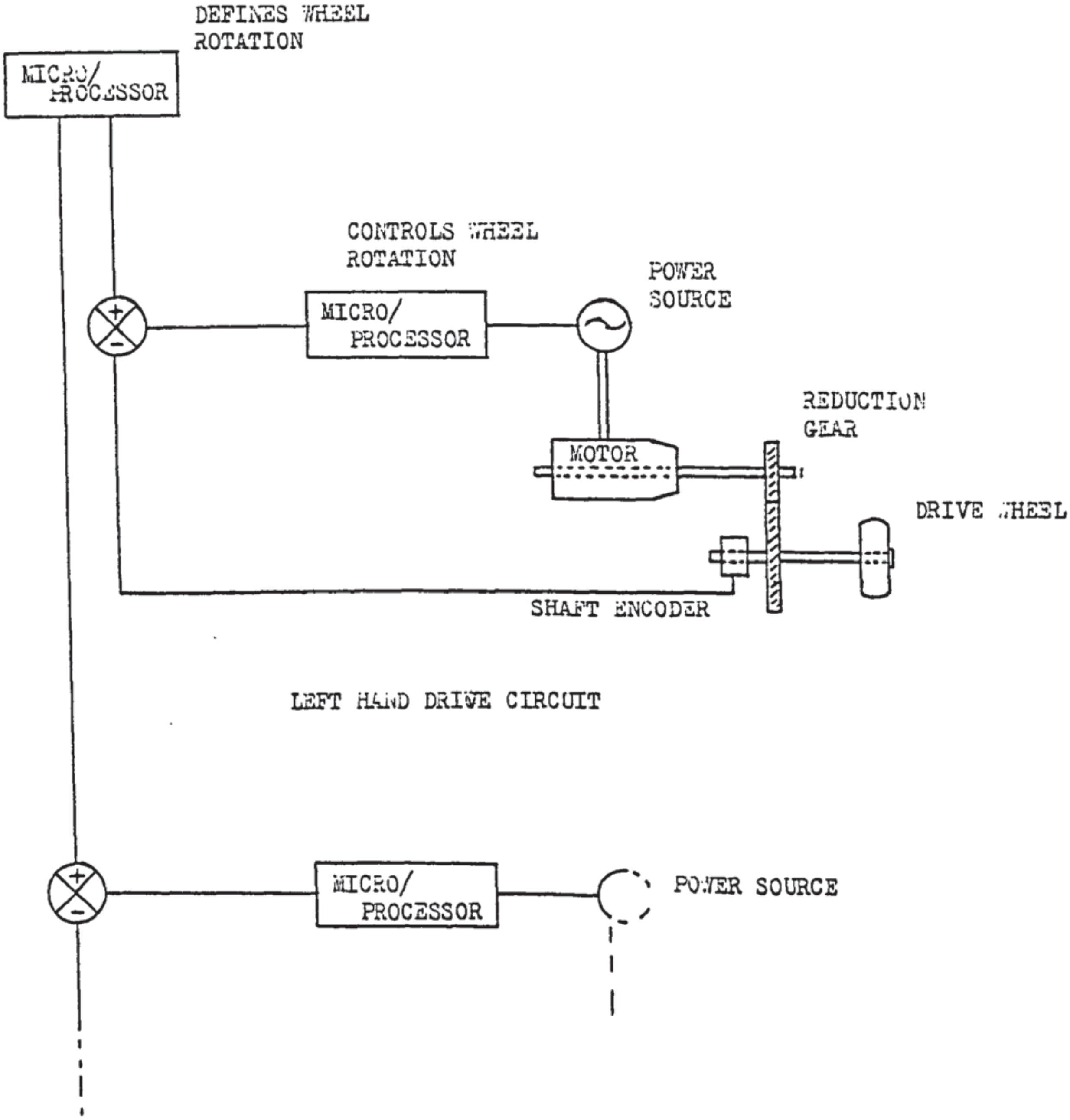

KEY:-

 WHITE STRIP

 BLACK STRIP

 BAR-TYPE CODED INSTRUCTIONS

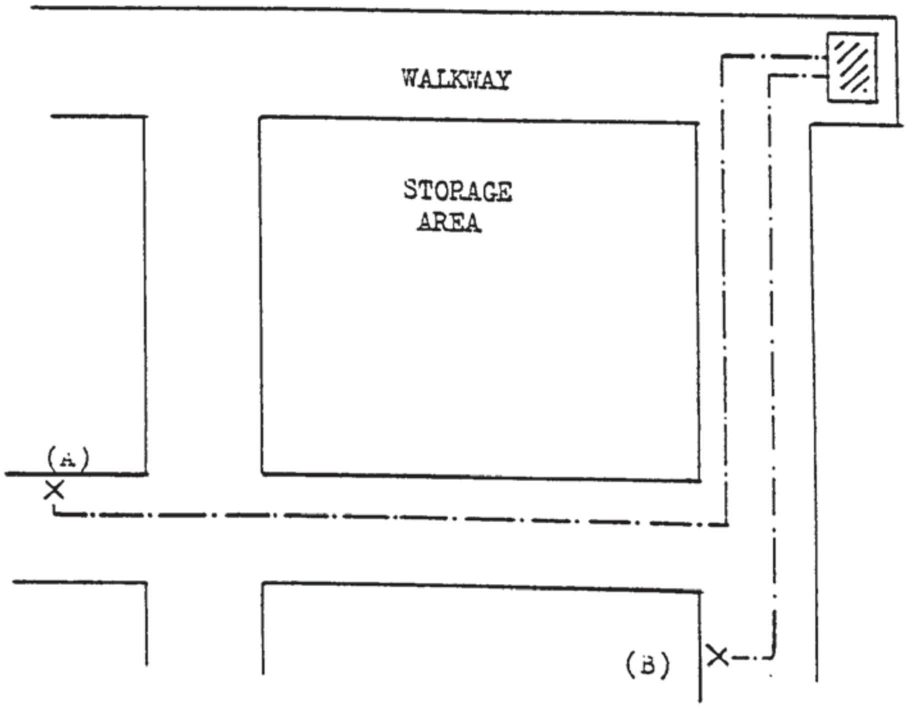
MICROPROCESSOR/SERVO CONTROL
OF DRIVE WHEELS




LEFT HAND DRIVE CIRCUIT

RIGHT HAND DRIVE CIRCUIT

## ODOMETRY WITH DEFINED ORIGIN AND OUTSTATIONS




| | |
|---|---|
| REQUIRED ROUTE | A-B |
| PROGRAMMED | A-O |
| | O-B |

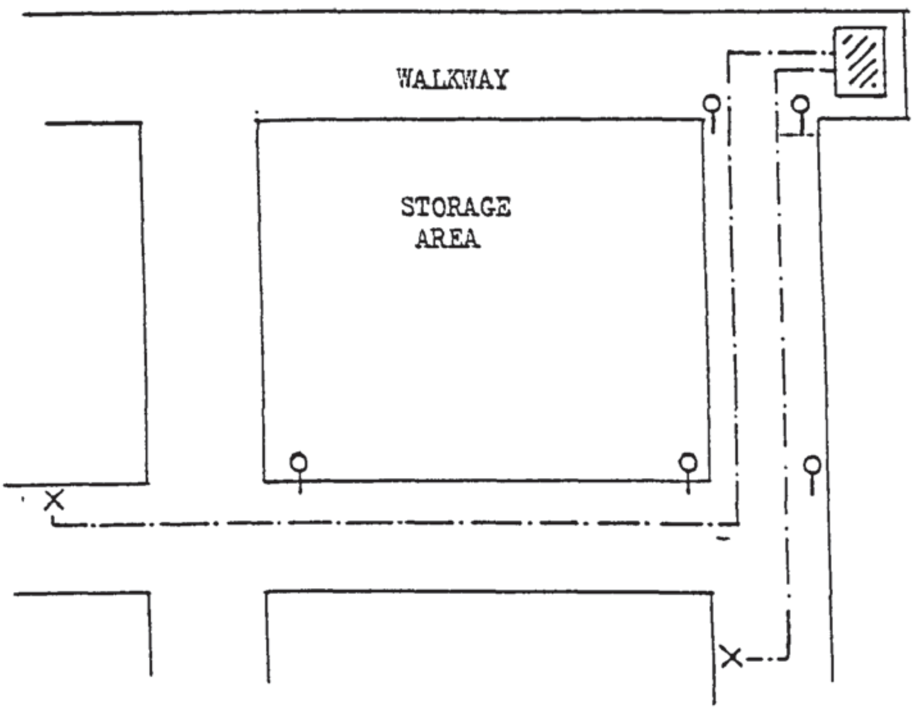
KEY:-

ORIGIN

OUTSTATION

PROGRAMMED ROUTE

## ODOMETRY WITH DEFINED ORIGIN, OUTSTATIONS AND PASSIVE BEACONS




REQUIRED ROUTE A-B
PROGRAMMED A-O
O-B

KEY:-

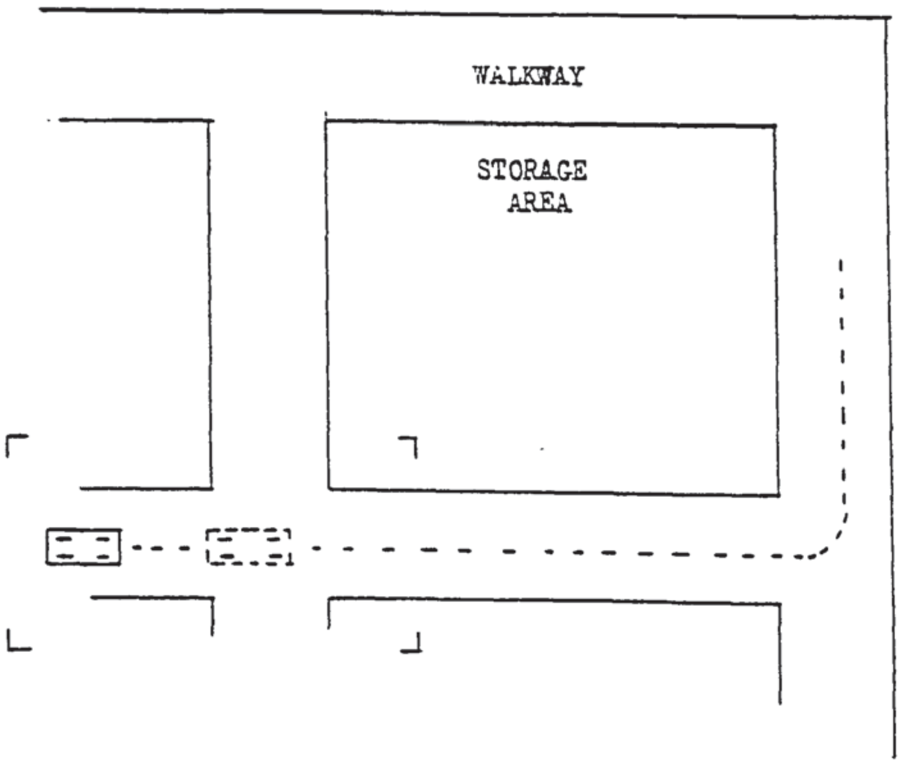
ORIGIN

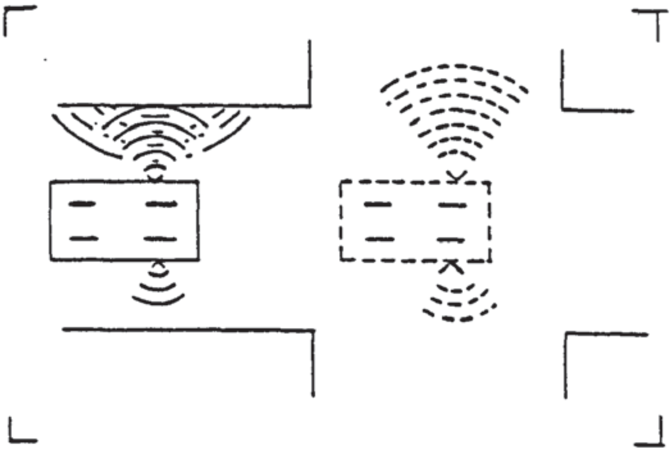
PASSIVE BEACON

OUTSTATION

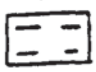
PROGRAMMED ROUTE

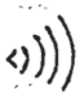
TRUCK WITH SIDE LOOKING
SENSORS



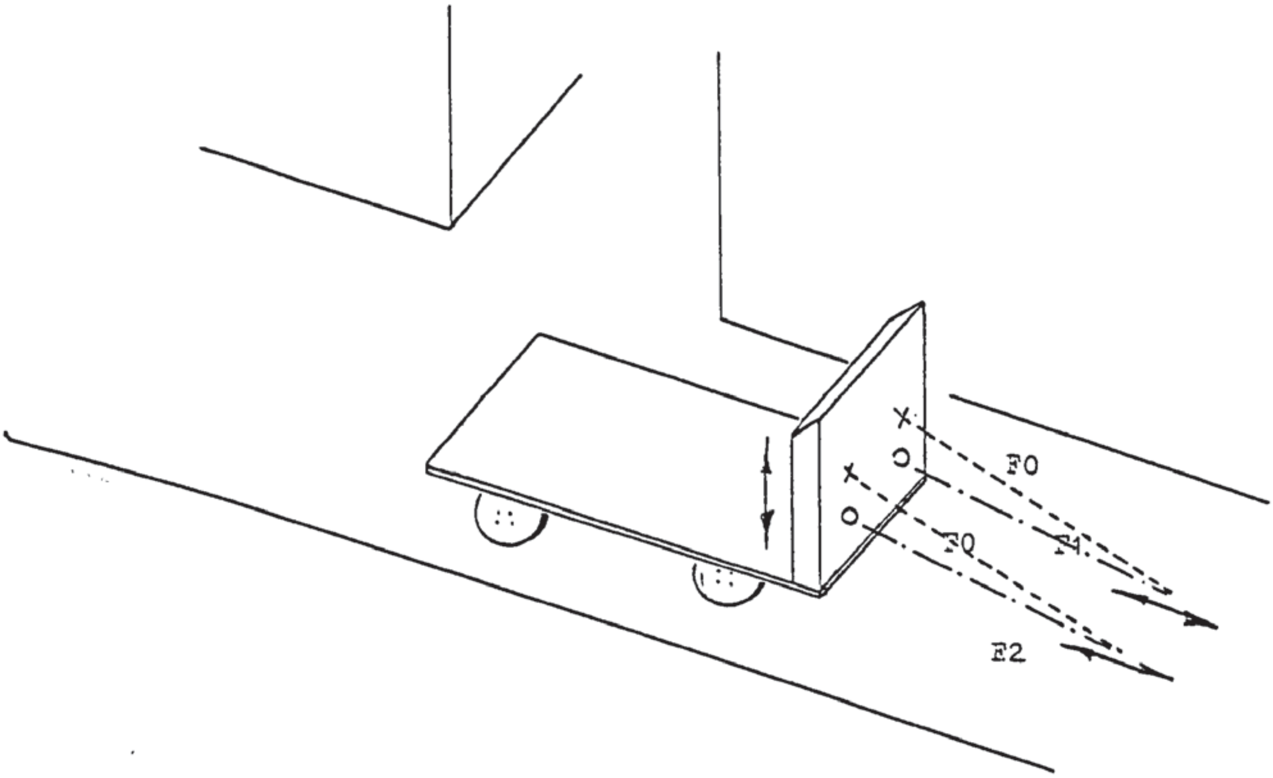



KEY:-

 TRUCK

 ACOUSTIC/ ELECTROMAGNETIC TRANSMISSION

VEHICLE VELOCITY SENSING




VEHICLE VELOCITY = FUNCTION (F0 - F1)+(F0 - F2)
DISTANCE = $\int_0^t V\,dt$
TURNING MOTION = FUNCTION (F1 - F2)

KEY:-

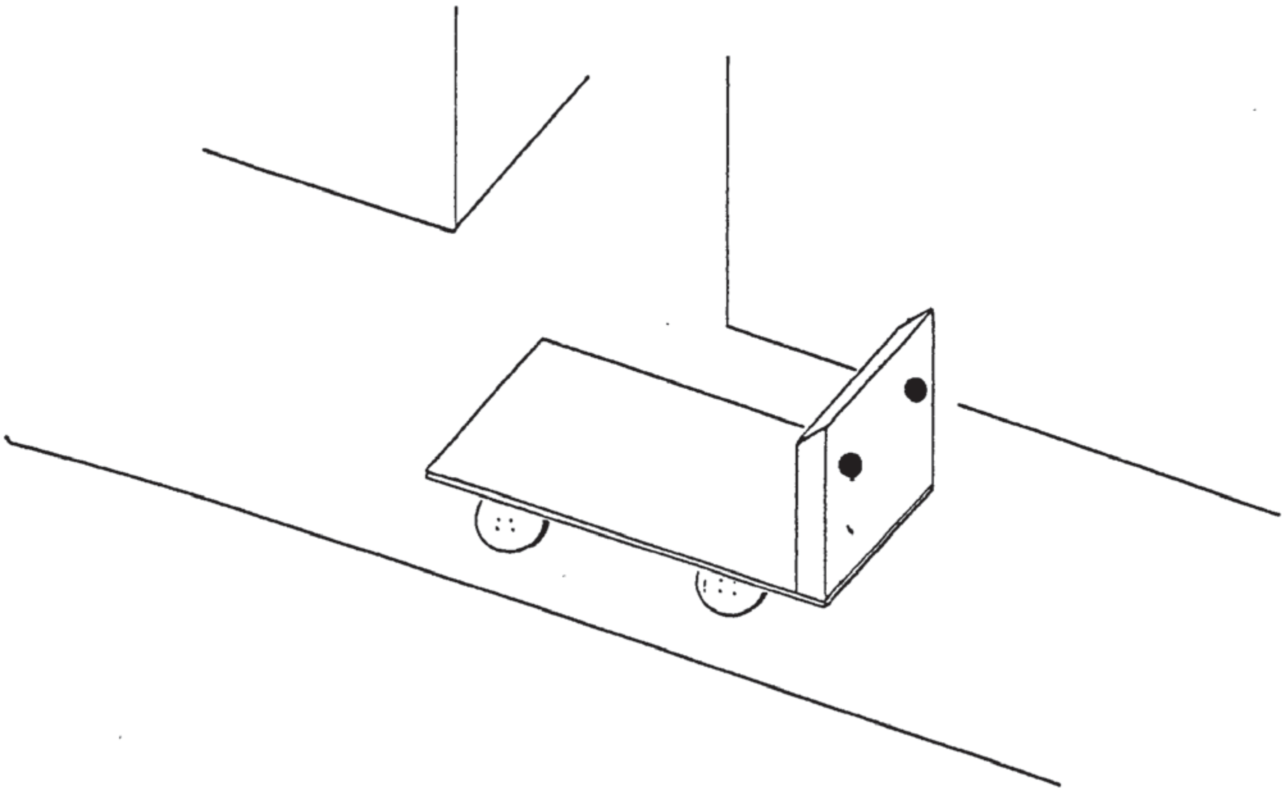
× TRANSMITTER

o RECIEVER

------- TRANSMITTED ELECTROMAGNETIC WAVE

—·—·—·— REFLECTED ELECTROMAGNETIC WAVE

OPTICAL CHARACTER RECOGNITION



SIGNAL PROCESSING ACCORDING TO:-

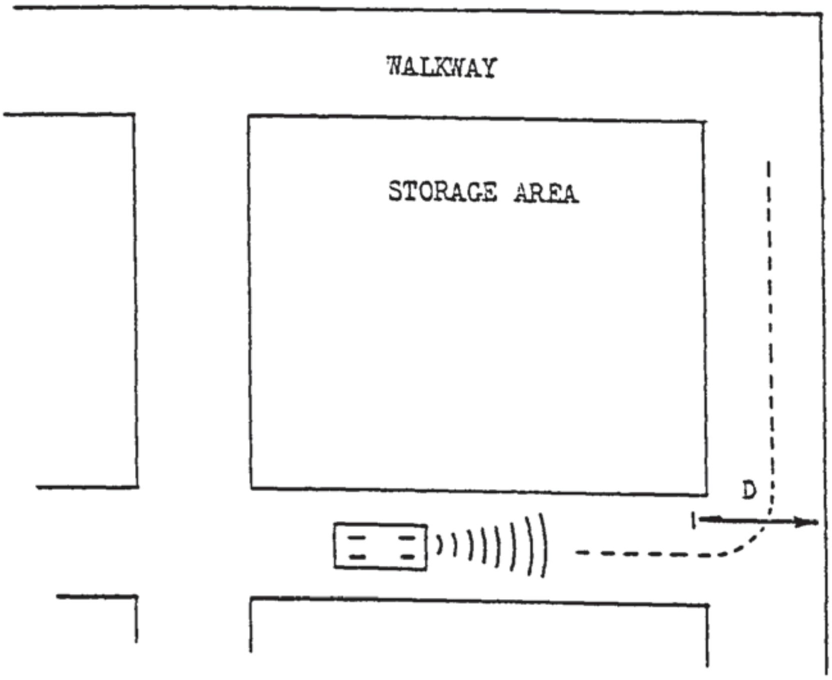
(i) CHARACTER RECOGNITION

(ii) LAWS OF PARALLAX

KEY:-

● OPTICAL RECEIVER

## LASER/MICROWAVE RANGE FINDING

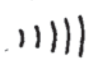



NOTE: VEHICLE PROGRAMMED TO TURN AT PRE SET DISTANCE D FROM OBJECT

DISTANCE D IS DEPENDANT UPON LOCATION IN ROUTE

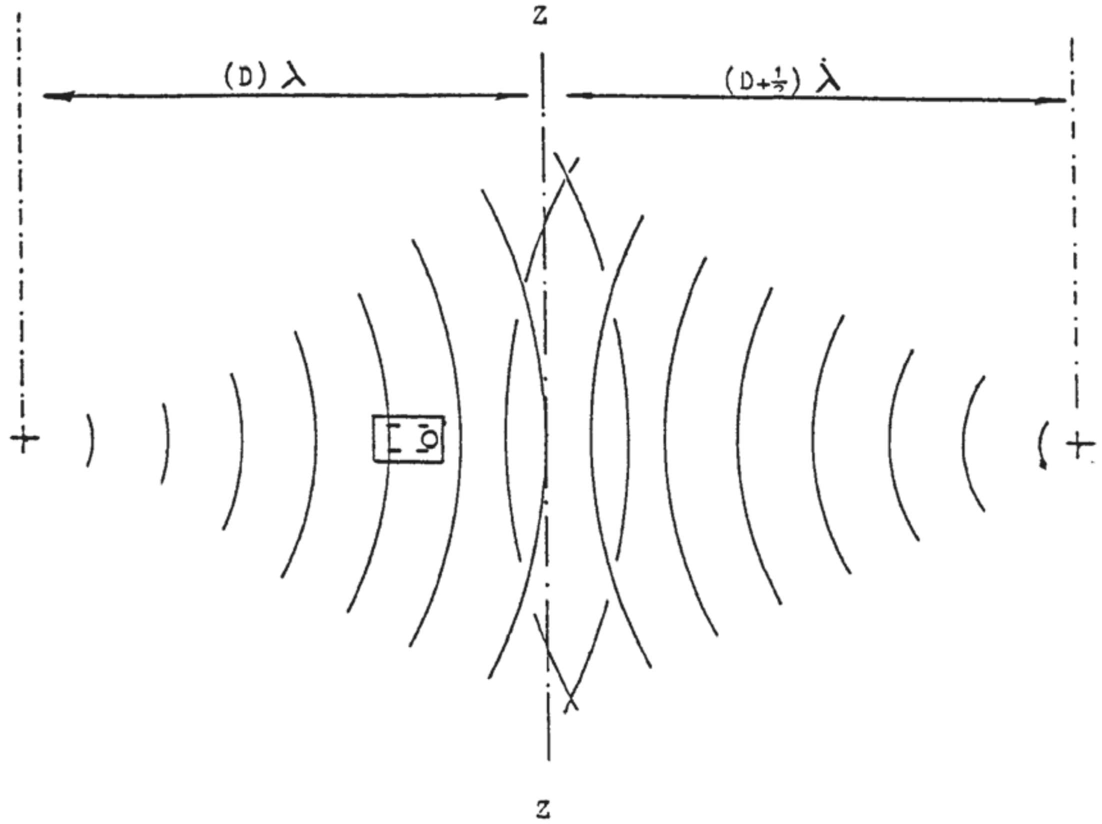
KEY:-

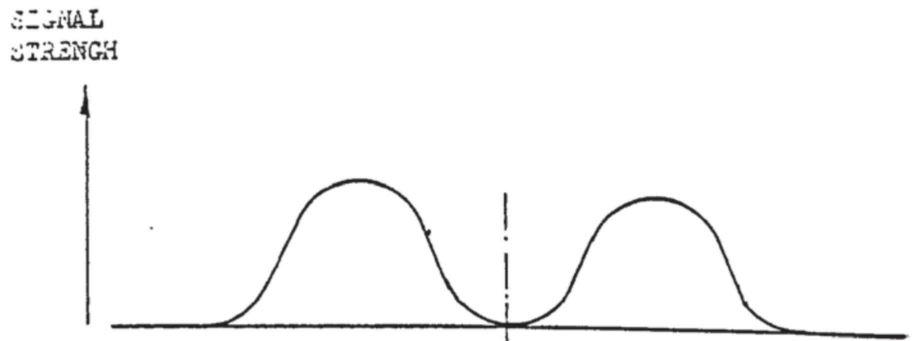
 VEHICLE

 ELECTROMAGNETIC TRANSMISSION

-------- VEHICLE ROUTE

ESTABLISH STANDING WAVES PATTERNS
ALONG VEHICLE ROUTE




CROSS SECTION Z Z

DISTANCE (D) MUST BE AN INTEGRAL NUMBER OF WAVELENGHTS

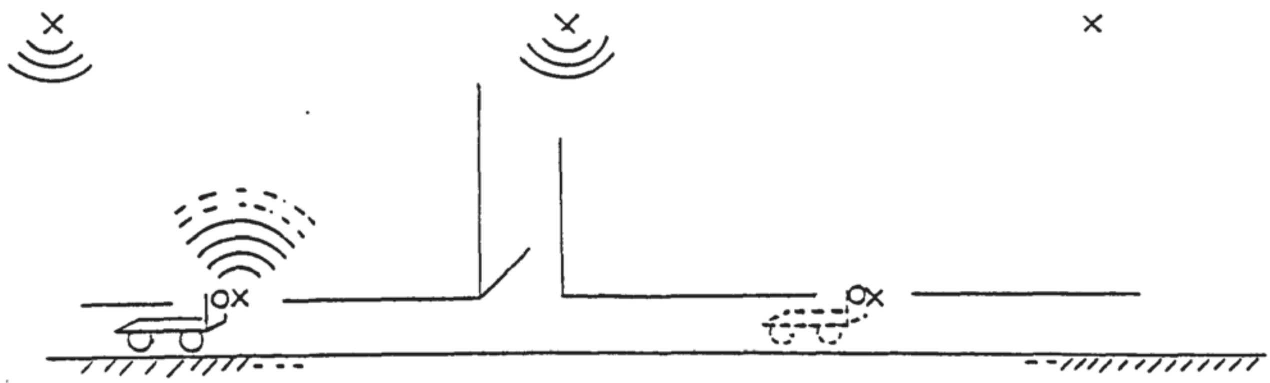
KEY:-

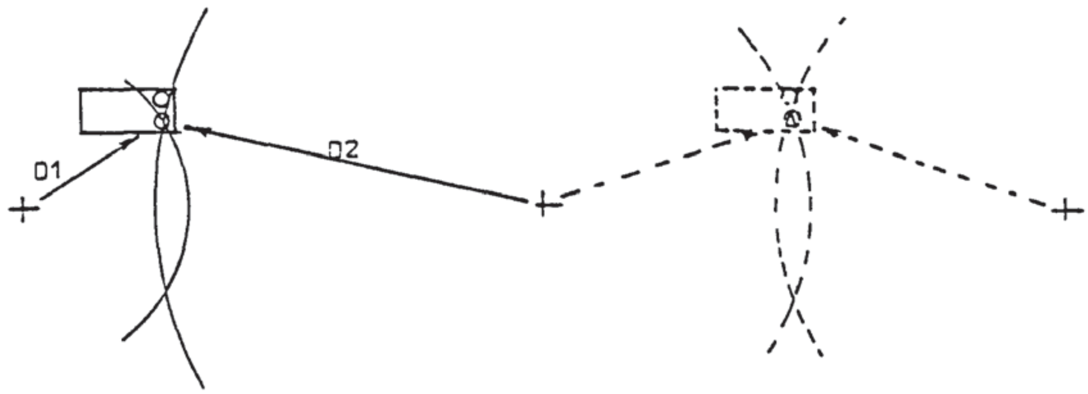
VEHICLE

RECIEVER

TRANSMITTER

PROVIDE STRING OF BEACONS ALONG VEHICLE PATH






NOTE: TWO RECIEVERS REQUIRED TO DEFINE UNIQUE VEHICLE POSITION

COMPUTED DISTANCE D1, D2 PROVIDE THE VEHICLE WITH REQUIRED INFORMATION FOR POSITION IDENTIFIFCATION

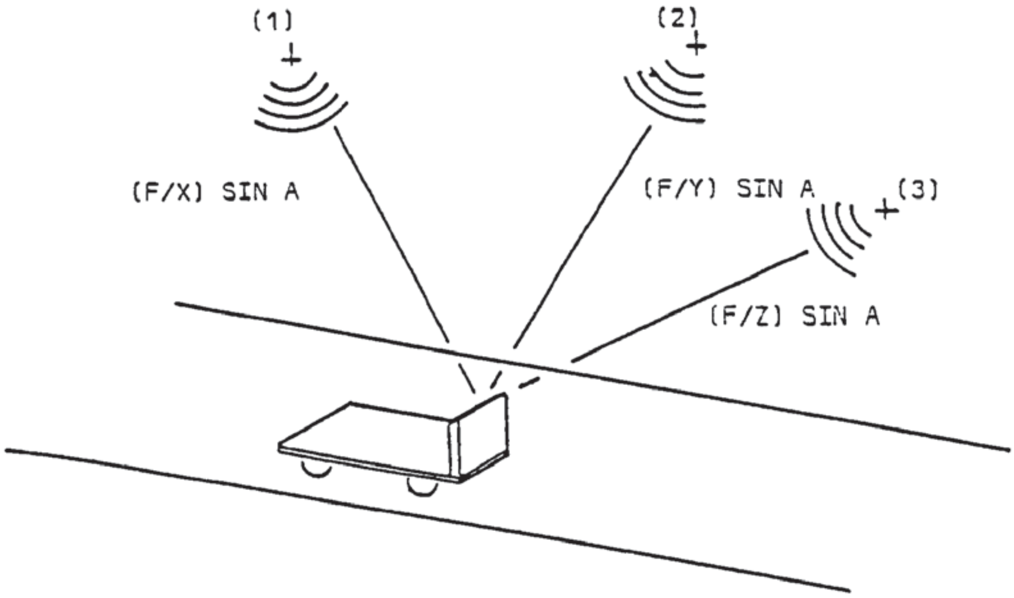
KEY:-

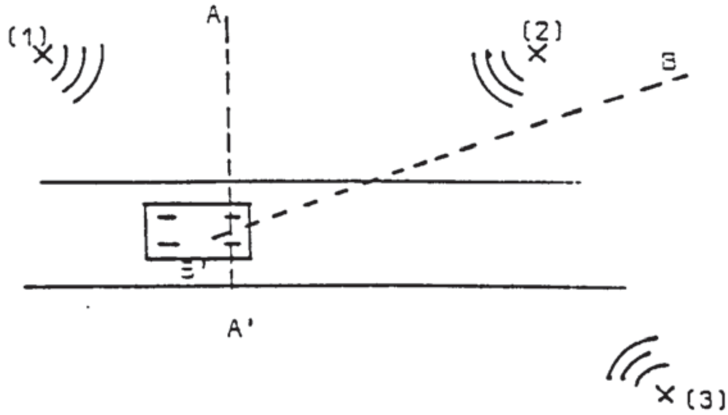
✕ TRANSMITTER

o RECEIVER

 VEHICLE

DETERMINATION OF POSITION BY PHASE ANGLE MEASUREMENT




NOTE: X, Y, Z ALL INTEGERS

: AA' LINE, DERIVED FROM PHASE DIFFERENCE BETWEEN BEACONS 1 AND 2

BB' LINE, DERIVED FROM PHASE DIFFERENCE BETWEEN BEACONS 2 AND 3

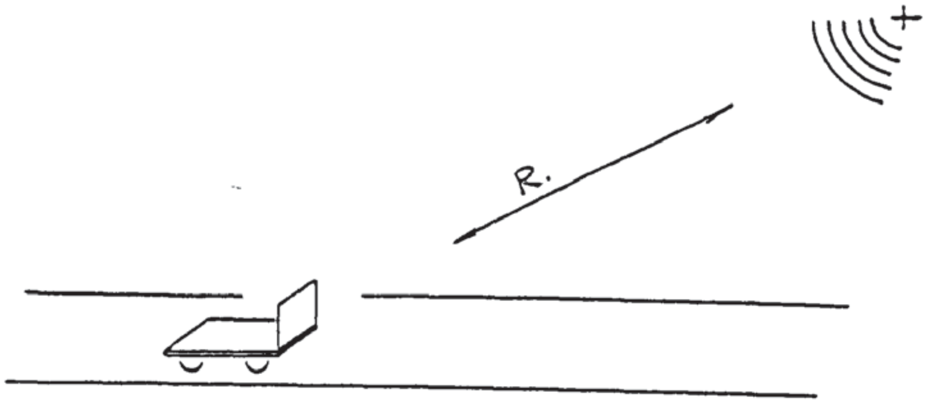
INTERSECTION OF LINES PROVIDES UNIQUE VEHICLE LOCATION

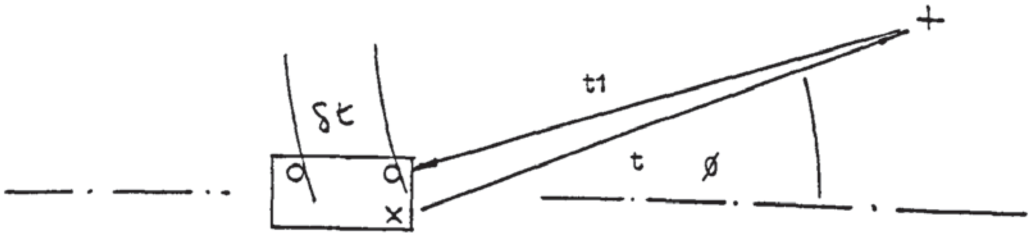
KEY:-

× TRANSMITTER

VEHICLE

DETERMINATION OF POSITION RELATIVE
TO SIMPLE BEACON




VEHICLE LOCATION NOT UNIQUE
VEHICLE ORIENTATION $\emptyset$ = FUNCTION ($\delta t$)
VEHICLE DISTANCE R = FUNCTION ($t+t1$)

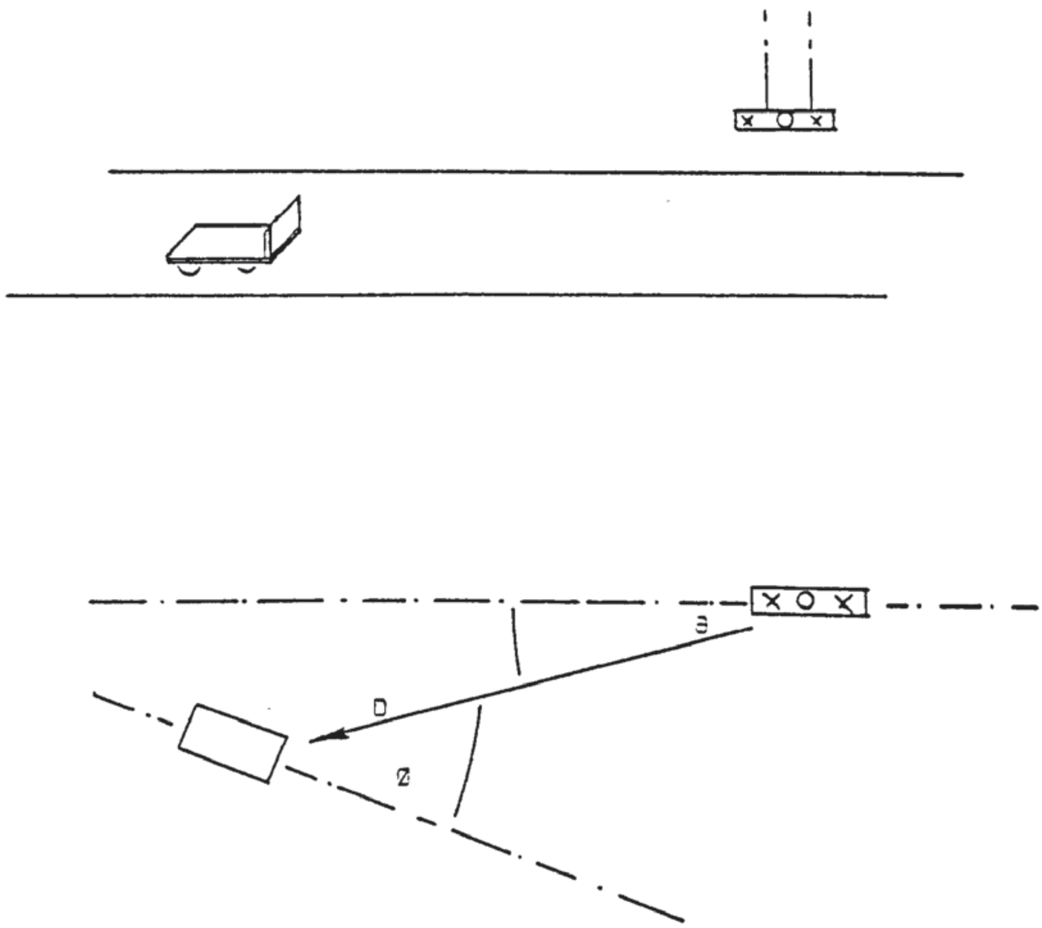
KEY:-

× TRANSMITTER

o RECEIVER

(19)

VEHICLE GUIDANCE USING A TWO TRANSMITTER/BEACON SYSTEM

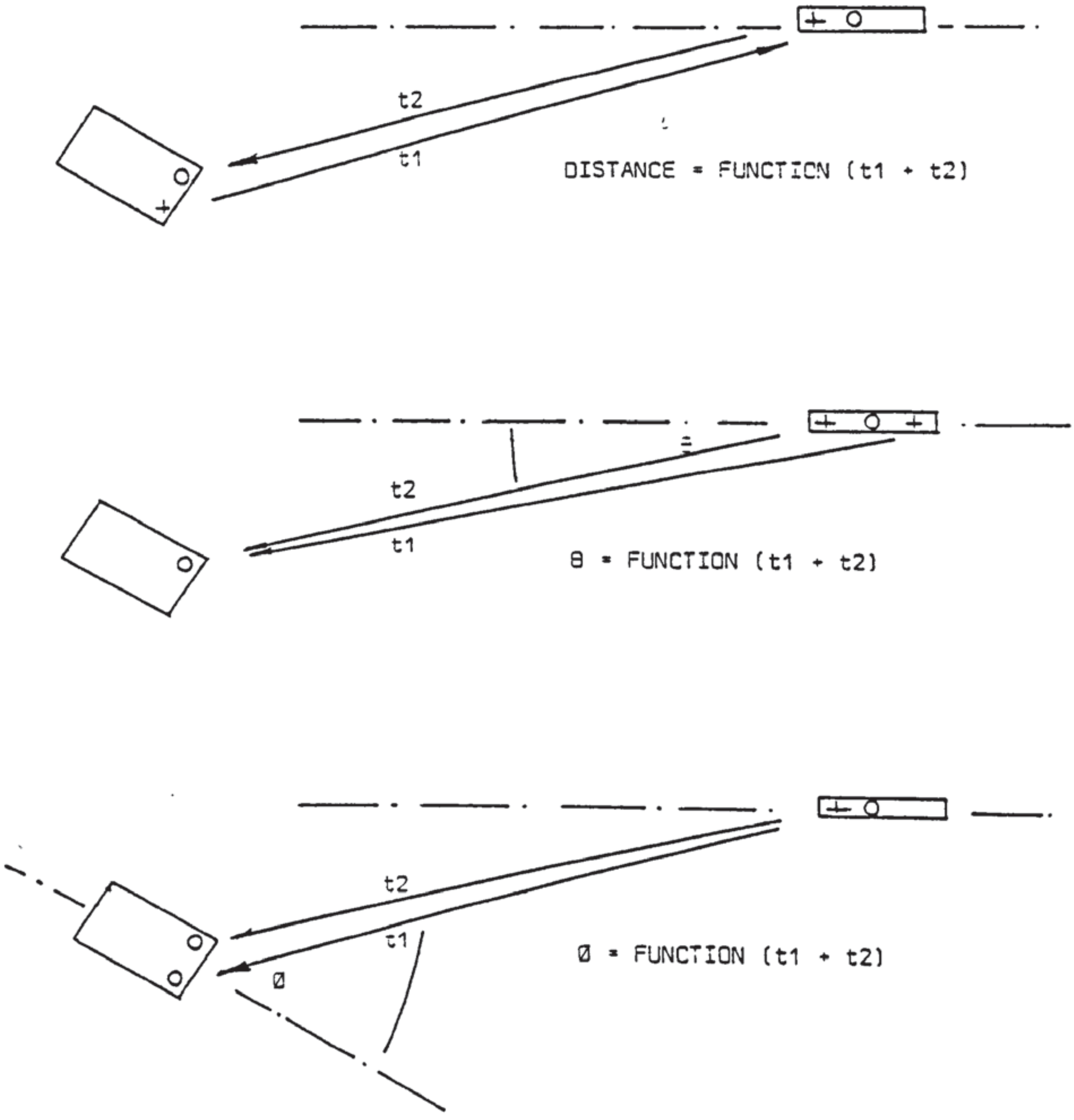



KEY:-

D DISTANCE FROM BEACON

θ ANGULAR POSITION RELATIVE TO BEACON

Ø VEHICLE ORIENTATION

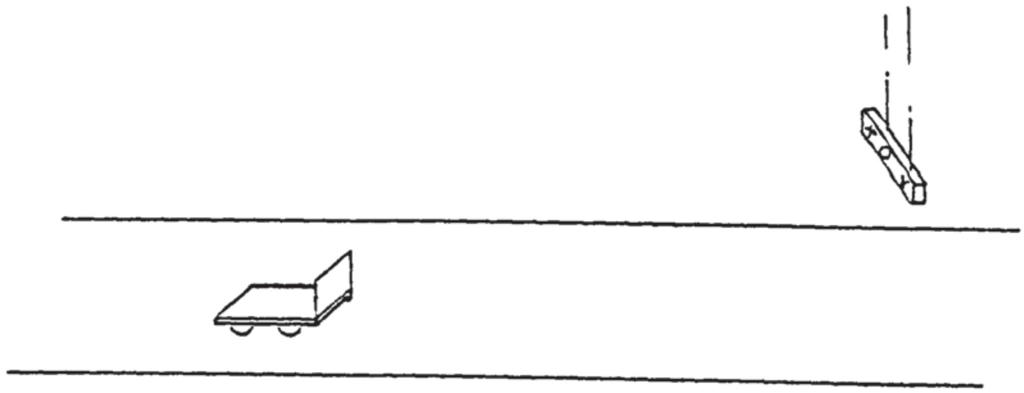


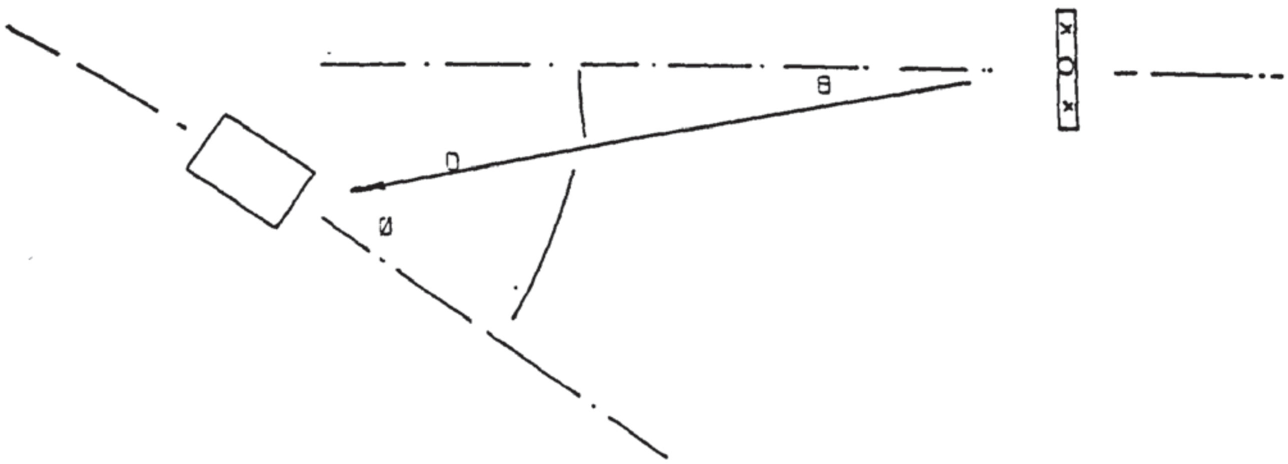

KEY:-

+ TRANSMITTER

O RECEIVER.

VEHICLE GUIDANCE USING A TWO TRANSMITTER/BEACON SYSTEM



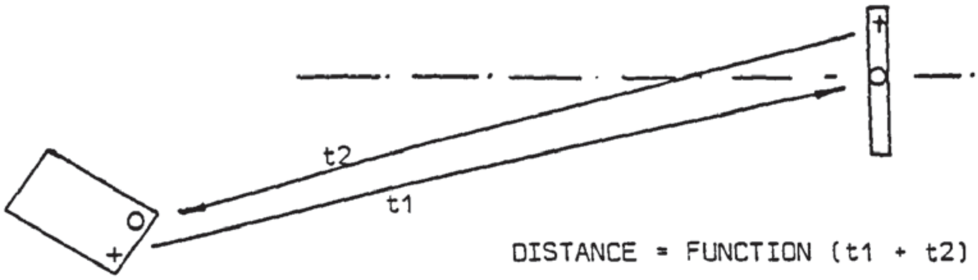



KEY:-

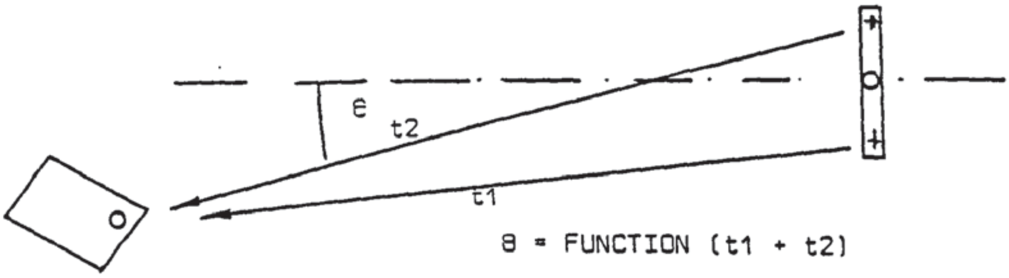
D DISTANCE FROM BEACON

θ ANGULAR POSITION RELATIVE TO BEACON

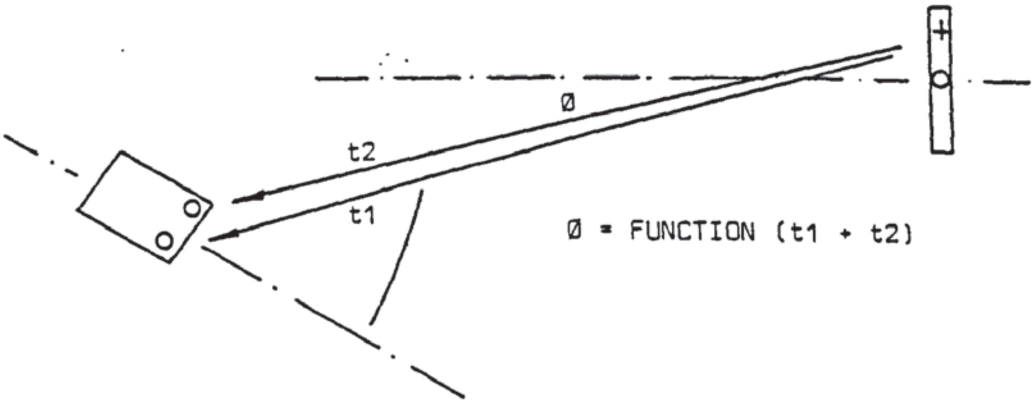
Ø VEHICLE ORIENTATION




DISTANCE = FUNCTION (t1 + t2)




θ = FUNCTION (t1 + t2)




Ø = FUNCTION (t1 + t2)

KEY:-

\+ TRANSMITTER

o RECEIVER

APPENDIX F

PROPOSALS FOR THE DEVELOPMENT OF THE ELECTRIC TRUCK

JANUARY 1983

GEEST INDUSTRIAL GROUP
BOSTON

# PROPOSALS FOR THE DEVELOPMENT OF THE ELECTRIC VEHICLE

D MENZIES BSc (HONS)
ELECTRIC VEHICLE
GEEST INDUSTRIAL GROUP
BOSTON

10 January 1983

ABSTRACT

This report contains recommendations for the development of the Electric Vehicle Division of Geest Industrial Group.

The declining sales of Tractamatics are studied and recommendations given.

The report recommends that the Tractamatic range be phased out over the next two years. It also suggests that two new and quite distinct vehicle ranges should be developed. One range to be designed specifically for light duty markets, the other for heavy duty markets.

On the new ranges, details are given for the rationalization of a build program, to standardise on vehicle components and thus improve margins through 'economies of scale'.

The projected sales of Geest Electric Vehicles for the next 5 years are given.

# GENERAL

Throughout this report the term series I refers to a proposed replacement vehicle for Tractamatic, and series II, to the range presently on test.

The present Tractamatic range has experienced declining sales for quite some time, see figure 1. I suggest that there are two main reasons for this:-

1. Compared to competitors Tractamatic is technically obsolete.

2. There has been a change in the basic requirements of the markets on which we compete.

The first requires no clarification, however in order to demonstrate the second, I subdivided the last 10 years sales figures into hospitals and others, see figures 2 and 3. The reason for the split is that hospitals represent our main light duty buyers, the remaining sales generally going to the heavy duty sector. This split, therefore, allows both markets to be assessed independently.

From figure 2 it is seen that hospital sales are experiencing only a marginal decline, this probably indicates that the facilities offered with Tractamatic basically fit the market requirements. It could also show that there is a lack of real competition in this area.

From figure 3 the direct sales to the heavy duty sector is quite clear. This decline almost certainly reflects a changing of market requirements, a shift towards more powerful and faster trucks, of the series II type.

The heavy duty market, once indistinguishable from other markets has now developed to the point where a definite requirement exists for a series II type truck. Tractamatic should, therefore, be withdrawn and replaced with a truck developed specifically for light duty applications. This action will broaden our Electric Vehicle range, allowing us to develop both segments of the industrial market independently.

RATIONALIZATION OF PRODUCTION

If a decision is made to retain and develop Tractamatic, it would be beneficial to incorporate, in the redesign, as many series 11 components as possible. This would provide future scope for improved margins through 'economies of scale'.

The following components should lend themself to this transfer:-

MECHANICAL DRIVE ASSEMBLY:- The differential and associated linkages could be incorporated in the redesign. This would replace the Tractamatic drive unit.

MOTOR SPEED CONTROLLER:- The electronic speed controller will operate at the reduced motor power levels.

BRAKES:- The electro-mechanical brakes will operate only if the present drive motor is modified. It is essential to have this facility.

CHARGER AND STEERING:- Although it will be necessary to use different components, the mounting and operating procedures could be similar.

OPERATOR CONTROLS:- Similar control positions would allow the use of a common electrical loom.

COMMERCIAL MARKETS

The type of mar-et the replacement vehicle (series I) is designed for, includes the following:-

- Schools
- Hospitals
- Public Buildings
- Shops
- Libraries

As we already have sales information on the hospital market I suggest we consider this first.

The number of hospitals in England and Wales is approximately 2000, 250 of which have in excess of 500 beds. If we assume that each of the 250 hospitals run, say 4 Electric Platform Trucks with a replacement ratio of 10%/annum then:-

$$\text{Annual hospital market} = \frac{250}{1} \times \frac{10}{100} \times 4$$

$$= 100 \text{ trucks.}$$

It would be reasonable to consider this market as expanding, gradually spreading to smaller hospitals.

If we study the buying pattern of hospitals it becomes apparent that sales are concentrated towards the latter end of the financial year.

The following demonstrates this:-

| FINANCIAL YEAR ENDS | HOSPITAL ORDERS TOTAL | HOSPITAL ORDERS DEC/MAR | % SALES DEC/MAR |
|---|---|---|---|
| April 73 | 14 | 9 | 65 |
| April 74 | 15 | 7 | 47 |
| April 75 | 20 | 17 | 85 |
| April 76 | 18 | 6 | 33 |
| April 77 | 8 | 8 | 100 |
| April 78 | 17 | 13 | 76 |
| April 79 | 29 | 13 | 45 |
| April 80 | 3 | 0 | 0 |
| April 81 | 13 | 11 | 85 |
| April 82 | 17 | 10 | 59 |
| | 154 | 94 | |

That is, on average:- 61% sold in 4 months DEC/MAR = 15%/month.
39% sold in 8 months APR/NOV = 5%/month.

So sales to hospital markets treble during the months Dec/Mar.

In the past two years this characteristic has become even more extreme, with peak sales occuring in the months Jan/Mar. This is undoubtably an effect of the change in government policy and should be noted.

As we expand in the hospital market it must be assumed that this buying pattern will continue. Indeed to stimulate demand it would seem reasonable to launch a sales drive in anticipation of this buying period, say in the months Oct/Feb.

This would, however result in an accentuation of the buying concentration and if ignored could result in the need to stockpile both components and assemblies.

...cont...

To remove this problem, and increase sales, it would seem reasonable to dismiss the hospital market during the month Mar/Sep and instead concentrate all sales effort on other potential users and so attempt to even out demand.

## COMMERCIAL MARKET REQUIREMENTS

If the new truck (series I) is to be successful attention must be paid to the following:-

1. Noise in operation.
2. Vehicle weight.
3. Safety.
4. Ease of operation.
5. Carrying capacity.
6. Cost.

1. Noise in operation:- The existing drive unit is quiet, the proposed 'rationalisation' of the mechanics should have little effect.

2. Vehicle weight:- The vehicle must be designed for use in lifts, it must have a lightweight construction.

3. Safety:- The rationalisation program will provide a parking brake and dead man facility as standard.

4. Ease of operation:- The steering should be altered to tiller type, with the operator leading the vehicle.

5. Load carrying capcity:- When Tractamatic is fully loaded the existing 'NICO' motor struggles on inclines. Taking account of the requirement to deplete existing stocks it would seem sensible to pospone any increase in motor rating for about one year (or until stocks are depleted).

6. Vehicle costs:- The market we will be entering is price sensitive. Our competitors vehicle sell for:-

| | |
|---|---|
| Petbow | £1900 |
| Isolec | £1725 |

An order of cost for series I is given below:-

| | TRACTAMATIC | SERIES I |
|---|---|---|
| Electrics | 160 | 145 |
| Meters ect | - | 50 |
| Motor | 140 | 160 |
| Drive Unit | 190 | 160(E) |
| Charger | - | 90 |
| Tyres | 100 | 100 |
| Brakes | 17 | 40(E) |
| Battery | 100 | 100 |
| Structure | 200 | 200 |
| Labour: Assembly | 300 | 150 |
| Overheads | 200 | 150 |
| | 1407 | 1345 |

(E) = Estimate

If we aim for a NSV of around £1900, the corresponding cost/margin ratio is 75/25.

It is important to note that most of the cost involved in the production of a series I truck is in component purchase. For this reason I suggest that if we wish to improve margins we aim for volume purchase and volume production.

SERIES I - N.S.V.

| | | |
|---|---|---|
| Development Cost: | Components | 4000 |
| | Labour (Development) | 5000 |
| | Labour (Assembly) | 2000 |
| | Expenses | 500 |
| | | £ 11500 |

Assume £11,500 loan, Interest payment:- £ 1150

| | | |
|---|---|---|
| Fixed Costs: | Stock Holding (Lost Interest) | 2000 |
| | Rent/rates | 300 |
| | Depreciation | 400 |
| | Sales (Promotional Lit) | 1500 |
| | | £ 4200 |

| | | |
|---|---|---|
| Variable Costs: | Components | 1045 |
| | Labour | 300 |
| | | £ 1345/vehicle |

Refer to figure 4 for graphic representation.

We now calculate the break even point for various selling values. With interest at 10% the break even point is when all investments return 10%/ annum.

$$\text{Return on Investment (ROI)} = \frac{\text{Sales Revenue - Costs}}{\text{Investment}} \times 100$$

(The break even point assumes no repayment of capital, cost = investment).

Sales Revenue = Sales (S) x NSV

Investment = 5350 + (S) x 1345

So break even volume (S)

$$(S) = \frac{5350}{0.91\ \text{NSV} - 1345}$$

This gave:-

| NSV | BREAK EVEN VOLUME | PROFIT ON ADDITIONAL SALE |
|---|---|---|
| 1600 | 48 | 255 |
| 1700 | 26 | 355 |
| 1800 | 18 | 455 |
| 1900 | 14 | 555 |
| 2000 | 11 | 655 |
| 2100 | 9 | 755 |

I suggest a NSV of £1900 initially, falling to £1800 as volumes increase.

TECHNICAL PROGRAM - SERIES I

| MODIFICATION | ACTION | DURATION(weeks) |
| --- | --- | --- |
| Drive Unit | Replace Tractamatic unit with differential and modify mountings as required. Copy from series II. | 4 |
| Motor | Modify stock of 'NICO' motors to take brake assembly. | - |
| Brakes | Remove existing brakes and fit electro-mechanical assembly - copy from series II. | 1 |
| Controls | Design and install: Hand operated controller, horn, key switch, fuse fault indicator etc, Design for meters: Hour run, Bat Condition, CLK. | 8 |
| Electronic speed controller | Copy and install speed controller. | 1 |
| Steering | Modify steering to perform as tiller with leading arm. | 7 |
| Total (Technical) | | 21 |

Other requirements:-

| | | |
| --- | --- | --- |
| Packaging | Improve general packaging of goods. | - |
| Welding | Improve. | - |
| Material Costing | Produce detailed costing of components for series I. | 1 |
| Labour costing | Produce costing of labour required. | - |
| Sales literature | Product literature to stress key features and project quality. | 3 |
| Technical Literature | Produce manual | 4 |

| | | |
|---|---|---|
| Engineering Drawings | Produce set of drawings for shop floor. | 4 |
| Prototype evaluation and modification | | 10 |
| Total (other) | | 22 |

PHASING OUT OF TRACTAMATIC

In deciding on a program for the phasing out of Tractamatic, the following points were considered:-

1. Projected sales of Tractamatic.
2. Level of existing stocks
3. Launch date of series I.

1. The sales of Tractamatic will probably continue declining. An estimation of between 10/15 sales/annum would seem reasonable.

2. The existing levels of stock would suggest a build of 20 vehicles, and a conversion of 15 drive motors to suit series I.

| | |
|---|---|
| Present stockholding: | £37500 |
| After build and conversion: | £10000* |

*This figure is an approximation based on the stock holding of major tractamatic components. The exact figure would have to take account of the requirement to continue to hold replacement parts.

3. Sales of series I will not start till October, possibly later. It would, therefore, seem reasonable to assume that Tractamatic sales in 1983, will be relatively unaffected, with competition arising in 1984. I suggest the following sales targets:

| YEAR | TRACTAMATIC SALES |
|---|---|
| 1983 | 14 |
| 1984 | 6 |
| 1985 | 0 |

ELECTRIC VEHICLE SALES

The projected sales figures for the electric vehicle divison are as shown in figure 5. In producing these figures, the following assumptions are made.

Tractamatic: existing stocks to be depleted, range phased out in 1984.

Series I (hospitals): developed and launched by 9/83, engineered specifically for the hospital market.

Series I (other): similar to series I (hospitals). The figures reflect a gradual sales build up, as specific light duty markets are identified and action taken.

Series II (heavy duty): developed and launched by 6/84. A gradual build up of sales, with specific industrial sectors being identified and action taken.

AGV: developed and launched by 2/85. The sales market is unknown, nominal values are shown.

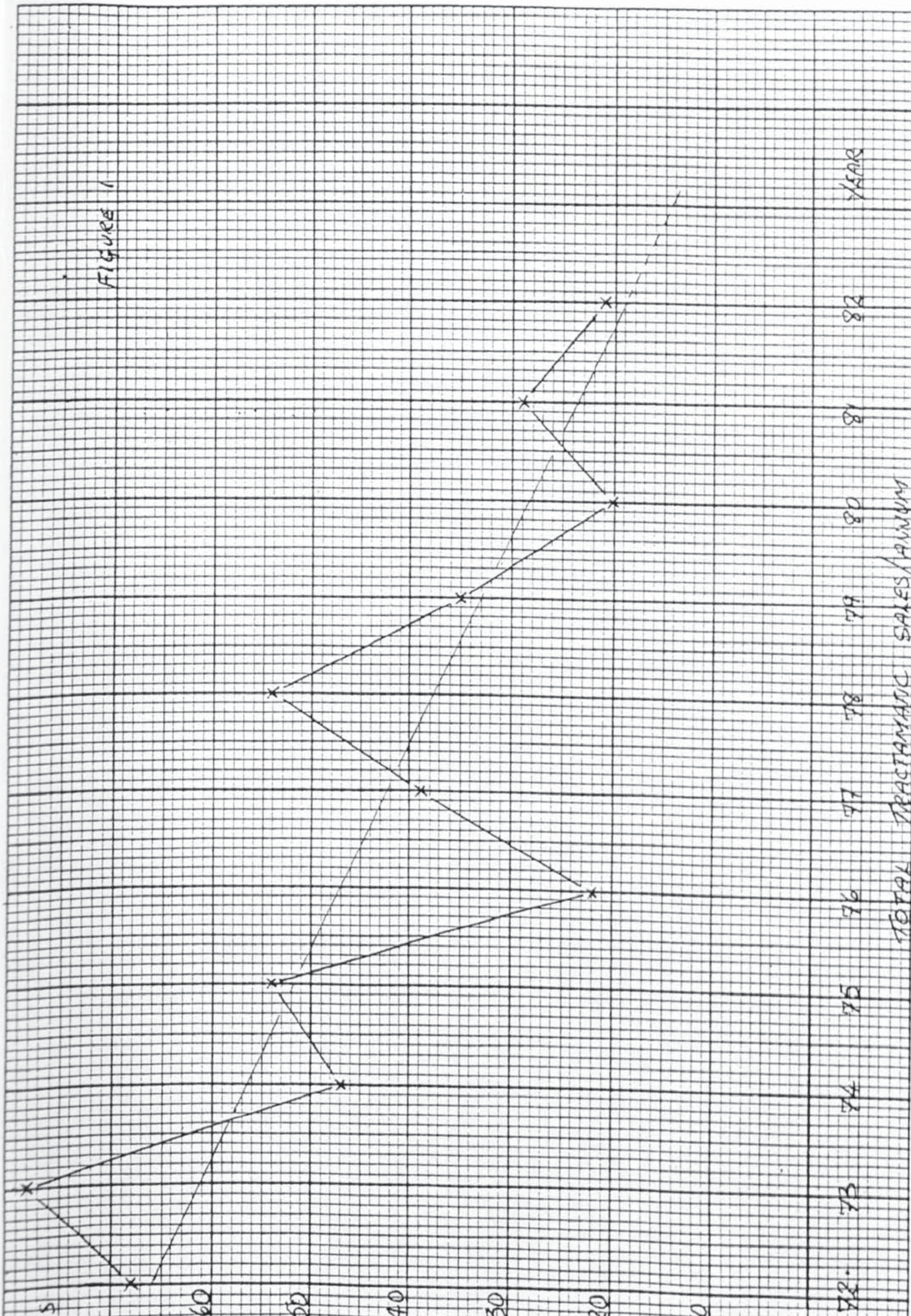


FIGURE 1
SALES VOL
60
50
40
30
20
10
72
73
74
75
76
77
78
79
80
81
82
YEAR
TOTAL TRACTAMATIC SALES/ANNUM

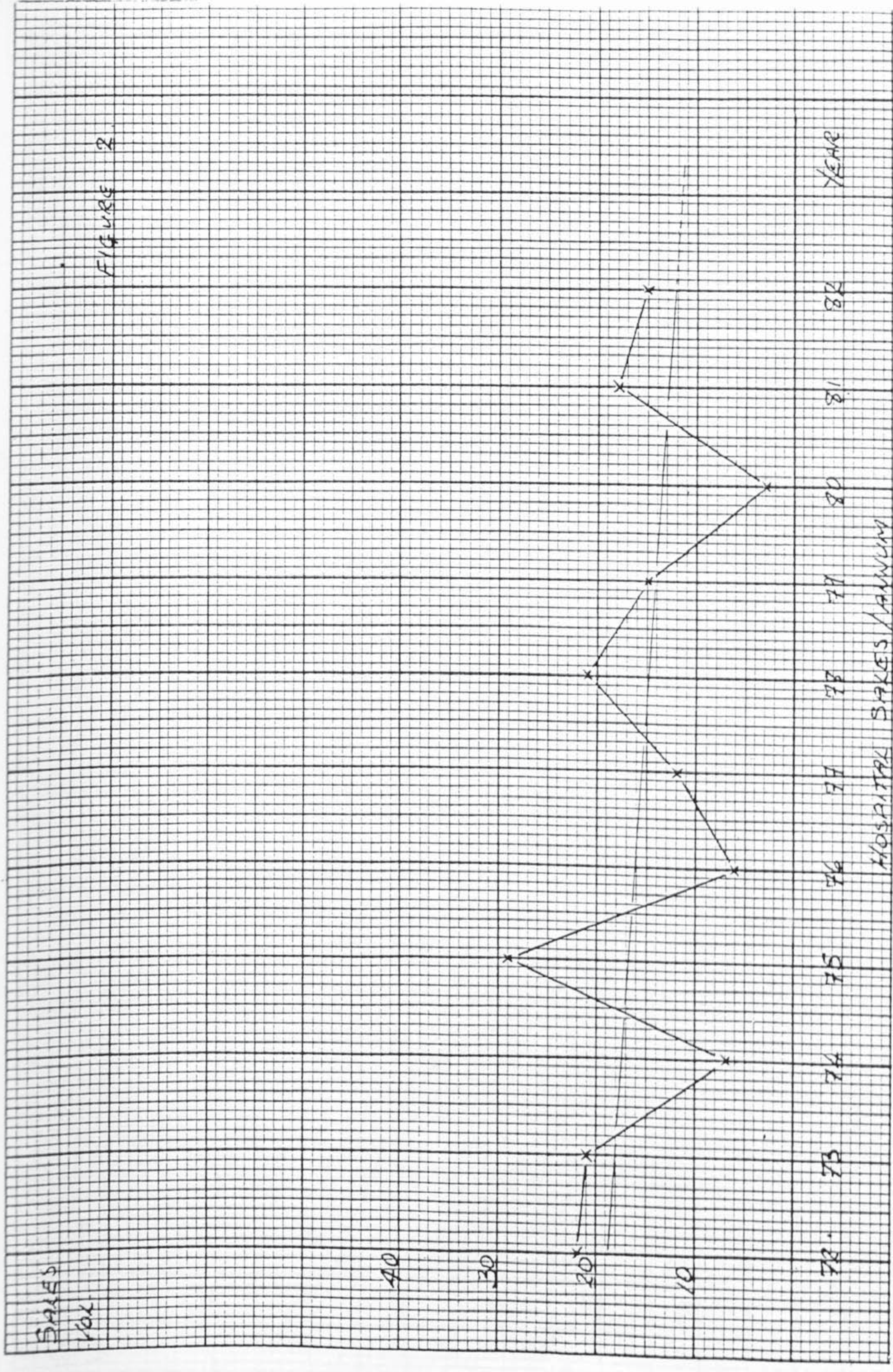


FIGURE 2
SALES
VOL
40
30
20
10
72
73
74
75
76
77
78
79
80
81
82
YEAR
HOSPITAL SALES/ANNUM

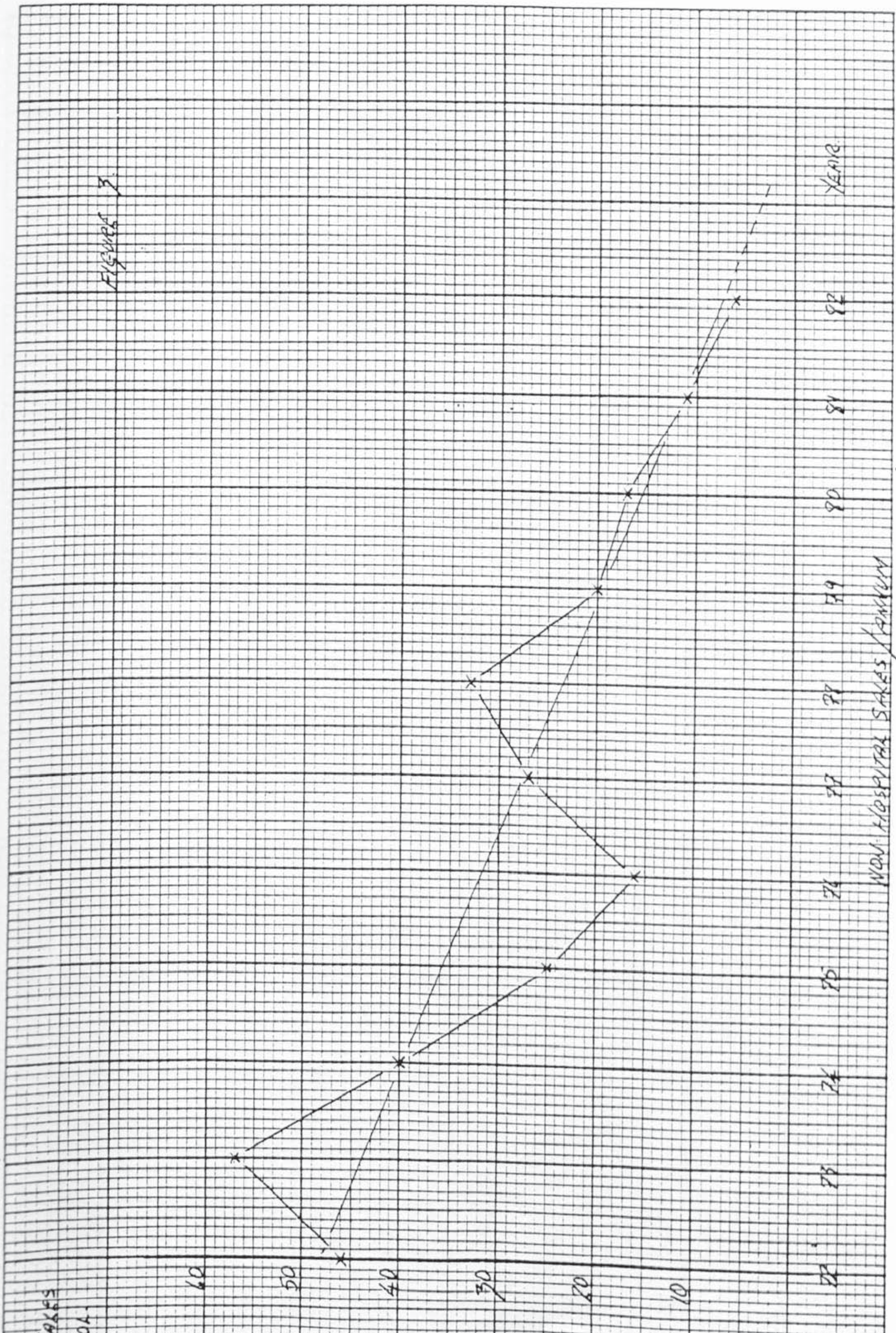


FIGURE 3
SALES VOL.
60
50
40
30
20
10
72
73
74
75
76
77
78
79
80
81
82
YEAR
NON-HOSPITAL SALES/ANNUM

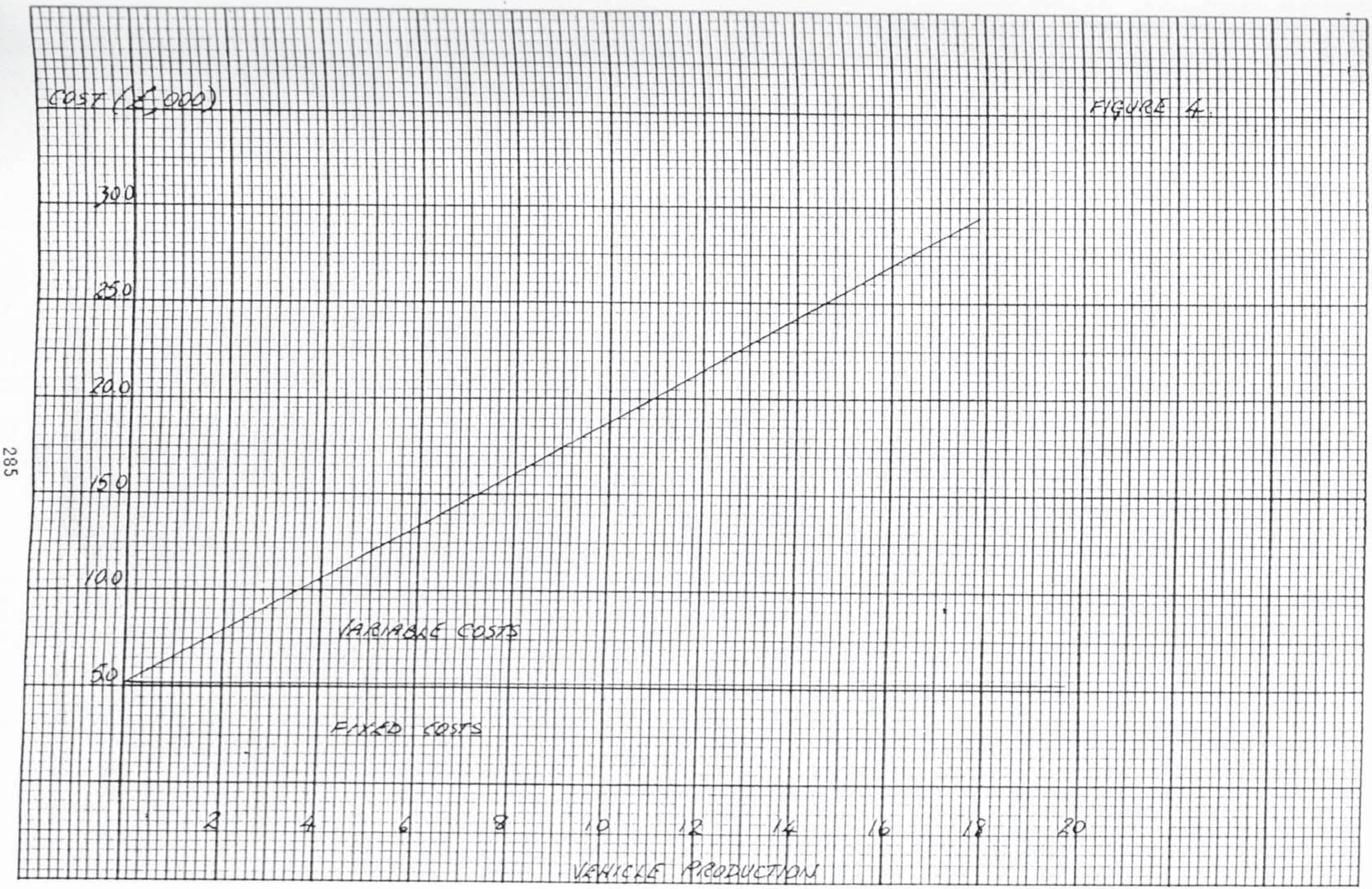
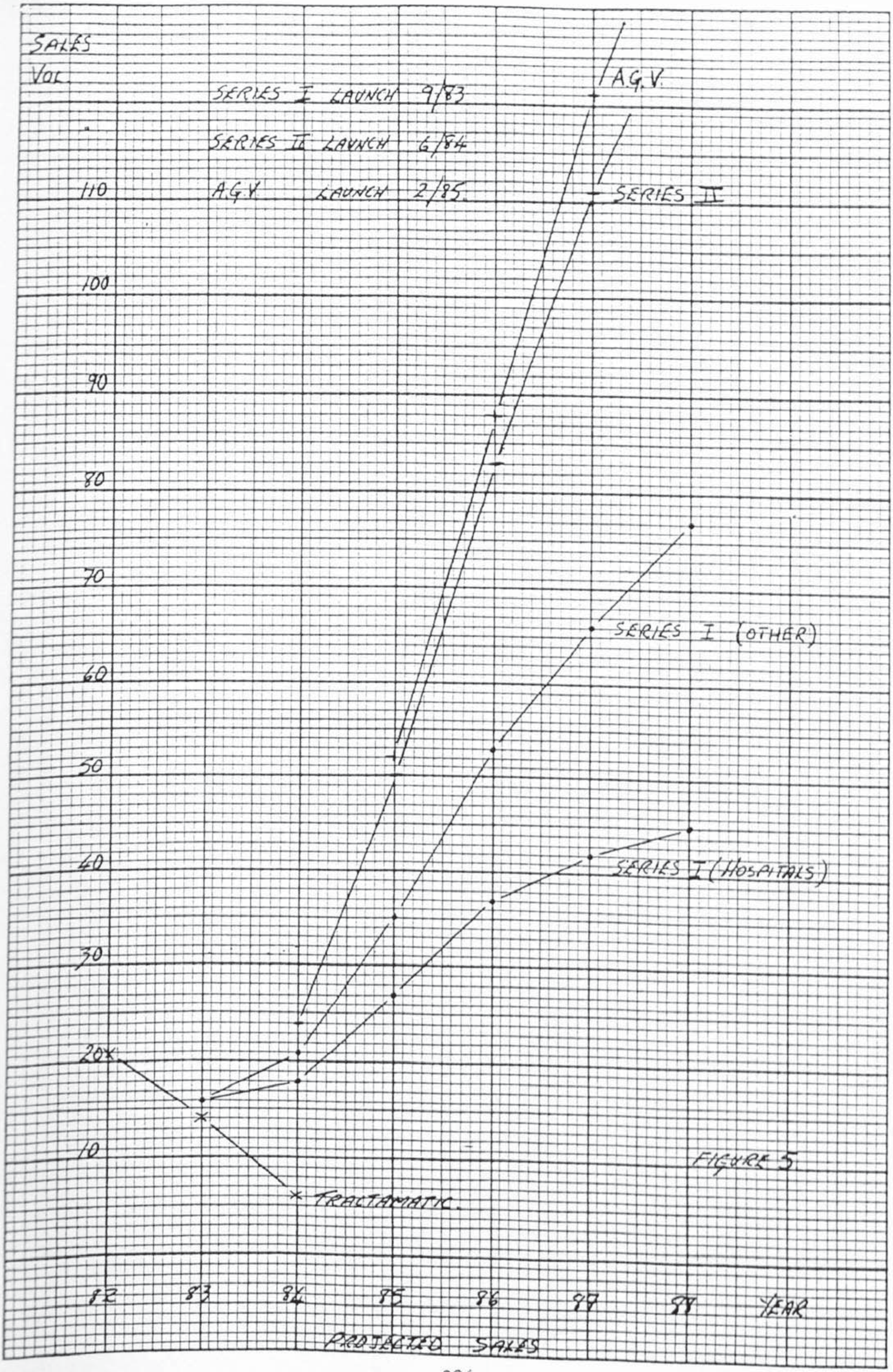


FIGURE 4.
COST (£,000)
300
250
200
150
100
50
VARIABLE COSTS
FIXED COSTS
2
4
6
8
10
12
14
16
18
20
VEHICLE PRODUCTION


SALES VOL.
SERIES I LAUNCH 9/83
SERIES II LAUNCH 6/84
A.G.V. LAUNCH 2/85.
110
100
90
80
70
60
50
40
30
20
10
A.G.V.
SERIES II
SERIES I (OTHER)
SERIES I (HOSPITALS)
TRACTAMATIC.
FIGURE 5
82
83
84
85
86
87
88
YEAR
PROJECTED SALES

APPENDIX G

RECOMMENDATION TO CHANGE INDUSTRIAL REMIT

MARCH 1983

Geest

| From: | To: |
|---|---|
| D MENZIES | P W BUCKEY |
| Ref: DM/SBH | Date: 18.3.83 |

I refer to our discussion on the possibility of changing the direction of this project.

I should like to list the reasons why I consider the present project direction, that is the development of an AGV system, to be unsuitable.

1. Lack of technical back up

   Sales and production staff are inexperienced with assembly and behaviour of sophisticated electronic products (new concepts).

2. Lack of servicing facilities

   No means of providing maintainence contracts, or of performing on site fault finding.

3. Requirement to establish credibility

   A credibility problem may exist if we attempt to launch a sophisticated new product into a new market.

4. Inability to satisfy demand

   A real danger exists that we could identify and stimulate a demand then find competitors with greater technical resources etc, capturing the market.

5. Lack of test facilities

   We do not have the sophisticated test equipment required for assembly work. Cost of equipment and training is high.

6. Development of exisiting products

   The size of the AGV project is such that few distractions can be accepted. The development of the existing electric vehicle range is simply to complex to be considered.

Basically, the technological jump from a 1963 truck design to a 1983 design incorporating communications circuitry, microprocessing and interfacing circuitry, etc, is too great. Geest have neither the resources to develop, or credibility to market, such a product, acquiring both could be expensive.

I suggest that the following project direction would be more beneficial.

New title "The application of marketing theory to product development - electric vehicles".

I should prefer to concentrate my effort on the development of the existing electric vehicles, and establishing a framework within Geest to optimise production and sales of these vehicles. This would include a study of market requirements and a policy of standardising on components.

...cont...

Geest

| From: | To: |
|---|---|
| D MENZIES | P W BUCKEY |
| Ref: DM/SBH | Date: 18.3.83 |

The project would, therefore, comprise of the following:-

1. Study present problems: (i) obsolete product range
   (ii) product orientated innovation
   (iii) no internal management controls

2. Define potential market segments and identify key requirements:
   (i) cost
   (ii) sophistication
   (iii) flexability
   (iv) reliability, etc.

3. Assess market potential for each segment.

4. Design/redesign electric vehicles. Rationalise on components. Make full use of in house resources and current technologies.

5. Create management controls to supervise the following:
   (i) production scheduling
   (ii) stock control
   (iii) sales strategies

I think IHD would now like to see the project change direction and, considering the structure of IHD project, I see no reason why they would object to the above proposals.

APPENDIX H

INDUSTRIAL REMIT - SMALL ELECTRIC TRUCK

APRIL 1983

In 1958 the Company introduced an electric platform truck into its range of material handling products, sales were moderately successful and established the company in the platform truck market. Lately, sales of the platform trucks have been falling to the point where the product must now be considered close to the end of its life cycle.

The nature of its sales would indicate that a market still exists in hospitals, warehouses, factories etc for a truck with suitable operational characteristics. It is, therefore, desirable to identify these characteristics and, if considered economical, incorporate them in the range of redesigned trucks.

The trucks should complement the existing material handling products, while at the same time establish a framework to allow future expansion in the electric vehicle market. This expansion might be achieved either through the launch of a new range of trucks, or by enhansing the truck sophistication, perhaps with the addition of a robotic facility.

The product should be designed to be acceptable from the marketing, business policy and production points of view so that the new version is wholly successful commercially.

## *APPENDIX I*

## *COPY OF QUESTIONNAIRE POSTED TO INDUSTRIAL MARKET USERS*

## APPENDIX J

## ANALYSIS OF QUESTIONNAIRE RETURNS FROM INDUSTRIAL MARKET

ANALYSIS OF POSTAL QUESTIONNAIRES

*Industrial Market Users*

A number of companies having purchased a Geest electric truck during the period 1963-1970 were questioned, by post, to establish their present usage of electric trucks.

Number of companies questioned: 108

| | |
|---|---|
| Number of replies: | 45 |
| Number 'Out of Business': | 6 |
| Total returns: | 51 |

The data contained in the questionnaire replies, which includes the answer as to whether the purchased Geest truck is still in use, is given in table J.1.

TABLE J.1:QUESTIONNAIRE RETURNS FROM INDUSTRIAL MARKET.

| | GEEST TRUCK YES | GEEST TRUCK NO | FORK LIFT | PALLET TRUCK | PLATFORM TRUCK | TOW-TUG |
|---|---|---|---|---|---|---|
| 1 | | * | * | | | |
| 2 | | * | * | | | |
| 3 | | * | | | | |
| 4 | * | | | | | |
| 5 | * | | * | | | |
| 6 | | * | * | | | |
| 7 | | * | | | | |
| 8 | | * | * | | | |
| 9 | * | | * | * | * | |
| 10 | | * | * | | | |
| 11 | | * | * | | | |
| 12 | | * | | | | |
| 13 | * | | * | | | |
| 14 | * | | * | | | |
| 15 | | * | | * | | |
| 16 | * | | | | * | |
| 17 | * | | * | * | | |
| 18 | * | | | | | |
| 19 | | * | * | | | |
| 20 | * | | * | | | |
| 21 | | * | * | | | |
| 22 | | * | | | * | |
| 23 | | * | * | | | |
| 24 | * | | * | | | |
| 25 | | * | * | | | |
| 26 | * | | * | | | |
| 27 | | * | * | | | |
| 28 | | * | | | | |
| 29 | | * | | | | |
| 30 | | * | | | | |
| 31 | * | | * | | | |
| 32 | * | | | | | |
| 33 | * | | * | | | |
| 34 | * | | | | | * |
| 35 | * | | | | | |
| 36 | | * | * | | | |
| 37 | | * | * | | | |
| 38 | | * | | * | | |
| 39 | | * | * | | | |
| 40 | | * | | | | * |
| 41 | | * | * | * | | * |
| 42 | * | | | | * | |
| 43 | | * | | | | |
| 44 | | * | | | | |
| 45 | * | | * | * | * | |

*APPENDIX K*

*COPY OF QUESTIONNAIRE POSTED TO HOSPITAL MARKET USERS*

## APPENDIX L

## ANALYSIS OF QUESTIONNAIRE RETURNS FROM HOSPITAL MARKET

*Hospital Market*

Variations in hospital sizes with its corresponding implications for workload could have been a significant variable in the usage and distribution of electric trucks. Thus the questionnaire distributed to this market was designed so as to take account of this variable. In fact, in the questionnaire this was achieved through a repositioning of the reply boxes to produce four versions, corresponding to hospitals sizes, 0-50, 50-250, 250-500, 500+, beds. From the questionnaire replies the actual number of trucks in use, by hospital size and by truck type, was translated into an estimate of the likely total populations, table L.1:

TABLE L.1:ANALYSIS OF TRUCK POPULATION IN THE HOSPITAL MARKET.

| BEDS: | EPT[a] | EQIV | ETT[b] | EQIV | DPPT[c] | EQIV | DPTT[d] | EQIV | FLT[e] | EQUV |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-50 | 9 | 303 | 16 | 539 | 4 | 135 | 1 | 36 | 3 | 101 |
| 50-250 | 45 | 784 | 41 | 714 | 1 | 17 | 9 | 157 | 8 | 139 |
| 250-500 | 40 | 316 | 72 | 568 | 8 | 63 | 0 | 0 | 8 | 63 |
| 500+ | 105 | 591 | 85 | 478 | 19 | 109 | 6 | 34 | 22 | 126 |
| | | 1994 | | 2299 | | 324 | | 227 | | 429 |

Key [a]: numbers of electric platform truck recorded in survey.
[b]: numbers of electric tow-tug recorded in survey.
[c]: numbers of diesel/petrol platform truck recorded in survey.
[d]: numbers of diesel/petrol tow-tug recorded in survey.
[e]: numbers of fork lift truck in survey.

APPENDIX M

DRAFT SPECIFICATION FOR FOUR MODELS

OF ELECTRIC TRUCK

GEEST

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

PEDESTRIAN PLATFORM TRUCK

| | | | |
|---|---|---|---|
| PERFORMANCE | | | |
| | LOAD CAPACITY | : | ½ - 1 TONNE |
| | SPEED UNLADEN | : | 2.5 mph |
| | LADEN | : | 2.0 mph |
| SPECIFICATION | | | |
| | DRIVE UNIT | : | 24v - 1¼ hp Electric motor coupled to oil immersed gear reduction unit. Direct drive to rear wheel differential. |
| | ELECTRICS | : | 4 x 6v (24v) Battery pack of capacity 190 A Hr. No built in battery charger. |
| | SPEED | : | 0 - 2 mph (forward/reverse) with infinitely variable control through hand operated electronic controller. |
| | LIGHTING | : | None |
| | STEERING | : | Tiller Type |
| | BRAKES | : | Dynamic braking on motor electro magnetic parking brake. |
| | CONTROLS | : | Keyswitch<br>Battery condition indicator. |
| | CHASSIS | : | On metal frame |
| | OTHER | : | 300 x 4" pneumatic tyres.<br>rub strip - white rubber<br>Horn<br>Rear tow bar attachment<br>Battery pack (electrical) connector/disconnect<br>Adjustable steering assembly |

TOTAL COST : £2,200 + VAT

GEEST

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

3 - 4 WHEEL RIDE-ON PLATFORM TRUCK

PERFORMANCE

| | | | |
|---|---|---|---|
| | LOAD CAPACITY | : | 1 TONNE |
| | SPEED UNLADEN | : | 5.5 mph |
| | LADEN | : | 4.0 mph |

SPECIFICATION

| | | | |
|---|---|---|---|
| | DRIVE UNIT | : | 24v - 1¼ hp Electric motor coupled to oil immersed gear reduction unit. Direct drive to rear wheel differential. |
| | ELECTRICS | : | 4 x 6v (24v) Battery pack of capacity 190 A Hr. Battery charger incorporated into truck design. |
| | SPEED | : | 0 - 4 mph (forward/reverse) with infinitely variable control through pedal operated electronic speed controller. |
| | LIGHTING | : | Headlights. Rear and brake lights. |
| | STEERING | : | Rack and pinion type - self centring. |
| | BRAKES | : | Dynamic braking on motor.<br>Shoe type Brakes on rear wheels - foot pedal operated.<br>Parking Brake on rear wheels. |
| | CONTROLS | : | Keyswitch<br>Battery condition indicator<br>Light switch<br>Foot pedals for accelerator and brakes<br>Hand brake |
| | CHASSIS | : | Glass fibre panels on metal structure |
| | OTHER | : | 300 x 4" pneumatic tyres<br>rub strip - white rubber<br>Horn<br>Rear tow bar attachment<br>Rubber decking<br>Cloth seat with rest<br>Built in charger (13A plug connector)<br>Mirror<br>Battery pack (electric) connector/disconnect<br>Adjustable steering assembly |

TOTAL COST : £3,600 + VAT

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP
Telephone: (0205) 69019
Telex: 32494

GEEST

PEDESTRIAN TOW TUG

PERFORMANCE

| | | |
|---|---|---|
| TOWING CAPACITY | : | 3 TONNE |
| SPEED UNLADEN | : | 2.5 mph |
| LADEN | : | 2.0 mph |

SPECIFICATION

| | | |
|---|---|---|
| DRIVE UNIT | : | 24v - 1½ hp Electric motor coupled to oil immersed gear reduction unit. Direct drive to rear wheel differential. |
| ELECTRICS | : | 4 x 6v (24v) Battery pack of capacity 190 A Hr. Battery charger incorporated into design. |
| SPEED | : | 0 - 2 mph infinitely variable through hand operated electronic speed controller. |
| STEERING | : | Tiller Type |
| BRAKES | : | Dynamic braking on motor electro mechanical parking brake tiller applied mechanical brake to drive wheels |
| CONTROLS | : | Keyswitch<br>Battery condition indicator<br>Hand Brake |
| CHASSIS | : | Fibre glass panels on metal frame |
| OTHER | : | 300 x 4" white pneumatic tyres<br>Rub strip white rubber<br>Rear tow bar attachment<br>Built in charger<br>Battery pack (electrical) connector/disconnect<br>Adjustable steering assembly |

TOTAL COST : £3,800 + VAT

# GEEST

**Geest Materials Handling Division,**
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

## 3 - 4 WHEEL RIDE-ON TOW TUG

| | | | |
|---|---|---|---|
| PERFORMANCE | TOWING CAPACITY | : | 4 TONNE |
| | SPEED UNLADEN | : | 5.5 mph |
| | LADEN | : | 4.0 mph |
| SPECIFICATION | DRIVE UNIT | : | 24v - 1¼ hp Electric motor coupled to oil immersed gear reduction unit. Direct drive to rear wheel differential. |
| | ELECTRICS | : | 4 x 6v (24v) Battery pack of capacity 190 A Hr. Battery charger incorporated into truck design. |
| | SPEED | : | 0 - 4 mph (forward/reverse) with infinitely variable control through pedal operated electronic speed controller. |
| | LIGHTING | : | Headlight. Front and rear direction indicators. Rear and brake lights. |
| | STEERING | : | Rack and pinion type - self centring. |
| | BRAKES | : | Dynamic braking on motor<br>Shoe type brakes on all wheels -<br>Foot pedal operated<br>Parking handbrake on rear wheel only |
| | CONTROLS | : | Direction indicator incorporated on steering stalk<br>Keyswitch<br>Battery condition indicator<br>Light Switch<br>Foot pedals for accelerator and brake<br>HandBrake |
| | CHASSIS | : | Replaceable glass fibre bodies on metal structure. |
| | OTHER | : | 400 x 4" white pneumatic tyres<br>Rub strip - white rubber<br>Electric horn<br>Tow bar attachment front and rear<br>Rubber decking<br>Cloth seats with armrests<br>Built in charger (13A plug connection)<br>Mirror<br>Battery pack (electrical) connector/disconnect<br>Adjustable steering assembly |
| | TOTAL COST | : | £5,200 + VAT |

## APPENDIX N

## COSTINGS OF FOUR MODELS OF ELECTRIC TRUCK

GEEST

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

PEDESTRIAN PLATFORD TRUCK

| | |
|---|---|
| Motor + Reduction Gear | 280 |
| Rear Differential and Metalwork | 100 |
| Battery Pack | 300 |
| Wiring | 20 |
| Speed Controller | 140 |
| Steering | 100 |
| Brakes | 60 |
| Controls (Meters etc.) | 100 |
| Wheels | 40 |
| Metalwork | 100 |
| Chassis | 50 |
| Labour | 100 |
| Contingency | 100 |
| | £ 1,220 |

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**GEEST**

Geest Materials
Handling Division,
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Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

PEDESTRIAN TOW TUG

COSTING MAY 1984

| | |
|---|---|
| Motor + Reduction Gear | 280 |
| Rear Differential and Connectors | 100 |
| Battery Pack | 300 |
| Charger | 120 |
| Wiring etc. | 20 |
| Electronic Controller | 140 |
| Steering | 100 |
| Brakes | 150 |
| Controls | 150 |
| Wheels | 40 |
| Metalwork | 100 |
| Chassis | 250 |
| Labour | 100 |
| Contingency | 200 |
| | £ 2,050 |

GEEST

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

## 3 - 4 WHEEL RIDE-ON PLATFORD TRUCK

| | |
|---|---|
| Motor + Reduction Gear | 280 |
| Rear Differential and Metalwork | 100 |
| Battery Pack | 300 |
| Charger | 120 |
| Lights | 50 |
| Wiring etc. | 20 |
| Speed Controller | 140 |
| Steering | 200 |
| Brakes | 150 |
| Controls (Meters etc.) | 180 |
| Foot Pedals | 50 |
| Wheels | 40 |
| Seat | 50 |
| Metalwork | 100 |
| Chassis | 150 |
| Labour | 130 |
| Contingency | 200 |
| | £ 2,300 |

GEEST

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Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP
Telephone: (0205) 69019
Telex: 32494

3 - 4 WHEEL TOW TUG

COSTING MAY 1984

| | |
|---|---|
| Motor + Reduction Gear | 280 |
| Rear Differential and Connectors | 100 |
| Battery Pack | 300 |
| Battery Charger | 120 |
| Lights | 80 |
| Wiring etc. | 20 |
| Thrysistor Controller | 140 |
| Steering | 200 |
| Brakes | 250 |
| Controls (metere etc.) | 200 |
| Foot Pedals | 50 |
| Wheels | 40 |
| Seat | 60 |
| Metalwork | 150 |
| Chassis | 350 |
| Labour | 160 |
| Contingency | 300 |
| | £ 2,800 |

## APPENDIX O

## PROPOSED ENGINEERING BUDGET FOR 1984

Geest

ENGINEERING & DEVELOPMENT OVERHEADS - 1984 — 1 November 1983

In 1983 there was no budget for development. Initially development costs were contained within Group Control costs but later allocated to Production Overheads. Menzies salary is currently reported under Administration.

It is suggested that in 1984 a separate cost centre is established for Engineering and Development for both control purposes and to reflect the operating cost of the factory separately.

Although the cost centre provides for the budgeting and collections of costs for Engineering and Development, the costs are only partly associated with Product Development. The greater part of these costs provide Engineering support to MH Custom Built, Production Engineering support to the factory, Industrial Engineering and technical support to GOM.

In the 1984 budget proposal are personnel and expenditure necessary to provide product development support to match the strategies proposed by the selling divisions.

The breakdown of total costs under these main headings are:-

| | | |
|---|---|---|
| 1. MH DIVISION | Total | £134,000 |
| 1.1 Electric Truck Project - | | £30,600 |
| Costs D C Menzies (salary, car and expenses) | | £10,800 |
| Technical and works manning | | 7,800 |
| Materials | | 17,000 |
| Other | | 2,000 |
| | | £37,600 |
| Less recovery from sale of preproduction units | | 7,000 |
| nett | | £30,600 |
| 1.2 Pallet Truck | Total | £14,700 |
| Technical and works time | | 4,600 |
| Tooling estimate | | 8,000 |
| Prototype materal | | 500 |
| Preproduction material | | 1,000 |
| Manuals | | 1,000 |
| | | £15,100 |
| recovery from sales | | 500 |
| | | £14,700 |
| 1.3 Safety Steps | Total | £11,500 |
| V E and technical time | | 3,600 |
| Works time | | 2,000 |
| Materials prototypes | | 400 |

...cont...

Geest

1.3 Continued....

| | |
|---|---|
| Preproduction materials | 2,000 |
| Tooling Estimate | 3,500 |
| Manuals | 1,000 |
| | £12,500 |
| recovery from sales | (1,000) |
| | £11,500 |

1.4 Firm Load Truck — Total £3,700

| | |
|---|---|
| Technical and works time | 1,800 |
| Prototype material | 300 |
| Tooling estimate | 2,000 |
| | £4,100 |
| less recovery from sales | (400) |
| | £3,700 |

1.5 General Provision — Total £21,000

Design work on selected standard products arising from Product Rationalisation and cost reduction programme.

| | |
|---|---|
| Technical and works time | 10,200 |
| Materials | 3,000 |
| Tooling | 8,000 |
| Manuals | 1,000 |
| Less recovery from sales | (1,200) |
| | £21,000 |

1.6 Custom Built Products — Total £52,600

Back up to sales to cover design, quotations etc.

| | |
|---|---|
| Technical time | 28,000 |
| Works time | 19,600 |
| Non-recovered materials | 5,000 |
| | £52,600 |

Geest

2. PETTIT DIVISION — Total £18,300

2.1 Flotilla Up Date — £7,200

| | |
|---|---|
| Technical and works time | 3,200 |
| Materials | 4,000 |
| Manuals | 1,500 |
| less recovered from sales | (1,500) |
| | £7,200 |

2.2 Series 77/88 Up date — Total £11,100

| | |
|---|---|
| Technical and works time | 4,600 |
| Materials | 6,000 |
| Tooling estimate | 2,000 |
| Manuals | 2,000 |
| less recovered from sales | (3,500) |
| | £11,100 |

3. GOM DIVISION — Total £14,000

3.1 Wheelbarrow Sprayer — Total £10,000

| | |
|---|---|
| Technical and works time | 4,900 |
| Materials preproduction | 1,300 |
| Tooling estimate | 3,000 |
| Manuals | 800 |
| | £10,000 |

3.2 Pettit Specials — Total £4,000

Quotatons and design back-up.

Technical time — £4,000

4. FACTORY BACK UP — Total £25,000

4.1 Standardisation of components, bills of materials, back up studies and data for MRP programme and manufacturing information - mainly Pettit products.

Technical time — £8,000

4.2 Production Engineering and Industrial Engineering.

Technical time — £17,000

5. GROUP TOTALS

| | |
|---|---|
| MH Division | £134,100 |
| Pettit Division | 18,300 |
| GOM Division | 14,000 |
| Factory | 25,100 |
| | £191,400 |

...cont...

Geest

The cost estimates are based upon manning costs at:-

Technical - £200/man week (5.30/hr)

Works - £140/man week (3.50/hr)

6. JUSTIFICATION OF EXPENDITURE

Any expenditure, particularly on Engineering and Development must be worthwhile. Engineering developments will only be worthwhile where the projects result in the generation of improved gross contribution to the business either through improved volume or improved margins or a combination of. both.

In this respect the proposed budgets relate directly to the selling strategies and operational budgets put forward by the Divisions already as follows:-

6.1 Electric Truck £30,600

- Not part of the MH needs for 1984 but part of a longer term development aimed at providing a modern electric truck range for future business development. The power system should be capable of adaptation to a number of electric power products.

Rated as speculative development expenditure.

6.2 Pallet Truck £14,700

Turnover value 1984 projected at £164K at present contribution rate this produces £13K of contribution. Projected contribution at a minimum 28% produces £46K of contribution, an increase of £33K. In addtion a successful project might well considerably increase volume.

6.3 Safety Steps £11,500

Projected turnover value of £118K with current gross margin at approximately 40% yields £47K gross margin.

The project is aimed at securing the existing business by improving the product and primarily increasing volume through increased acceptability.

A volume increase of 25% is needed to recover development costs in 12 months, if no cost reduction results from the project.

6.4 Firm Loading Truck £3,700

Design project to standardise between components used on the firm loading and balanced truck. The objective is to reduce costs, increase control and perhaps raise volumes.

Projected turnover 1984 is £188K producing gross margin £75K (40%). Volume increase of 5% is required to cover project costs if no cost reduction results.

...cont...

Geest

6.5 Product Rationalisation £21,000

General Provision

Remaining standard products are projected to sell £440K in 1984. As with the specific projects 6.3 and 6.4 this provision is to either improve products and volumes or reduce costs. Specific projects would be selected resulting from production rationalisation and market potential.

6.6 Custom Built Products £52,600

The level of back up estimated is based upon the experience of 1983 and reflects the same level of technical activity. Unless specific decisions are made not to try for particular types of business this back up is needed to process the same level of enquiries, costings, designs and production engineering information.

However £52.6K represents 15% of the expected £350K turnover in Custom Built products and is difficult to justify. This same level of back up represented approximately 8% of the £500K turnover in 1983 and is more realistic.

There is little doubt that either the level of expenditure must be reduced by dealing only with selected enquiries or we must expect a higher level of business from this area of activity. However, a reduction in resource allocated could well ensure that the £350K projected is the maximum we can expect to achieve.

Some further thought is obviously necessary in the whole area of the Custom Built business.

6.7 Flotilla Up Date £7,200

Projected £80K turnover in 1984 would justify the above expenditure but quite obviously a greater turnover must be expected from this product.

Clearly, with a product closer to the requirements of the market, the market share and turnover is much higher than £80K. Möre market research may be necessary to establish whether further changes, features and/or improvements might be justified.

6.8 Series 77/88 Up Date £11,100

The level of cost estimated assumes that the testing of the prototype built in 1982 will be adequate and that this information can be used as a basis for the updating of detailed components.

This will not be verified until the prototype is inspected and a report received from Geest Farms.

£425K of Group turnover for 1984 will depend upon how acceptable the product is to the market and the £11K expenditure could, in this respect, be regarded as minimal.

6.9 Trailers £0K

The sales plan for 1984 does not contain any requirement for design and development of trailers.

...cont...

Geest

£160K is the forecast turnover for 1984 and £140K is forecast in 1983. 1982 sales ammounted to £350K.

We have experienced a £200K loss of business in 1983 in a market which has proved to have held up to at least the 1982 levels. A.E.A. statistics actually show an increase in the market over 1982.

In theory (assuming 25% gross margin) we could have spent £50K maintaining our market at £350K, achieved the same results in 1983 and be better equiped to seek an improvement on the £160K turnover in 1984. In practice the level of expenditure necessary to obtain business from this market between £300K-£500K is likely to be no more than £20K.

6.10 Factored Products

No allowance is made for technical support to existing or new factored products for 1984.

6.11 Wheelbarrow Sprayer £10,000

This expenditure is difficult to justify in the short term since this investment will not be recovered in less than 2 years from launch.

However, the actual market is extremely difficult to estimate and the project is worthwhile as a speculative development.

6.12 Overseas Specials (Pettit Products) £4,000

Allowance made for 20 ~~mayn~~ weeks of back up. This is usually we justified since considerable turnover has historically resulted from this activity. Average results over the past four years suggests that more back up would be justified by diverting resource from MH Home Market specials.

6.13 Factory back-up £25,000

This expenditure is necessary to improve the factory control through industrial and production engineering. Mainly a reflection of the technical manning for the factory included in the Engineering and Development cost centre as apposed to specific projects.

7. OVERHEAD SCHEDULE

7.1 Salaries

This reflects the 1983 establishment but including for the full year:-

Design Engineer - replacement for G Taylor
Production Engiener - To be recruited
D Menzies - previously in administration

Additional personnel proposed are:-

Quality Engineer - to be justified
Draughtsman - one of the two temporary draughtsmen currently employed.

...cont...

Geest

The analysis of manning required to fulfil all project listed is 7 people for design/development. The current strength is 4. It is therefore proposed to offer an existing temporary draughtsman a 12 month contract and obtain additional support from consultants.

£64K

7.2 Indirect Wages

Reflects the current establishment of 4 engaged on sample production, prototypes and jigs and fixtures.

£34K

7.3 Jigs and Tools

Consolidation of the expenditure listed against specific projects.

£26.5K

7.4 Vehicles

Covers car scheme for B Johnson, the car allocated to Menzies, running costs for both and casual mileage for technical personnel.

£5K

7.5 Consultancy

Budgeted at £25K but could be higher if "in house" resources are diverted to additional projects (eg British Rail project).

Alternative to this is to employ additional "in house" personnel at £17K.

£25K

7.6 Materials

Allows for a £15K recovery from sale of preproduction models. Actual spend is £40K.

It has been the tendency to consume production materials and components and hence not reflect these costs under development. If materials consumption is collected accurately and such costs reflected against specific projects we could expect to see a marginal improvement in factory margins.

However, if costs are collected this way, then any sales of products manufactured from Engineering and Development materials and labour must be recovered within this cost centre.

£25K

7.7 Drawing Office Expenses

General provision for DO supplies.

£1.5K

...cont...

7.8 Test Equipment

Mainly associated with the Electric Truck project.

£2K

7 9 Product Manuals

Mainly bought out services to revise and rewrite operators and spare parts manuals for n~~o~~ew or updated products.

£8K

APPENDIX P

INDUSTRIAL REMIT - PRODUCT LINE ACQUISITIONS

DECEMBER 1983 (FORMALISED FEBRUARY 1984)

APPENDIX Q

PRELIMINARY ENGINEERING DRAWINGS OF NEW ELECTRIC TRUCKS

GEEST

Geest Materials
Handling Division,
Marsh Lane, Boston,
Lincolnshire PE21 7RP

Telephone: (0205) 69019
Telex: 32494

I refer to our recent discussion on the subject of electric vehicles.

As mentioned, we are presently working on the design of a range of small electric powered vehicles. Our earlier research has shown that the potential demand from within the hospital market is sufficient to warrant a design engineered specifically for this market.

Earlier interviews with hospital personnel have led to the development of the designs shown on the attached A2 sheets.

The intention is to select from these designs, those identified as being most appropriate for this market. In addition any design deficiences highlighted at this stage will be corrected before the launch of the selected models.

I would therefore be grateful if either yourself or a colleague could find time to study the designs and indicate those which you consider most appropriate for use within hospitals.

Any comments you may have on either the features or layout of the proposed designs would also be appreciated.

I look forward to our meeting.

Thank you for agreeing to take part in this exercise.

Yours sincerely

D MENZIES
Product Development Manager

APPENDIX R

F.W. PETTIT PRODUCT STRATEGY DOCUMENT

HASSIA POTATO EQUIPMENT

FEBRUARY 1984

- F. W. Pettit

T. M. Parsons

Mr. P. N. Sillars

HASSIA

9th February 1984

1. BACKGROUND

Since we acquired the Hassia franchise for the United Kingdom in 1981, sales have been made through numerous dealer outlets mainly on a non-exclusive basis. The product has gained good acceptance so far as good reliability and performance is concerned and it would be accurate to say that this opinion is shared by the majority of dealers and farmers who are familiar with the Hassia range of potato planters and harvesters. The major problem area has been supporting the sales that have been made with inadequate service back-up and immediate response to service enquiries. As our sales have increased then our limited manpower resources has failed to cope adequately to demands that have been imposed. Therefore, many of the original dealers who sold Hassia for us have become dissatisfied with the lack of support from both the sales and service aspect that we have been unable to provide.

Since joining Pettit's in February 1983, one of my major objectives has been to consolidate Hassia's position in the market by appointing "Key Dealers" (preferably multi-branch) in selected areas. In so doing we should have been able to have provided sufficient support to these new dealers with product training so that they would be more able to cope with the day-to-day service demands.

Since February 1983, we have appointed:

| | | |
|---|---|---|
| Ben Turners | - | Kent, East Sussex, Hampshire. |
| Ernest Doe | - | Essex, Cambridgeshire, Suffolk. |
| Shukers | - | Shropshire, North Worcestershire, North Herefordshire. |
| Hallmark Tractors | - | South Staffordshire, North Warwickshire. |
| Platts | - | South Yorkshire, North Lincolnshi |
| Medland, Sanders & Twose | - | Devon, Cornwall. |

In addition to these dealers we still have some of the original ones who operate in territories outside of the trading areas covered by the above. Obviously the demands on our personnel are extreme during planting and harvesting seasons and although we may not be involved with so many dealers we are vulnerable should we fail to satisfy the needs of one "Key Dealer" as this would dramatically effect our presence over a wide trading area and with the closing down of Fulford Trumps has made a significant impact on our sales in Cornwall.

Continued/...

2. GENERAL

1.1. Potato Harvester and Planter Market

Attached please find details of harvester and planter sales in the U.K. from 1979 through to October 1983. Potato harvester sales show an increase of 33.3% over the 1979 sales figure with sales upto the end of November 1983, 604 units. Potato planters sales have been fairly steady since 1981 and will probably average out at about 450 for 1983. The significant factor is the number of planter manufacturers has reduced from 11 in 1989 to 6 in 1983. The market therefore for potato harvesters is continuing to grow although the range of potato harvesters is much broader than before. Obviously harvesters will range from the simple digger/lifter to the sophisticated single and two row manned machine. More recently there has been an increase in the smaller end of the potato harvester market particularly in the £9,000 to £12,000 price range where small offset machines are becoming popular.

1.2. Competition

By far the major competitor is Richard Pearson selling through main dealers and sub dealers throughout the Country and also selling through their retails outlet in Lincolnshire and Scotland. This company is highly specialised in the potato harvesting market and has a large staff of people based around the Country located in the principal potato growing areas. Their continuous contact with dealers and end users and their attention to detail has placed them in an unassailable lead in the U.K. market. Currently they claim that they have 75% of the U.K. market and claim that they have received orders for 400 potato harvesters as of the end of January. The company has four full time demonstration teams complete with the necessary trucks who are able to intensively demonstrate their machines throughout the potato harvesting season. Pearson's also are extremely influential with the major potato growers due to the high standards that they set.

1.3. Other Competitors

Other competitors consist of Bonhill, Juko, Samro, Amac (Benedict), Keyag Gruse and Elbar. Of the remaining competitors there is little to choose between any of them, but perhaps Amac would be more successful than the others despite having a limited range of potato harvesters.

It is significant that Pearson's react strongly against any small competitor that shows any threat of increasing sales. Our dealers have been confronted with extremely aggressive pricing this year particularly by Pearson's as a result we failed to achieve 'Out-of-Season' orders to-date.

Continued/...

1.4. Pricing

Attached is a harvester pricing comparison which shows that the Hassia equipment is of a distinct price disadvantage against the major competitors and this is proven to be one of the major constraints in achieving sales. In addition to the terms quoted for Grimme and Amac, these two companies are able to be more competitive when selling through their retail outlets.

3. CONCLUSIONS

The potato harvester market is continuing to grow and shows no signs of decreasing. The smaller competitors are all struggling to achieve major market shares that are being totally dominated by Pearson's.

Many large dealers and in particular the new "Key Dealers" we have recently appointed, have expressed growing interest in potato harvesting equipment many of whom were formally Pearson/Grimme dealers who have disagreed with Pearson's method of distribution on a non-exclusive basis which has seriously eroded their margins. These dealers also objected to Pearson's dictatorial attitude.

The potato harvester market is very one sided at the moment and is in need of a strong number 2. Whoever makes a determined effort to achieve a major share in the market will do so at the expense of some of the weaker competitors as well as reducing Pearson's share.

4. RECOMMENDATIONS

%.1. In order to consolidate and increase substantially, it is imperative that we strengthen our sales and service team. Please refer to the Pettit Organisation phase 1 sheet attached. In addition to the personnel requirement, we would require our own demonstration unit, tractor unit and low loader so that we are not relying on haulage contractors. A better equipped workshop is required for machine preparation and reconditioning. As additional capital expenditure is involved in supporting our Hassia potato equipment sales which can hardly be justified against 1983 results, this increase in service facilities should be considered along with the introduction of Wu Trucks where I would envisage a considerable amount of product service support will be required. Based on the sales projection for 1984, we would need to establish a specialised team of technical personnel concentrating solely on Wu products. The Hassia and Wu service requirements could then be incorporated in a larger and better equipped service facility. Provided we are able to support our dealers I am confident of achieving considerable improvements in sales of Hassia products from 1984 onwards. I therefore recommend that urgent consideration should be given towards expanding our operation within these areas. Please refer to phase 2 organisation chart incorporating the Wu products.

Continued/...

4.2. Urgent pricing action needs to be taken with Hassia to place us in a more favourable position as our operating costs need to be increased to achieve the results that I consider are possible. Currently our Gross Contribution levels do not justify any substantial capital expenditure.

TMP
9.2.84

APPENDIX S

HASSIA MARKET STRATEGY - SUMMARY OF CONCLUSIONS

MARCH 1984

## 1. SUMMARY OF CONCLUSIONS

1.1 The G.B. market for potato harvesters is contracting at the rate of 2% per annum. This trend is not long term and should stabilise within the next few years.

1.2 The annual demand pattern for harvesters is cyclic and follows an eight year pattern.

1.3 The forecast (G.B.) market demand for harvesters is:

| Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Units | 1226 | 1295 | 609 | 410 | 420 |
| Retail Value(£M) | 17.8 | 18.8 | 8.8 | 6.0 | 6.1 |

1.4 The G.B. demand for harvesters is built up as follows:

| | England | Scotland | Wales |
|---|---|---|---|
| % G.B. | 83 | 14 | 3 |

1.5 Hassia has a G.B. market share of around 3%.

1.6 The present Hassia operation trades at a loss.

1.7 The annual G.C. values obtained by Hassia are as follows:

| Year | 1981 | 1982 | 1983 | (1984)* |
|---|---|---|---|---|
| G.C.(%) | 32.6 | 28.6 | 18.6 | 17.7 |

* provisional

1.8 The fall in the G.C. value is due to a failure to increase retail prices in line with costs. A failure to respond to the weakening DM/£ exchange rate has resulted in a five percentage points fall in Hassia G.C.

1.9 To restore the Hassia G.C. to 20+% the following retail price rises are required:

| | | % Retail Price Rise |
|---|---|---|
| Planters: | GLE 2 | +2 |
| | GLO 2D | +5 |
| | GLB 2D | +5 |
| Harvesters: | Z 2U | +10 |

1.10 The present strategy of maximising land coverage is inappropriate and should be changed to one of maximising market share coverage. The latter approach cannot justify the continuation of any Hassia operation in either Scotland or Wales.

1.11 The two highest buyer concentrations exist in the Eastern and Western counties of England.

| | Eastern | Western |
|---|---|---|
| % English buyer market | 51 | 21 |

1.12 Recommendation is that a retail outlet be formed to cover the Eastern counties and a wholesale operation be developed to cover the Western counties.

1.13 R. Pearsons Ltd. are our major competitive threat. However the size of the Hassia 'buyer market' coverage will hinder their ability to respond.

1.14 Due to the growing market demand in 1984 and 1985, the apparent effect of the Hassia operation on R.P. sales will be minimal. Thus R.P. is unlikely to over react to the Hassia operation.

At best R.P. can only discount retail prices by 5%. To go above this figure will push the company into losses.

1.15 An East coast retail operation could be expected to achieve the following sales:

| Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Turnover (£,000) | 116 | 751 | 1003 | 1024 | 1215 |
| Gross Cont.(£,000) | 41 | 263 | 351 | 358 | 425 |

1.16 The West coast wholesale operation is expected to return the following:

| Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Turnover (£,000) | 97 | 336 | 243 | 214 | 230 |
| Gross Cont.(£,000) | 19 | 67 | 49 | 43 | 46 |

1.17 Overheads for the above operation are estimated at £180,000. The present Hassia operation incurs overheads of approximately £100,000. So the suggested restructuring of Hassia will result in additional overheads of the order of £80,000.

1.18 The sales for the proposed Hassia operation are estimated at:

| Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Turnover (£,000) | 213 | 1087 | 1246 | 1238 | 1445 |
| Gross Cont.(£,000) | 60 | 330 | 400 | 401 | 471 |

1.19 The restructuring should result in Hassia showing a trading profit from 1985. The profit/loss projections are:

| Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Profit(Loss)£,000 | (40) | 152 | 177 | 178 | 248 |

APPENDIX T

GEEST PROFIT/LOSS ACCOUNT OF

JANUARY-JUNE 1984

GEEST INDUSTRIAL GROUP LTD

ESTIMATED PROFIT AND LOSS REPORT

| PERIODS 1&2 | PERIOD 03 | PERIOD 04 | PERIOD 05 | PERIOD 06 | | CUM.TO 06 | CUMBUD 06 | VAR/CE |
|---|---|---|---|---|---|---|---|---|
| | | | | | SALES | | | |
| 210 | 167 | 121 | 132 | 130 | MH | 760 | 737 | 23 |
| 161 | 180 | 91 | 80 | 139 | FWP | 651 | 829 | -178 |
| 169 | 101 | 60 | 75 | 160 | GOM | 565 | 598 | -33 |
| 20 | 10 | 30 | 28 | 30 | POST | 118 | 155 | -37 |
| -33 | -30 | -37 | -44 | -43 | INT DIV | -187 | -282 | -95 |
| 527 | 428 | 265 | 271 | 416 | TOTAL | 1907 | 2037 | -130 |
| | | | | | GROSS CONT | | | |
| 57 | 41 | 30 | 32 | 32 | MH | 192 | 221 | -29 |
| 37 | 37 | 20 | 17 | 31 | FWP | 142 | 216 | -74 |
| 30 | 18 | 10 | 12 | 25 | GOM | 95 | 96 | -1 |
| 6 | 3 | 9 | 8 | 9 | POST | 35 | 46 | -11 |
| 130 | 99 | 69 | 69 | 97 | TOTAL | 464 | 579 | -115 |
| | | | | | O'HEADS | | | |
| 14 | 13 | 16 | 13 | 8 | MH | 64 | 67 | 3 |
| 33 | 17 | 18 | 16 | 21 | FWP | 105 | 109 | 4 |
| 10 | 7 | 4 | 5 | 6 | GOM | 32 | 38 | 6 |
| 3 | 47 | 2 | 2 | 2 | POST | 56 | 60 | 4 |
| 61 | 39 | 31 | 31 | 38 | PROD. | 200 | 225 | 25 |
| 11 | 8 | 5 | 5 | 6 | DEV. | 35 | 96 | 61 |
| 29 | 15 | 10 | 8 | 8 | ESTAB. | 70 | 81 | 11 |
| 31 | 16 | 15 | 15 | 18 | ADMIN. | 95 | 110 | 15 |
| -2 | 1 | 1 | 1 | 1 | DIST | 2 | 6 | 4 |
| 2 | 4 | 3 | 2 | 3 | WU MARK | 14 | 7 | -7 |
| 192 | 167 | 105 | 98 | 111 | TOTAL | 673 | 799 | 126 |
| -62 | -68 | -36 | -29 | -14 | TRADING P/-LOSS | -209 | -220 | 11 |
| 20 | 12 | 10 | 10 | 12 | RENT | 64 | 64 | 0 |
| 23 | 12 | 13 | 13 | 14 | FINANCE | 75 | 70 | -5 |
| 4 | 1 | 1 | 0 | 0 | C/LEVY | 6 | 14 | 8 |
| -109 | -93 | -60 | -52 | -40 | NET P&-LOSS | -354 | -368 | 14 |
| -149 | -53 | -57 | -58 | -51 | BUDGET | -368 | -368 | |
| 40 | -40 | -3 | 6 | 11 | VARIANC | 14 | | |

## APPENDIX U

## CHANGES TO GEEST HIERARCHY ON NOVEMBER 1983

Aston University

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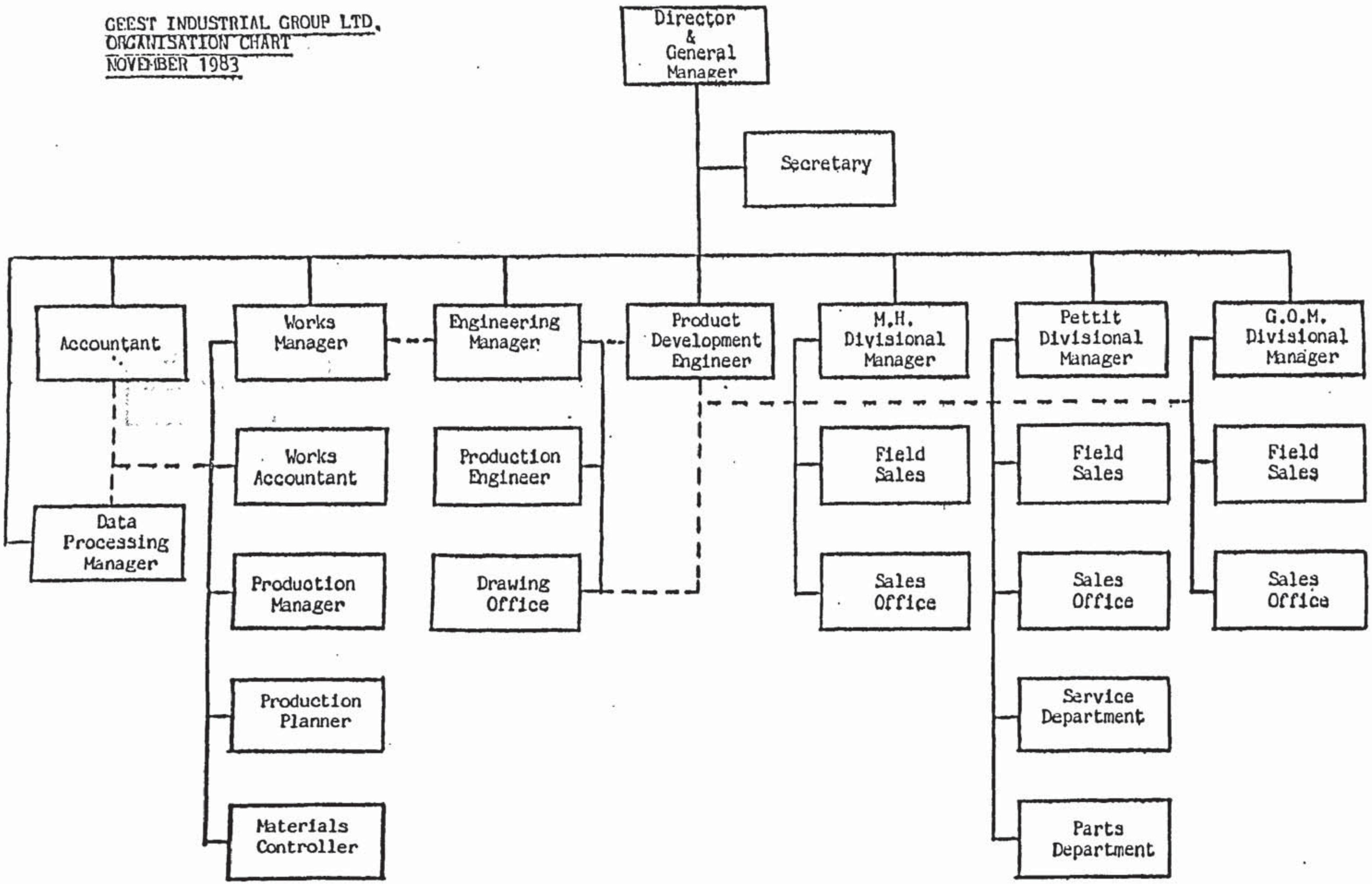
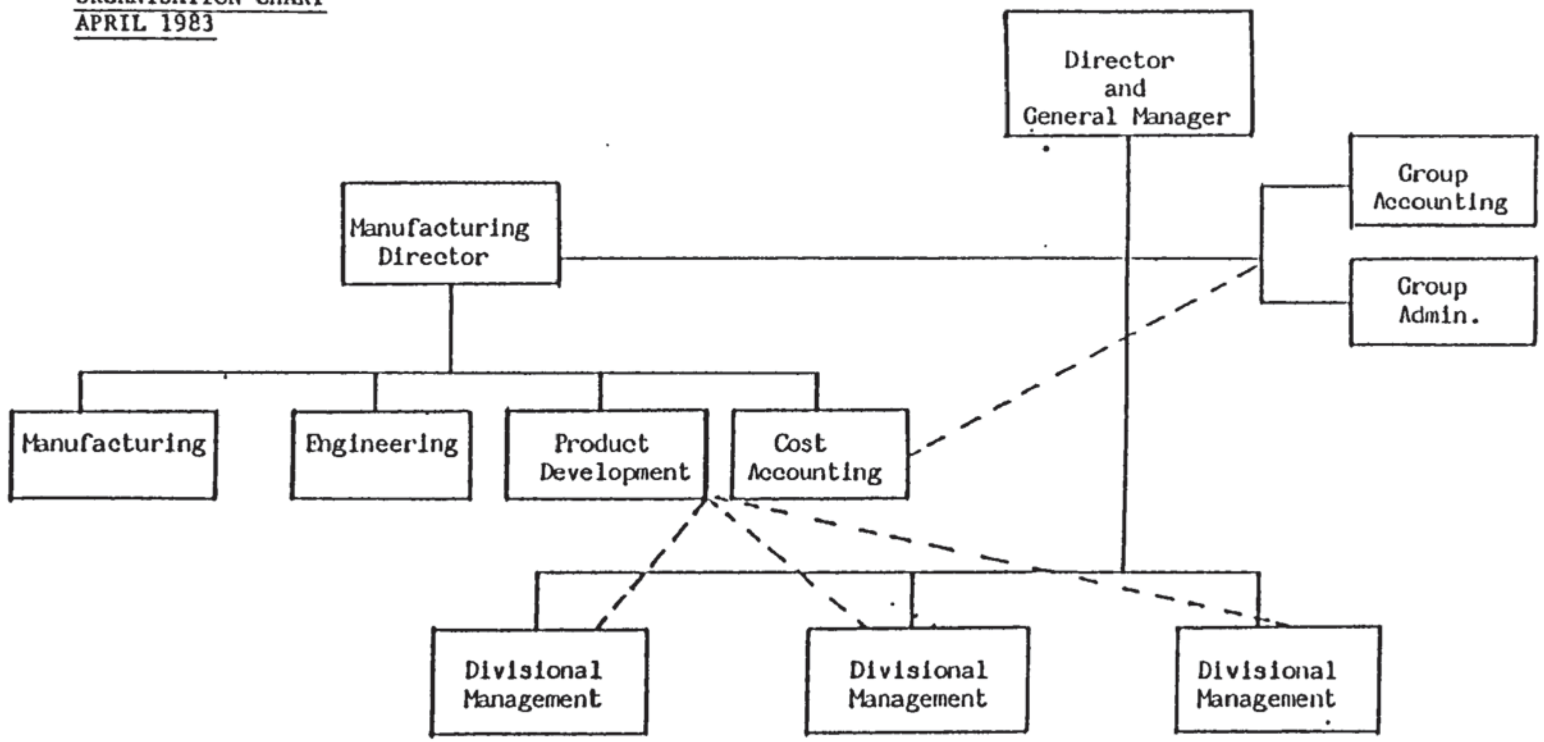
GEEST INDUSTRIAL GROUP LTD.
ORGANISATION CHART
NOVEMBER 1983



GEEST INDUSTRIAL GROUP LTD
ORGANISATION CHART
APRIL 1983



APPENDIX V

SPECIAL PROJECT CO-ORDINATOR INDUSTRIAL REMIT

FEBRUARY 1984

Geest

PRELIMINARY TASKS FOR PROJECT ENGINEER,
WU PRODUCTS

1. Establish with the relevant authorities (Driver & Vehicle Licensing Directorate at Swansea, Vehicle & Components Approval Division at Bristol, and Vehicle Standards & Engineering Division in London) the necessary Type Approval procedure appropriate to each vehicle and obtain such approval at the earliest possible date.

2. Negotiate with Wu International Limited any modifications needed to comply with the Type Approval regulations on the most favourable basis, and the costs related thereto.

3. Similarly to negotiate with H.M. Customs & Excise (in consultation with our agents) the most favourable import duty rate obtainable for each model.

4. Calculate price build-ups for the product range based on all known elements and various assumptions for those which are not yet known.

5. Conduct a survey of all potentially competitive vehicles, and compare their prices with those calculated for Wu products.

6. Study the levels of trade discounts currently granted to retailers of comparable products, and develop proposals based on discounts being related to dealer input (e.g. stock holding, forward commitments, demonstration undertakings, sales promotion effort, service back-up, parts facilities, etc.)

7. Organise visit of Wu personnel in February (or as soon as evaluation units received) for product training and demonstration programme at suitable locations involving key potential dealers.

8. Identify and arrange suitable operators for evaluation exercise under varying conditions, and draw up appropriate 'log book' for recording relevant details of hours worked, fuel consumption, difficulties encountered, breakages, overall performance, etc. Establish programme for each unit.

9. Recommend types and quantities of promotional material required for launch programme in consultation with advertising agents, and arrange procurement of agreed items.

10. In consultation with the MH and FWP Divisional Managers recommend quantities and models for further orders on Wu International (resulting from evaluation findings) to meet needs of introductory programme and subsequent demand, based on 3 months firm/3 months forecast schedule.

23rd November, 1983

Peter N. Sillars

APPENDIX W

MINUTES OF PROJECT TEAM MEETING

17 JANUARY 1983

GEEST INTELLIGENT TRUCK, MINUTES OF SECOND PROJECT TEAM MEETING HELD AT GEEST INDUSTRIAL GROUP, BOSTON 17 JANUARY 1983

Present: Mr P J Lambert - Industrial Supervisor
Mr P W Buckey - Associate Industrial Supervisor
Professor K Foster - Acamdemic Supervisor
Mr A Montgomerie - IHD Tutor
Mr J Bayliss - IHD Representative
Mr D C Menzies - IHD Student

1. The minutes of the last meeting were agreed.

2. Mr Montgomerie requested the following addition be made to the agenda.

   ii(a) Purpose and direction of Meeting. This was accepted.

3. It was recorded that Mr J Bayliss, has not been appointed as the associate academic supervisor, as was suggested in the agenda heading.

4. The report on Materials Handling, presented at the previous progress meeting was re-issued. This took place as a matter of record only.

5. Details showing the 'order of cost' of all relevant materials handling (MH) vehicles, associated particularly with the horizontal transportation of goods, were issued to members. Photocopies identifying these vehicles were attached.

6. Details of the product portfolios of all automated guided vehicle (AGV) distributors incorporated in England, were issued to members.

7. It was reported that the accounts of all AGV distributors were studied, as were Lansing Bagnall and Geest accounts, in an effort to establish any trends associated with AGV sales.

   All accounts showed similar characteristics, a period of rapid growth in turnover from 76-79 followed by static or declining figures.

8. It was suggested that a more detailed analysis may prove useful. Mr Bayliss, accepted that Historic Growth Analysis was inappropriate and agreed that the Gordon Growth Model should be applied. The results will be presented at the next meeting.

9. The profit/earnings figures for Malthouse Hunter were distributed to members. It was noted that retained earnings increased by only £50,000 in 4 years and turnover never went above £1 million.

10. The present AGV market in the UK comprises of 70 installations, 35 of which are fully integrated. This figure compares with 300 installations per country in Europe.

11. It was suggested that the UK market is restricted by the inflexibility and cost of AGV's. Their application being practical only where special factors influence the decision, reliability, hazardous area etc.

...cont...

12. It was recognised that as present AGV costs fall, existing markets will expand and new markets develop. As Geest would prefer not to be in the position of competing with Jungheinrich, Fata, etc the only alternative is to identify these new markets.

13. The following were proposed as possible markets:-

where the operator presently uses a manual or electric platform/pallet truck to:

1. Perform intermittent but routine operations.

2. Cope with peaks during abnormal productions runs.

3. Transfer equipment to/from batch runs.

These concepts can equally be applied to warehouse applications.

14. Mr Lambert, drew the members attention to the contrast between the type of markets proposed by Geest and the present AGV type installation.

18. The point was made that existing AGV distributors favour heavy duty applications, where there systems ability can be fully utilized.

This is highlighted by their respective product ranges and the tendency to establish design teams capable of providing integrated MH systems.

16. To assess the size of possible markets, the 1980 populations figures for MH electric vehicles were distributed.

17. Professor Foster, mentioned that the replacement market for electric platform/pallet trucks was limited and that other markets would probably be required. A narrow market could be used to Geests advantage if a large percentage could be captured so creating savings through 'economies of scale'.

18. Attention was drawn to the declining sales of Geest electric vehicles. It was suggested that this was indicative of a 'technological sensitive' market.

19. If the intelligent truck is to be sold as an upgrading of the platform/pallet truck then in order to satisfy present user usage a manual mode of operation would be essential.

20. It was agreed that the vehicle and guidance system must be capable of being installed with minimal disturbance to existing layout and operations.

21. Volume penetration of the market could only be achieved if vehicle costs, etc could be favourably compared against the equivalent labout requirements. This cost constraint will have to be defined.

22. Possible vehicle functions and control methods were discussed. The idea of a simple point-to-point system with the capability of expanding as required was considered interesting. It was agreed that this concept should be developed further.

23. A beacon type vehicle navigation system was discussed. In describing the operation of the system a similarity was drawn between a possible method of route selection and travel in London underground (station by station).

...cont...

24. Both active and passive beacons were considered. It was agreed that the beacon should require no external connections (services) and should be capable of operating without attention for considerable periods.

25. The possibility of producing a bolt on guidance system was considered feasable.

26. The possibility of selling the guidance system seperately was discussed. It was pointed out that the primary function was the production and selling of electric vehicles.

27. It was noted that a breakdown of the estimated research costs will be required. This figure will be used when applying for government assistance and when estimating break even volumes and cost for the intelligent truck.

28. The possibility that current UK research is already going on into the development of a beacon type navigation system has to be considered. It was agreed that this should be investigated.

29. The provisional project timetable was accepted.

30. Attention was drawn to the following specific tasks requiring attention:

    1. outline product specification

    2. identify market.

31. On government assistance, Professor Foster, mentioned that Dr Larcombe had received considerable funding for his research work on guided vehicles, and that further funding would only be forthcoming if a new and novel approach to vehicle guidance or usage could be established.

    It was accepted that this possibility existed.

32. A meeting between the writer and Dr Larcombe would now be useful in order to identify any basic project differences. A meeting will be attempted in February.

    It was recommended that prior to this meeting a visit to Aston would be useful in order to obtain background information. This will be arranged.

33. On funding, the following three sources were mentioned:-

    SCRC - Research funding

    BTG - Development

    PPDS/DOI - Prototype evaluation

34. The next date of application for government funding is 15 March 1983. It was agreed that a grant should be applied for, an attempt will be made to meet this deadline.

35. The next progress meeting will be held at 14.00 hours on Friday 4 March 1983. The meeting will be held at Aston.

D Menzies BSc. (Hons)
19 January 1983

Distribution:- All present
File

APPENDIX X

MINUTES OF PROJECT TEAM MEETING

4 MARCH 1983

GEEST INTELLIGENT TRUCK, MINUTES OF THIRD PROJECT TEAM MEETING HELD AT ASTON ON 4th MARCH 1983

PRESENT: Mr P J L Lambert - Industrial Supervisor
Mr G A Montgomerie - IHD Tutor
Mr G A Jones - Department of Mechanical Engineering
Mr J Bayliss - Associate Academic Supervisor
Mr D C Menzies - IHD Student

1. The minutes of the last meeting were agreed.

2. The appointment of Mr Bayliss to the position of Associate Academic Supervisor was noted.

3. The possibility that Mr Jones may assume the role presently performed by Professor Foster was noted.

4. Mr Lambert expressed his annoyance with the frequency of changes to the project team construction.

5. It was pointed out that the study of company accounts was proving of little use, and the suggestion made that this exercise should be concluded.

6. More documentation is required on all decision making processes.

7. Separate meetings will be held, with individual team members, to discuss the marketing and technical aspects of the project.

8. The project brief will have to be clarified.

9. A weekly progress report will be produced and issued to team members.

10. Any literature required for discussion at a progress meeting will be distributed along with the agenda.

11. The project timetable is to be redefined and re-issued. If possible the estimated expenditure at each stage of the project should be included.

12. Mr Montgomerie to look into sources of funding for project.

13. Mr Lambert accepted that money will be required for research equipment. Documented proof of requirements will be necessary.

14. Date and place of next meeting to be agreed.

D MENZIES
8th March 1983

Distribution: All Present
Mr P Buckey
Professor Foster
File

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