THE AGRICULTURAL ENGINEER

Volume 40, Number 3 AUTUMN 1985

Agricultural Engineering towards 2000

The Institution of Agricultural Engineers

Journal and Proceedings

The views and opinions expressed in papers and individual contributions are not those necessarily of the Institution.

The Hon Editor reserves the right to edit any material sent in to the Journal.

In the interests of factual reporting, reference to trade names and proprietary products may be inevitable. No endorsement of the named products or manufacturers is intended and no adverse criticism is implied of similar products which are not mentioned.

Front cover:
A strip seeder designed and developed by SIAE and subsequently manufactured by Bernewood Designs of Thame for retailing by Messrs Hunters of Chester

THE AGRICULTURAL ENGINEER is published quarterly
by the Institution of Agricultural Engineers
West End Road, Silsoe, Bedford MK45 4DU
Tel: 0525 61096

Price £4.50 per copy, annual subscription £18.00 (post free in UK)

THE AGRICULTURAL ENGINEER

Volume 40, Number 3 AUTUMN 1985

Contents

ISSN 0308-5732

Presidential address

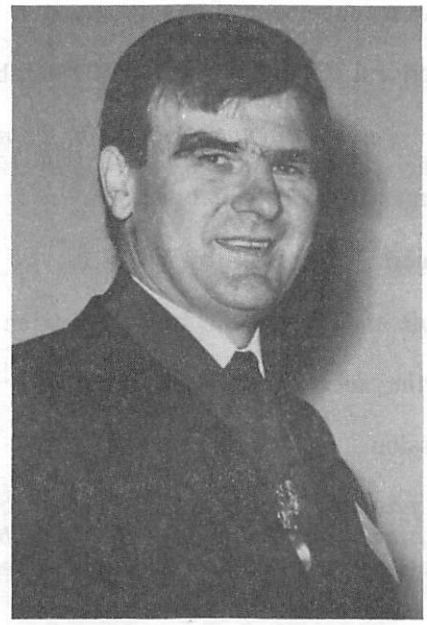
Engineering for tomorrow's agriculture: the need for partnership and the management of change

B A May

Introduction

IN the twenty-first century, the mid-1980's will probably be remembered as a time when agriculture in Britain was described as 'an industry in abrupt transition'; when the science base of agriculture was under extensive review; when foundations were being laid for major developments in the food industry; when the engineering profession in Britain was in the midst of significant change and when the agricultural engineering manufacturing industry in Britain was slowly turning round, a drastic decline experienced in the previous decade. The mid-1980's are also likely to be recorded as a period of continuing difficulty in terms of creating an efficient and productive agriculture in developing countries. Despite continuing advances in science, engineering and technology relevant to agriculture, it has not been possible to find means of applying these advances widely and effectively in food deficit regions of the world.

The 1985 Presidential Address of the Institution of Agricultural Engineers is presented against this background of change and challenge. Agricultural engineers are playing a full part in these developments, sharing in the successes — and the failures. Much of the success achieved by agricultural engineers has been through working in partnership with farmers, scientists, industrialists and others. Some of these partnerships are explored in this address, in terms of what is being achieved and how they are assisting in meeting change and the need for change.



(Silsoe College photograph)

Consideration is also given to the future role of partnerships involving the agricultural engineer.

The subject of this address is therefore broad and directed towards a wide audience which includes Institution members, other scientists and engineers connected with agriculture, farmers and those in the early stages of career selection and development.

The address has two aims. One is to emphasise and demonstrate that agricultural engineers recognise the need to maintain existing partnerships and form new ones to be effective and successful in their work; the other is to suggest that change is frequently inevitable, but, viewed positively, can be managed to some advantage in most situations.

The farmer

Over the centuries, farmers have become expert at managing change brought about by many factors occurring naturally and man-made. In recent decades, agricultural engineers have provided an increasingly important means by which farmers can manage change which occurs in their work. This effective partnership between the farmer and the agricultural engineer has always been close, for the simple reason that in the early days and notably during the first half of this century, in Europe and North America most engineers working in agriculture were also farmers.

The original aim of the farmer was to produce food to feed himself and his family. Under such circumstances, engineers had only a small role to play, but even in those early times engineers had already begun to co-operate with the farmer, particularly in controlling water availability through irrigation and drainage systems. As communities have developed, the farmer has been called upon to feed an increasing number of non-food producers living and working in urban areas. To achieve this, a rapid change from labour to capital intensive farming usually occurs, with increasing assistance from the agricultural engineer to provide the mechanisation components and systems which enable the plough to replace the hoe and the tractor to replace the animal.

Professor Brian May is Head of Silsoe College and Dean of the Faculty of Agricultural Engineering, Food Production and Rural Land Use, Cranfield Institute of Technology.

The Presidential Address was delivered at the Annual Conference entitled: Agricultural Engineering Towards 2000, and held at the National Agricultural Centre, on 14 May 1985.

In most parts of the developed world, the farmer, with the assistance of the agricultural engineer and others, has fully achieved what has been required of him through dramatic changes in farming patterns and practices. Britain, for example, now has less than three per cent of the working population in farming, producing 80% of the temperate climate food consumed. Self-sufficiency in the context of the European Community is further advanced, in some commodities currently beyond 100%. Marketing practices combined with continued high production levels have on occasion caused large food reserves to be accumulated. There is concern that the cost of achieving self-sufficiency in food has been high in environmental terms. The image of the farmer has suffered because of this and because of public concern for animal welfare under intensive farming conditions. As food production levels reach desired targets, government subsidy levels, other support systems and quotas are correspondingly adjusted.

Against this background, farmers and agricultural engineers are reviewing their partnership for the future. The challenge is to maintain levels of food production at the farm gate which satisfy a wide range of needs under conditions of complex and often unpredictable change. The review includes the seeking of partnership beyond the farm gate both for fresh and processed agricultural products. The farmer and the agricultural engineer are together developing an understanding of the nature and direction of change which is important if its management is to be effective. Situations involving over-production and excess capacity are receiving careful attention, both in farming and in the support industries. Farmers, assisted by agricultural engineers, will, however, need to ensure that required food production targets already reached are maintained responsibly and consistently in a tighter and more demanding market economy. To achieve this, advanced and appropriate machinery and equipment will be necessary to maintain flexibility, timeliness and production requirements. There are, however, no universal solutions in agriculture. Particular situations and style of farming enterprise have particular needs. While the total number of farmers may decrease, profitability will remain high on the list of management priorities for most farming enterprises.

The large, specialised farmer may become even more intensive in his production methods to maintain profits at reduced margins. Agricultural engineers continue to assist these farmers with field machines and animal production systems having increased capacity and higher efficiency levels. Agricultural engineers are also working on buildings, mechanisation and controls for protected cropping — a highly intensive and potentially very profitable system especially in favourable climates. The smaller farmer will be looking for lower capacity, cheaper machines and equipment matched to small farm conditions and requirements. Simplicity is likely to be favoured, combined with high reliability and minimum running costs. While the agricultural engineer can usually design and develop systems for the small farmer, the commercial availability sometimes does not follow, because of low price expectations or limited numbers required. In such circumstances, the farmer may have to make or adapt machines on the farm. Perhaps the most common requirement in farming will be for reduced input costs while maintaining existing levels of output. The agricultural engineer has much to contribute to the farmer in this area. For example, through machines and equipment which will give more efficient weed control, more accurate fertiliser placement, better water application, reduced cultivations and lower energy requirements for tractors and machines.

Agricultural engineering contributions to environmental needs have been significant and will continue through such developments as slurry injection and straw incorporation into the soil. The agricultural engineer also considers the environmental needs of farm workers — for example, through cab and workspace layout developments which improve safety and reduce exposure to noise and vibration.

Attention to animal welfare by agricultural engineers takes many forms, an impressive example of which is the mechanical chicken harvester used to collect poultry in broiler houses at levels of stress to the chicken significantly below hand collection. Agricultural engineers are participating fully in using the results of animal behavioural and physiological studies to assist in the development of commercially viable systems which enable animals to live in groups more akin to traditional methods. Such systems may utilise bedding for livestock, avoid the need to tether individual animals, provide individual care and feed with the assistance of animal identification electronics and gives attention to the control of dust, temperature, air movement and humidity, in the interest of livestock comfort and freedom from disease.

Partnership between the agricultural engineer and the farmer is thus as important in the future as it has been in the past, to enable those beyond the farm gate to benefit fully from an efficient, productive and responsible agricultural industry.

The scientist

Agriculture is a science-based industry. Science is making substantial contributions to the success of the industry through work in plant breeding and genetics, crop nutrition and protection, soil physics and chemistry and by increasing the understanding of biochemical and physiological processes of growth and development in plants. In the case of livestock, the agricultural scientist is making important contributions in animal breeding, nutrition, disease control and production.

Further advances are being made by the scientist in the fields of genetic engineering and biotechnology. Techniques are being developed which are potentially of considerable importance to agriculture. Examples include tissue culture and embryo transplants.

The agricultural engineer has traditionally worked closely with the scientist to help the farmer to get the best from the results of this scientific work in practice. To assist in effective and rapid uptake of results of research on the farm, scientists and agricultural engineers often work side by side. Examples of this include mechanisation of the laboratory techniques for tissue culture, design of applicators for highly concentrated low volume chemicals, low volume localised water supply for plants, and the utilisation of

animal and plant by-products such as slurry and straw.

In addition to working with agricultural scientists, the agricultural engineer is bringing to the farmer the concepts and ideas from other branches of science. Materials science, for example, enables the agricultural engineer to design machines and equipment capable of working under the abrasive and corrosive conditions commonly experienced in agriculture. The agricultural engineer is particularly concerned with modern branches of applied science. Remote sensing, using satellite imagery is being applied by agricultural engineers in partnership with scientists for land soil and crop surveys. The application of a wide range of physical and chemical sensors in agricultural systems is a high priority and an expanding field. Robotics has potential in materials handling applications. Cybernetics, the interlinking of control, measurement and communication has important future prospects for the development of agriculture.

In Britain, economic pressures and changing research priorities are reducing the amount of public sector support for some branches of science. Agricultural science is affected by this situation and several changes are in progress. In order to meet this challenge, scientists and engineers will need to find ever more effective ways of working together to ensure that scarce public funds are put to best use in the service of the farmer.

Central to this will be the identification of acceptable criteria for assessing scientific and engineering research as closely associated, but individual activities. It will also become desirable and perhaps essential, to consider the establishment of a recognised measure of performance whereby the contribution of public sector work to profitable agriculture can be quantified. In this way, a basis may be found for helping to ensure continued and adequate public funding for essential longer-term work in support of agriculture conducted by scientists and engineers individually and in partnership.

The industrialist

The work of the agricultural scientist and agricultural engineer can usually only become effective and available to the farmer when the industrialist completes the chain by providing the means of application in the form of commercially available products such as seeds, fertiliser, chemicals, vaccines, animal feed, buildings and machinery. The agricultural engineer is involved in some way with all of these products. The link between the agricultural engineer and the industrialist is therefore vital.

Most industrialists connected with agriculture have been required to face considerable challenge and need for change during the recession. This has applied particularly to British agricultural machinery manufacturers. Some companies have reduced staff levels by two thirds, while others are no longer trading. Re-investment in production capability and trained manpower is, however, beginning to occur. Individual companies are increasingly finding themselves in a position where they can be receptive to ideas for new products and market strategies. The British agricultural engineering manufacturing industry is now winning a greater share of the business at home and overseas. Inevitably, this trend is not occurring as rapidly as everyone would wish. There are reasons for this. Major uncertainties still exist for agriculture locally and farther afield. This situation limits the amount of investment which industrialists and their financial partners are prepared to make in order to develop commercially the many good ideas originated by agricultural engineers. Despite the encouraging signs of recovery, industry knows that it must contain risk through a cautiously optimistic approach. The balance between risk and caution is critical. Flexibility is a necessary requirement within each organisation to facilitate rapid response to change in highly competitive situations. Incorrect judgement may transfer the initiative to another company, perhaps located in another country.

In Britain, the industrial sector relevant to agricultural engineering is characterised by a large number of small companies. The strength of our future industrial base in Britain is likely to be largely determined by the continued existence and strong development of these small companies. Small companies are paricularly vulnerable when attempting to exploit some of the higher technology generated by scientists and developed into practical forms by the agricultural engineer for the benefit of the farmer. The continued public support for industry in sharing some of the risks associated with the initial development of new products and markets, is thus vital during the current periods of uncertainty and in the longer term.

Other professional engineers

In order to utilise fully the work of agricultural scientists, the agricultural industry attracts the support of professional engineers from several groups other than agricultural engineering. This is welcomed by the agricultural engineer in a positive sense as a means of strengthening the role of the engineer in agriculture. It also helps to unify the engineering profession as a whole and to ensure that the best and most appropriate engineers available are at the service of the farmer.

Included amongst the professional engineering partners are those from the mechanical, electrical, chemical and civil disciplines. Less commonly, many of the remaining branches of engineering are working in agriculture.

The mechanical engineer is prominent in the area of mechanical design, including engines, gearboxes, transmissions and linkages for self-propelled equipment. Electrical and electronics engineers are developing some of the instrumentation, sensors and controls used by the farmer. Chemical engineers are contributing to the development of plant for animal waste treatment, while civil engineers often practise beyond the dam and primary distribution system to work directly in irrigation and drainage schemes. The agricultural engineer may be found working professionally in all of these areas and he plays a unique role where there is a requirement for a combination of fundamental engineering skills combined with a thorough understanding of agricultural need.

Through its specialist groups, the Institution of Agricultural Engineers encourages collaboration with members of other engineering institutions to enable a joint approach to be taken to engineering problems which occur in agriculture. The specialist groups also bring together engineers registered at all levels within the Institution of Agricultural Engineers. This

arrangement assists communication between engineers in management, design, installation, servicing, maintenance and operation. In agricultural engineering, these partnerships between registered engineers in all grades and non-registered members, are as important as the exclusive co-operation between chartered engineers. These and perhaps other partnership arrangements in engineering will need to be further developed in the future with emphasis on high professional standards and industrial relevance. In Britain, this will be necessary under the leadership of the Engineering Council to maintain and further improve the standing of the engineering profession as a whole within industry and society generally.

Partnerships in developing countries

The major contributor to food production for local consumption in developing countries is usually the small farmer. The agricultural engineer is producing a wide range of ideas for individual machines, equipment and complete systems which can help the small farmer to make use of adapted and new technology. The small farmer is often working at subsistence level and in a non-market economy. Consequently, many of the agricultural engineer's ideas never reach the farmer because of the lack of an industrial link in the chain. Where an industrial link does exist in response to market economies elsewhere, it may be beyond the reach of the local farmer because the purchase price is incapable of being supported by his income. Subsidy through local or foreign aid may help in the shorter term, but different solutions need to be sought for the longer term.

Partnerships in developing countries with small farmers, industrialists and others, are therefore difficult for agricultural engineers. In attempting to provide for the smaller farmer, the agricultural engineer must take account of the social, political, physical and economic realities of the system within which the farmer works. It should be recognised that these realities are subject to change which is sometimes marked and often unpredictable. In such cases, it often becomes necessary to replace longer-term, planned agricultural development with emergency food aid policies.

In many situations the engineering solution may be simple, but making it appropriate, affordable and useable by the farmer can be intellectually demanding and elusive in a practical sense, leading to frustration and failure, particularly if the realities are not fully considered. There are ways in which the agricultural engineer's ideas can reach the small subsistence farmer, if only to relieve some of the drudgery. These usually involve further partnerships with government departments, development corporations, co-operatives, aid agencies and occasionally, private sector groups. In several developing countries, more emphasis is being given to expansion of the private sector in ways which might assist the small farmer. The agricultural engineer will have an important part to play in this.

Export crops are often dealt with on a larger scale in developing countries. Examples include cotton, sugar, coffee, tea, rubber and palm oil. The agricultural engineer is sometimes able to help by providing relatively sophisticated technology to these enterprises, usually on a commercial basis. The need for good quality management and well-trained operators can also be fulfilled through co-operation with the agricultural engineer.

It is in this larger-scale agriculture linked to a market economy where commercial practice is mainly applied in developing countries. The agricultural engineer, often working in partnership with the importer or foreign manufacturer, needs to know at an early stage when local communities expect conventional agency arrangements and imported complete machines to be replaced by joint ventures and local assembly leading to local manufacture. Such industrial transformations may be desirable, but need time, careful planning and the availability of local support services and skills before they can be applied successfully. Local government also has an important role to play in creating a favourable and stable environment within which such transformations can occur. Some progress has been made with agricultural tractors and other technologies such as fertilisers. Local manufacture of indigeneous or licensed farm machinery and equipment is less common, especially in Africa.

The application of existing and the development of new technologies can bring new problems for the farmer and for the rural sector generally in developing countries. This will require special attention by the agricultural engineer working in partnership with the scientist. For example, the construction of surface reservoirs and irrigation schemes can bring many benefits to less fortunate rural communities. They can also bring vast health problems by creating conditions where vector-borne diseases can flourish, such as malaria and river blindness. River dams and large irrigation schemes can reduce water flows to a point where weed control becomes difficult and communities dependent upon fishing become threatened.

Maintaining satisfactory relationships between soil, plant and water is essential for crop production in all parts of the world. It is the basis of several important partnerships for the agricultural engineer, especially in developing countries where conditions can present considerable challenge, caused, for example, by salination, erosion or water deficiency. Technology needs to be applied with great care and experience under such conditions. Attention also needs to be given to social, economic and management problems which may arise from technology application in developing countries.

Despite the difficulties, the achievement of a rapid transformation of agriculture in developing countries through effective application of agricultural technologies is probably the only means of winning the race between increased food production and population growth. Effective application, invariably involving the agricultural engineer, will need to be measured in terms of improvement in output performance rather than level of expansion of inputs. Aid will need to continue to play a prominent part in this to give time for the commercially-orientated transformation to be developed to strengthen the economic base of agriculture. Expert administration of the aid will be necessary if it is to produce the intended effects. Most successful aid projects are only partially supported by aid funds. They are often initiated and managed by local staff. They are in complete

accord with local government policy and capable of becoming self-supporting within an agreed time period. Agricultural engineers working in partnership within such systems find it necessary to become familiar with such criteria for success in aid. In addition, this involves the principles and practice of aid co-ordination, aid co-financing, aid dependence and aid-trade relationships. Agricultural engineers are also required to give due care to the rural environment in developing countries and, unless labour shortages already exist, propose engineering solutions which will encourage rural communities to remain in the higher potential rural areas. Where this is not possible, the challenge is to develop techniques and systems for increased food production in rural areas of lower potential.

Some other partners

In addition to the partnerships discussed so far in this Address, mention should be made of others which may be well established or at a formative stage of development.

The scientist is co-operating with the agricultural engineer in knowledge advancement and the industrialist is a prime mover in knowledge application. Knowledge dissemination involves the agricultural engineer in further partnerships with trainers, extension workers and consultants. Each has a key role to play in helping to ensure that there is a sufficient supply of suitably-trained and regularly updated agricultural engineers. Agricultural engineering knowledge also needs to be disseminated to farmers in many circumstances. Other agricultural engineering partners need to be appropriately informed about engineering matters.

Quality and effectiveness of dissemination is likely to be sought in future through the provision of innovative programmes designed to meet practical needs in a flexible manner. A thoroughly professional and practical approach to knowledge dissemination is essential if the skills and competence of the national agricultural engineering workforce at all levels is to meet industrial requirements. Failure to do this will assist overseas competitors to overtake and out-distance the local industrial community in the race for orders. It is therefore necessary both for the providers and employers to recognise the urgent need to bring about dramatic changes in attitude and practice with regard to training. This emphasis on change, professionalism and accountability is already having a marked effect upon the content and style of education and training programmes in Britain. The Institution of Agricultural Engineers is playing an important role in connection with the development and accreditation of agricultural engineering programmes. Agricultural engineers are working with several national organisations in assisting this process of change. Prominent amongst these organisations are the Agricultural Engineers Association, the Department of Trade and Industry and the British Agricultural and Garden Machinery Association. Correctly managed, these changes in dissemination practices can and do produce benefits for the farmer, ultimately in terms of better products, improved systems and practical advice leading to increased profitability.

Over the years the agricultural engineer has established partnerships in agriculture, forestry, horticulture, the water industry and rural land use. The prospect of several new partnerships is now emerging, beyond the farm gate. The food industry generally is expanding and in need of a wide range of engineering inputs particularly related to food processing and fresh food chilling. The agricultural engineer is in a good position to help with some of these inputs. The Institution of Agricultural Engineers is a potentially relevant professional base for those working on engineering aspects of the food industry.

Developments in the food industry are also likely to have an increasing effect on farming practices and outputs. Agricultural engineers, in partnership with the farmer and others, will need to react positively to these changes to help to ensure that adequate and regular supplies of produce of the right quality are available on competitive terms for subsequent processing or handling in the food chain. Where excess is produced by the farmer for whatever reason, the agricultural engineer may be able to help to devise new processes and profitable methods of utilisation.

We are already producing food without the support of agriculture at all. Ways are being developed to farm the sea. There may be a role for the agricultural engineer in this field and others, but in the main and for the foreseeable future, agriculture is likely to provide the operating base for the vast majority of agricultural engineers.

In all of our efforts, individually and in partnership, we must never forget the most important partner of all — the consumer. With the help of packaging, materials handling, marketing and many other specialists, our common purpose is to ensure that the consumer, whether in Doncaster or Dacca, receives a regular supply of food from agriculture and its allied industries, in an attractive form, at an acceptable price and without undue stress on the environment. It is on this aim that all of our efforts should be focussed and the ultimate measure of our success depend.

Guest Editorial

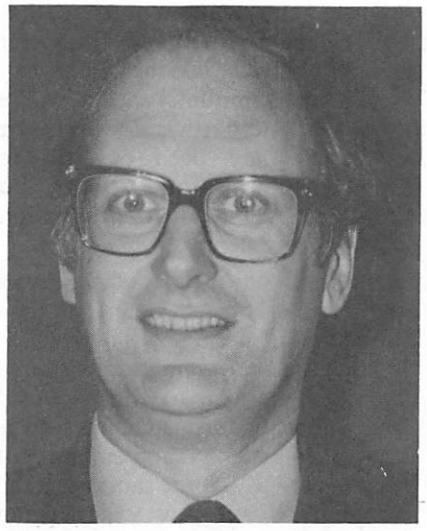
Agricultural Engineering towards 2000

G H Evans

YOU will recall that last year's Conference ran on the same general title as this year, that is "Agricultural Engineering towards 2000". At that time we took a preliminary look at our industry, examined some of its problems, and started to look ahead to the future. Today, we are going a stage further and our four speakers will spell out the way to success for our industry. It is very much a "how to do it" day.

The manufacturing sector of our industry has a great opportunity to create wealth, but this wealth will only come through long term planning rather than any short term expediency. Only by being profitable can our industry develop real strengths; the strength to develop products, the strength to develop markets and the strength to develop the careers of those who have chosen to work in this industry.

It is unfortunate that the creation of wealth is not a priority in everyone's mind, and it is equally unfortunate that the counting of wealth is so often more highly rewarded than its creation.



Engineers, and particularly agricultural engineers, who are at the foundation of wealth creation, are often inadequately rewarded for their efforts both in monetary terms and in recognition.

If we look back over the past six or seven years, you will probably agree that we have now had enough criticism of our industry from outsiders. Let's not deny, however, that many of the problems from which we suffer are of our own making, but this certainly does not apply to all of them. The doom and gloom merchants have had their say and they must be reminded that depression is based on yesterday's news. Today's news is there are agricultural and tractor manufacturers who are now succeeding both at home and abroad with much better performances than have been achieved in recent years.

For example, in 1984, tractor production increased by 12% and tractor exports increased by 23%. In fact 79% of all the tractors produced in this country went overseas. Let's not forget the machinery manufacturers who increased their exports by 15% during last year.

These encouraging statistics are a strong indicator of our industry's improving performance, and whilst it is sad that our employment numbers fell by a further six per cent in the year, the underlying effect is that we now have an industry that has increased its productivity by leaps and bounds so that we are becoming competitive again.

At our Conference today, we have to show the outside world that we have got our act together and that we are a force to be reckoned with. We can make no better start than by listening to our speakers who are chosen for their very real experience, either directly inside our industry, or very closely involved in supporting our wealth creating activity.

Geoffrey Evans is Chairman of A C Bamlett Ltd, Thirsk, and acted as Chairman of the Annual Conference held at the National Agricultural Centre, on 14 May 1985.

Investment prospects and needs

R L Dodsworth

Summary

A REVIEW of the areas in a company where investment should be made to ensure the healthy development of an agricultural engineering company in the economic climate that will exist to the year 2000.

Introduction

My aim in this paper is to look at the areas in a company where I feel investment is necessary and also to touch briefly on the prospects for investment in the agricultural engineering industry in the future.

Before looking in more detail at the question of investment, however, it is relevant to look back at what has happened in this country in the last five years. The experience of the agricultural engineering industry has been similar to industry as a whole over that period in that we were faced, in 1980, with a world depression and, at the same time, a need to improve our productivity and cost competitiveness compared with our overseas competitors.

It is fair to say that, up until that time, the agricultural engineering industry had experienced a steady growth in business which, whilst not necessarily being of an even pattern, had at least kept factories working at acceptable levels of production. The effect of the recession that hit us in 1980 was to expose rather sharply some of the inefficiencies that existed in the industry. Too many companies in the UK had been too dependent on the UK market where they had been able to earn a good living without the necessity of having to get involved in the more difficult business of exporting. Even those companies who were exporting found that some of the traditional and perhaps easier markets were no longer open due to lack of funds, which left increasing competition in the remaining 'tough' markets such as continental Europe.

Bob Dodsworth is Group Chief Executive of Ransomes, Sims & Jefferies plc, Ipswich, Suffolk.

This paper was presented at the Annual Conference entitled: Agricultural Engineering Towards 2000, held at the National Agricultural Centre, on 14 May 1985.

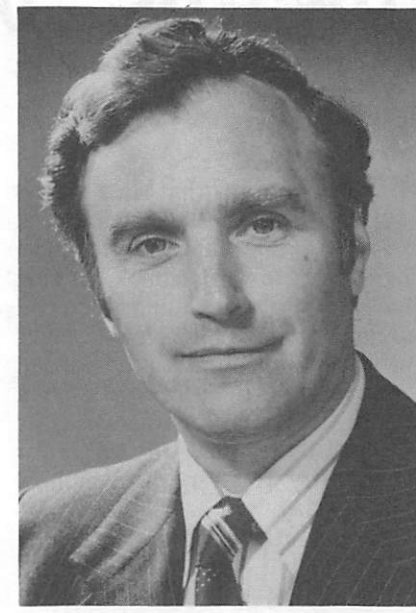
There is no doubt in my mind that UK companies suffered from not being involved in the European Economic Community earlier, where those that had participated from the very start had been engaged in intense competition which had sharpened their own production skills and efficiencies.

International trade was increasing and, as it happens, increasing at a time when demand was falling away. In 1980, we were vividly exposed to a situation where capacity in the world for producing farm machinery was very much greater than demand, not least in the UK. At the same time, the competition we were experiencing was getting much stronger, and unfortunately the foreign competition found the UK to be a relatively profitable market in which to operate.

The effect of this has been so dramatic that some companies have disappeared completely from the scene, whilst others have had to radically change and re-think their objectives to remain competitive and survive.

We do live increasingly in the age of the specialist, and many of the companies in the agricultural engineering industry were, in my view, engaged in designing and manufacturing a range of products that covered too wide a spread, and, as a consequence, were not doing anything really well. It has been important for companies to identify their own particular speciality and the range of products upon which they are going to concentrate. Companies have also had to recognise that even then they are probably only going to succeed if the market in which they operate is large enough.

In the future, it seems unlikely that the UK market is going to be big enough for companies to get the sort of volume they will need to succeed



long term against the international competition we face.

We have to remember that important as the UK market is, it is a comparatively small market and will remain so in the European context as a whole. We have to recognise that companies will only succeed in the future if they are designing, developing and producing products for at least the European markets as a whole and, indeed, we should really be regarding the European market now as our home market.

This is not to say that the markets beyond Europe are unattractive because I am sure they are important too, and it is important to keep in touch with them. They do, however, tend to be more volatile than the stabler European market and it would be unwise to invest too heavily in products for markets which could be going flat out one year, with no business the next.

So, I feel that when looking at investment in the general sense for the future, companies should be thinking about specialising in a certain product area for a market wider than just the UK and certainly, at least, the European market as a whole.

Marketing

Turning now to the areas in a company where I feel investment is

needed, I am not restricting myself to those which involve the purchase of straightforward tangible assets because there are others, and the first is marketing. Clearly, a company must fully understand and know the market in which it operates. It is worth spending money on employing your own people or even an outside agency to ensure you have a complete picture of the size of the market and the type of product required in the sector in which you operate, and in doing this it is important again to look at the key export markets.

Some of the markets in Europe are considerably bigger than the UK market and to achieve a small percentage share of some of those markets can be very rewarding. It is, however, very important to understand the product requirements. Too often in the past it has been the practice of companies to develop products for the UK market and then try to go out and sell them in other markets in Europe. Whilst the basic requirements might be almost the same, this often does not work because small alterations or a slightly different design are needed to make them acceptable in other countries. It is therefore important to put some investment into obtaining this knowledge before you start on the design and development of a new product because it is often possible to have considerable commonality in a product, whilst at the same time catering for the special requirements of an individual market. Once you have achieved sales to a particular country, it is then easier to keep abreast of the changes in trend taking place in that country.

Design and development

The next area I would like to look at is investment in the design and development of products. New products are the life-blood of all companies and unless we devote sufficient investment in this area and use it properly the company will eventually suffer.

It is not, however, just a question of how much money you are prepared to invest, but also, of course, the efficiency with which it is used.

How much investment should be made varies from company to company, but as a rule of thumb, I feel that unless a company is spending 3% of its annual turnover on research, design and development, then it is probably not spending enough to ensure its future. If it is investing more than 5% then it seems to me that it is probably not going to be able to make full and proper use of the investment that is being put in and is therefore wasting some of its expenditure.

In deciding in which products to invest, there should be a sufficiently wide market so that it is possible to generate an adequate level of turnover and profitability. Each project should be carefully monitored at regular intervals to ensure that the ultimate objectives on profitability remain intact.

An important factor in developing a new product is to try and bring it to the market place as quickly as possible after conception. Any investment which helps towards this goal is worthwhile. Two aids in this connection are computers and test rigs. The use of small computers can take the slog out of a lot of engineering work, and computer-aided design when fully integrated into the design office can significantly increase productivity. The cost of investment in the latter can be high, but it is an area which I feel all companies should be looking at.

One of the difficulties that many of us in the agricultural engineering industry experience is the shortness of our seasons and therefore a limited time in which to actually test our products in work. By investing in test equipment which today can be very sophisticated, we can, in many instances, put products or parts of products through what amounts to a number of years' work, and in effect a product's life span, in a matter of weeks. Whilst I do not pretend that this is an adequate substitute for actually testing a product in work with a typical operator, it is, nevertheless, a valuable adjunct to the normal test and development work, and, coupled with the investment in computers, has helped to reduce the development time of new products which is vital when dealing with international competition.

Manufacturing

Investment in manufacturing can come in different ways. It is an area where in the last five years companies have had to examine closely their position for the future. Many companies in our industry, as indeed in many other industries, have been in existence for a long time and have through necessity over that period tended to become very self-sufficient

Fig 1 This 9-furrow "push-pull" ploughing combination incorporates the recently introduced TSR 300HD 6-furrow plough. It is operating on a medium heavy land farm in Suffolk, ploughing 35 cm wide furrows 23 cm deep with a 120 kW tractor (photograph: Ransomes Sims & Jefferies plc)

in what they manufacture. However, we now live in the age of the specialist, and it is unrealistic to think that small, medium and, even to some extent, large companies can be efficient in all manufacturing activities or have any chance of keeping themselves up to date in all areas for the future. I believe, therefore, that companies must examine which areas of manufacture are important to them and where they are going to have the throughput to justify doing the work themselves. They can then concentrate on these areas and buy out remaining parts from specialists who can produce competitively.

Obviously, dramatic changes to a manufacturing structure cannot be made overnight, but it is worth doing an exercise to visualise where you would like the structure to be if you were starting from scratch and then working out a timetable to move towards the ideal over a period of time. There have been some important trends in this direction over the last five years. Help in moving towards this policy can come from the wider market in which we now operate. At one time we did not look very much further than the UK when we were buying but now, just as we are regarding Europe as our home market for selling, we should regard Europe as our home market for buying and certainly there are many specialist manufacturers of components and parts in Europe to ensure competitive prices can be obtained.

This brings me to look more closely at the individual areas of manufacture and, firstly, buildings.

Buildings

It is important to be conscious of the proper use of space and to be looking all the time at how you can make the best use of the space you have available and, indeed, if you have too much space, whether or not you can make it revenue-earning in some other way. Going back to the 1960's and early 70's, the cost of space was comparatively cheap. However, we have now been through a period when, in many areas of the country, local authority rates and fuel costs for heating buildings (to name just two items) have risen considerably and this can make building space very expensive. We must, therefore, be sure that we are making adequate use of the space that we occupy.

Plant and machinery

The nature of investment in plant and machinery will depend upon the areas in which the company decides to specialise for the future. I think it is important that in those areas which you do choose, you are certain that you are going to be able to afford the investment to keep the machinery up to date and competitive with anybody else, and this entails ensuring that there will be an adequate and continuous throughput for the equipment being purchased.

With the sort of high technology plant that is available (computer numerical control machines of all types, robot welders, etc), it is vital to make maximum use of it to justify the investment and keep costs competitive. We should, for high cost investment be looking at two if not three shift working. This in itself in some parts of the country may mean a change in attitudes of the workforce.

There has been some adverse comment about the reduction in capital allowances for plant and machinery that was introduced in the budget last year, but, personally, I think the changes were a move in the right direction and should encourage investment for genuine investment reasons rather than as so often has happened in the past, to avoid paying tax. In fact, I think this is one thing that has bedevilled us in the agricultural engineering industry for some years in that when a farmer has had a good year he has, in a number of instances, bought machinery when perhaps he didn't need it in order to absorb his tax position which has tended to distort the market from one year to another.

The UK manufacturer has not always been able to respond quickly to these violent swings which as a consequence has often led to foreign competition taking advantage of the situation. I would much rather have a position where corporation tax on profits is lower, which in turn provides encouragement for investment in machinery for the right reasons of being more efficient, so that you can earn more profit knowing that you will be able to retain more of what you earn.

The switch (when we finally complete it) will lead perhaps to a more even flow of investment by the farmer which will be better for the industry as a whole.

I would, however, put in one personal plea here for the British manufacturer and that is related to the 25% reducing balance which is not very satisfactory. The straight-line method would be far better and much more in line with competition in other countries and, indeed, it would be preferable to go to a 20% straight-line method instead of the current 25% reducing balance. Pressure is being exerted on the Chancellor by British industry to make this move and I hope that eventually we shall see this change.

I do have fairly strong views that, when investing in buildings and in plant and machinery, companies should not be fooled by incentives that are available. We have seen companies moving to development areas because of the grant available on buildings, and subsequently regretting it. We have seen companies purchasing plant and machinery either because of the incentive available or to absorb a tax position, and then regretting it in a year or two's time when they would have been better to have paid the tax and at least have some money still available.

Every investment project should stand up commercially in its own right without the exceptional incentives that are sometimes available. If it does that and then you can take advantage of incentives, then surely this should be regarded as a bonus rather than an essential ingredient in making a decision in the first place.

When it comes to deciding the relative merits of investment projects, there are of course all manner of formulae and methods available for consideration. I believe in a rather simple approach and take the view that anything that gives me a pay-back within a year on a straightforward basis is an immediate starter; anything inside two years is a high priority; three to four years will be considered, anything in excess of four years is probably not worth looking at and there must be some better way of doing it.

Production control

Another area that is worthy of consideration on the manufacturing side is to ensure an efficient system of production control. Investment in this area can get you a good pay back if it means a reduction in the lead

times of your product manufacture or the stock that you carry and really these should be the two principal objectives of an efficient production control system. The period between placing an order on the works for a product to its completion should be reduced to a minimum whilst at the same time the stock involved throughout the production process must be closely watched. This will involve good control over suppliers as bought-in components will have to come in to tighter delivery tolerances.

Distribution

A final area that I would touch on for investment is in distribution. At the end of the day, to some extent, it does not matter how good a product we have or how competitive the price, unless we have the right distribution network that can sell the product for us and give the required after sales service, we will not capitalise to the full extent on what we have developed and produced. I am not a believer that manufacturing companies are very successful in the distribution or retail business, but it may be necessary from time to time to invest in distribution to get your product going in a certain country even if this is of a temporary nature.

The future

Looking ahead to the future and the prospects for investment in the agricultural engineering industry, I look back again over the last five years and the rationalisation that has taken place. It seems to me that it is inevitable that this rationalisation is going to continue in the years ahead as there is still too much capacity in the industry in relation to world requirements, and it seems unlikely that demand is going to increase significantly for farm machinery products in the foreseeable future. So what I think we are going to see is further amalgamation and even the demise of some companies from farm machinery. In the long run, however, we are engaged in an industry which is involved in producing food for people.

The world population is still growing and the requirements for food are going to continue, and the requirement for machinery involved in that food production will continue also. Therefore, there is going to be a continuing demand for farm machinery and there is after all a very big world market — indeed, the European market alone is huge. Those companies that clearly identify the area in which they are going to concentrate so that they become specialists in that area and who can identify and sell in a sufficiently large market, will, I am sure in the long run be able to generate the profits that make investment worthwhile.

Engineering for profit

J V Fox

Summary

A REVIEW of the factors influencing the British agricultural engineering manufacturing industry and of the innovation, engineering, marketing and management philosophies which are required to optimise performance and profitability.

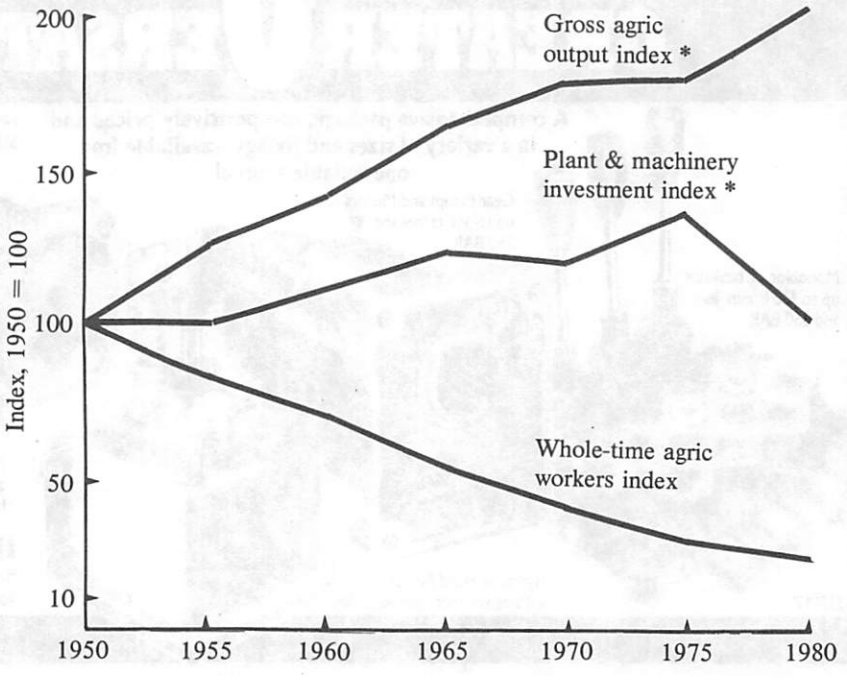
Background

The explosive period of farm mechanisation occurred immediately following the Second World War and continued for 30 years, during which time manufacturing capacity was progressively built up to meet a continuously growing demand for machinery of all kinds. At the same time, the employment of labour on the land declined and production rose dramatically. Figure 1 shows this effect quite clearly; the graph indicates total employment in UK agriculture, total investment in machinery and gross output, at constant prices, over the period 1950–1980.

Mechanisation reached a peak in 1979–80 and a decline began, representing what had then become largely a replacement market. It is considered unlikely that demand will ever again reach the levels of the end of the last decade and as a consequence a massive restructuring of the manufacturing industry has become inevitable. This has of course already begun, with the closure of many factories and the disappearance of famous names. Some of these names have since re-emerged as essentially new companies, invariably operating on a greatly reduced scale, and with overheads geared to the new reality. The events most widely reported have so far concerned tractor and combine manufacturers, and names such as David Brown, British Leyland, County, Roadless, the MF combine plants, International Harvester, come to mind. They are by no means all, however, and the shake-out will continue, not only among the erstwhile giants of the industry but among the smaller equipment manufacturers of both Europe and North America.

The fundmental reason for the decline can thus be regarded as the natural and normal consequence of a market approaching saturation, but it has been exacerbated by a world recession of unparalleled severity and by the realisation that agriculture in the developed countries cannot forever enjoy a uniquely privileged and protected position in economic and market terms. Not only, therefore, are the customers upon whom the machinery industries relies well equipped and able, in practical terms, to operate with only a low level of new capital expenditure, but they themselves are increasingly anxious and uncertain as to what the future holds for them. Couple this to a period of falling inflation and high real interest charges, providing the strongest motivation to leave cash in the bank or to hold down

Fig 1 Agricultural output, investment and employment 1950–1980 (at constant prices £ sterling)*



John Fox is Chairman and Managing Director of Bomford & Evershed Ltd, Evesham, Worcs.

This paper was presented at the Annual Conference entitled: Agricultural Engineering towards 2000, held at the National Agricultural Centre, on 14 May 1985.

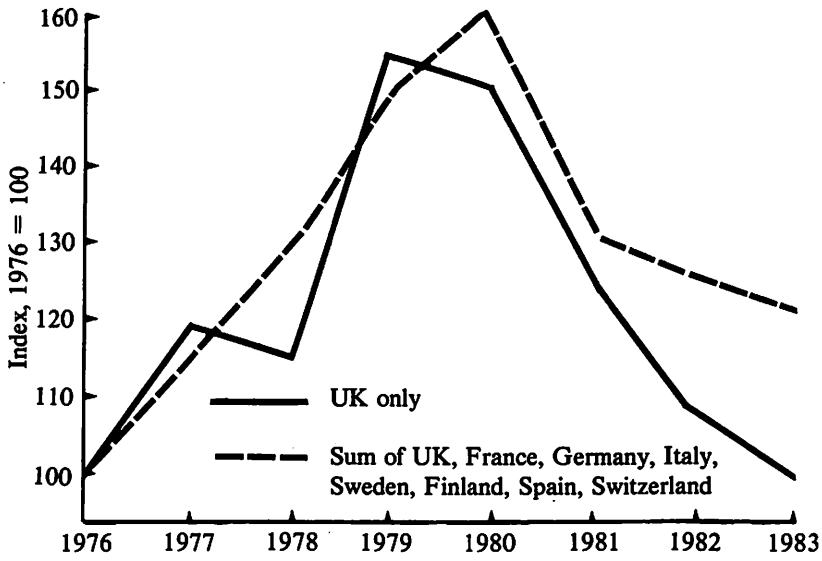
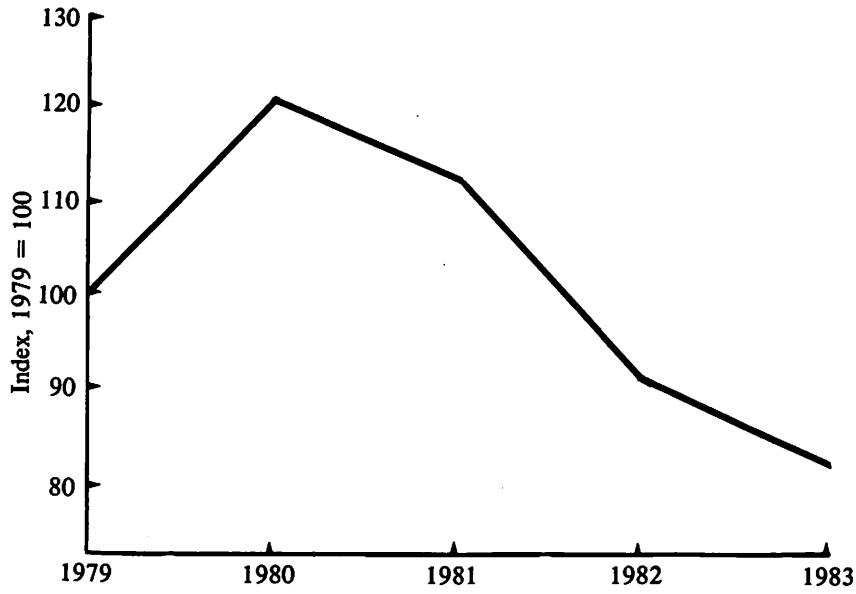


Fig 2 Total sales of agricultural machinery and tractors (at constant prices US $)

Fig 3 Sum of exports of agricultural machinery and tractors (at constant prices US $) from UK, France, Germany, Italy, Netherlands, Finland, Austria, Switzerland to non-EEC countries



borrowings, and the stage is set for a massive cutback. Against this background it is perhaps surprising that the decline has not been more severe, and figure 2 shows that the present level of European activity is still at around 75% of the 1979–80 peak.

There must be reasons for this apart from the natural tendency to resist change, and it might be thought that exports could provide an answer. However, a more detailed look at export performance of the UK and European industries (figure 3) shows *that there has been an* actual decline during the period since 1980.

Before returning to the question of why the decline has not been worse it is relevant to consider what part exports could play in the future of the industry. The majority of the world is still undermechanised by European and American standards, and on the face of it there should be virtually unlimited scope for expansion. This thought was undoubtedly behind the concept of aid to developing countries in the period since 1945, and we have now reached the situation where total debts from these countries stand at around $1100 billion. There is an old and true saying that if you owe your bank manager £1000 you have a problem, but if you owe him £1 million he has a problem.

The fact is that almost all of these vast debts are irrecoverable; in some cases the interest payments alone exceed the gross national product of the debtor country and extra loans are needed annually simply to pay the interest. If the debts were written off the majority of the major banks would be insolvent, and so the pretence is maintained, repayments are re-scheduled into the future and the experts go on hoping for a miracle.

Fortunately that is not a problem that agricultural engineers have to solve, but its existence is closely related to the future prospects of our industry. No matter how relevant our products may be to the needs of a third world market, no matter how competitive our prices nor how quick our delivery, if the customer has no hard currency at his disposal then there can be no sale. In effect, more and more markets are closing down, notwithstanding that the need within them for modern and efficient machinery and methods may be desperate. Those that remain, in the third world, invariably have the benefit of natural resources, usually in the form of oil, which enable them to trade on world markets. Unless and until a solution to the problem of their vast and ever-increasing debts can be found, it would be imprudent, to say the least, to look to them as an answer to the excess production capacity of the countries of the North. Even then, it is arguable that the should develop their own manufacturing capability rather than rely on imports, and in fact that must be the course that events will take.

On the level of corporate planning, therefore, we have to accept that our scope for market development is circumscribed by forces outside our control. If we direct our efforts and resources to markets which offer no tangible prospect of profit we are certain to go out of business, whereas if we stick to the well-trodden paths of Europe and North America we face ever-increasing competition and the near-certainty of reducing margins and volumes. Neither of these options is attractive, but there is a third which may well be, and it is at least a partial answer to the question as to why the decline since 1978 has not been more severe. This third option, it is suggested, is to

concentrate upon innovation as a means of increasing volumes and holding margins, and it becomes vital in terms of survival in those sectors of the industry which are being completely overtaken by new technology. For example, inter-row cultivations have been totally superseded by chemical control, sickle-bar mowers by rotary types, reaper-binders by combine harvesters. Advanced technology, for instance electronic monitoring of combine performance or automatic cluster removal in milking parlours, means that in many cases the demand is not only concentrated on the new and sophisticated products, but that such is their efficiency and performance that fewer of them are actually required. There is nevertheless a substantial demand for them during the build-up period, and at the same time the market for the traditional product can collapse virtually overnight. It therefore behoves every manufacturer to watch closely for the writing on the wall, and to respond to it. Better still, it should be he who puts that writing on others' walls.

Innovation

There is no situation, nor set of circumstances, no matter how adverse, that cannot be turned to advantage, and never is that precept more apt than when adversity produces innovation. Innovation creates opportunity, and opportunity is the first essential step towards success. It is however very difficult to innovate successfully, and whilst that gives it scarcity value the benefit is small if a high proportion of new projects fall by the wayside. For that reason it is worthwhile to consider some of the factors that must be taken into account when planning the initiation and development of a new product. The attractions are obvious; a product that is new and unique and meets a real need has an enormous potential market even if times are hard, and if it reduces the user's production costs, saves labour and improves quality then it may sell even better when agricultural margins are under threat. It can represent a lifeline to a manufacturer whose existing products are aging or facing strong competition in the market-place, and he can be tempted to put everything he has behind a good new idea, and risk all if it should fail.

That is essentially bad management; it is a cardinal sin to put a business at risk on a single throw of the dice, and it is a long-term failure of management if a company is in the position of being forced to do so. In fact the dice are loaded because not only must the new product meet the needs of the market, it must also meet the needs of the company that produces it. That requirement is not infrequently overlooked or ignored, but any management that ignores it does so at its peril.

Probably the supreme example was the development of Concorde, a task which in the event was far beyond the combined resources of the aerospace industries of the UK and France and which, without the injection of astronomic sums of

Table 1: Compatibility between company and product: marketing

Product will sell in adequate volume in	a) Existing company markets b) Parallel markets c) Different markets
In relation to the existing range, new product will	a) Complement b) Not relate c) Compete d) Conflict
Existing sales/service organisation would	a) Cope without change b) Need minor changes c) Need major reorganisation
Length of selling period in year	a) All year round b) Two seasons c) One season d) One short season
Existing company image will	a) Help sell the product b) Have marginal effect c) Have negative effect
Product life (predicted exploitable demand) will be	a) More than ten years b) Five to ten years c) Less than five years

Table 2: Compatibility between company and product: production

Technology required is/appears to be	a) Routine b) Not difficult for us c) Out of our class
Processes involved are expected to be	a) Standard practice b) Not difficult to install/ subcontract c) Require major reorganisation
Physical size/shape of product is	a) Easily handleable b) Possible to handle c) Not handleable in existing factory
Materials and components are	a) Mainly in stock/regular production b) Easily obtainable c) Special/difficult to obtain
Predicted volumes and batch sizes are	a) Above average for us b) Very large c) Below average
Manufacturing "season" and stocking commitment will relate to	a) Year-round demand b) Two seasons per annum c) One (short) season
Packing for home/export will be likely to involve	a) Simple compact pack b) Expensive compact pack c) Large low density unstackable pack

taxpayers' money, would inevitably have brought about the collapse of those industries. In addition, the finished product, which is technically a masterpiece, proved to be an economic disaster. Coming closer to home it is notable that the major tractor manufacturers have progressively pulled out of the direct manufacture of farm machinery, and whenever machinery manufacturers have moved into tractor production such ventures have almost invariably been short-lived.

The key word is compatibility; between the product and the company producing it no less than between the product and the needs of the market. Tables 1–4 are in the form of checklists which can be used to establish compatibility of the product with the existing marketing, production, design and finance functions of the company, and unless a project achieves a satisfactory rating in such a scrutiny it is unwise to let it proceed any further. It is imperative to keep in mind that any commercial organisation that does not make a profit does not make anything else, for very long, and whilst many ideas may be considered and rejected at relatively little cost, the abandonment of a major project at an advanced stage of development can prove disastrous. Not only does the entire cost have to be written off but there may ensue a gap of perhaps two years whilst another project is being brought into production, and that may be, and often is, too wide a gap to bridge. A company faced with such a dilemma will almost invariably decide to tough it out and go ahead, in the manner of the RB 211 engine or the Learfan aircraft project, not to mention De Lorean; the end result is the same, but usually rather more spectacular and expensive.

There is no substitute for a careful and clear-eyed appraisal prior to becoming committed to a project, nor for the courage to reject a good idea if the facts and figures do not add up to a profit at the end of the day. It must always be realised that the need for a decision is itself a failure of management, since if all the relevant data are available, as they should be, then the appropriate course of action is invariably clearly evident and only requires to be confirmed. The more difficult a decision, the greater the lack of essential information, and the greater is the certainty that such a decision is little if any better than a guess, or the toss of a coin. There are occasions when such decisions have to be taken, but they must be viewed with the gravest reservations and checked against facts at the earliest opportunity, and they should never be of such magnitude as to put the business at risk.

However, it is relatively easy for a drowning man to decide to throw aside a leaking life-jacket if he has another, and hopefully, intact jacket floating beside him, and that analogy readily extends to the situation of a manager considering whether to commit substantial resources to the

Table 3: Compatibility between company and product: design

Existing knowledge and engineering capacity is expected to be	a) Adequate b) Not certain c) Additional staff required d) Probably inadequate
Feasibility of the project is judged to be	a) Certain b) Probable c) Not predictable
Existing research facilities will	a) Be able to handle the project b) Require supplementing c) Not be capable
Design/development staff complement and workload in D.O.	a) Will enable work to proceed b) Indicate additional staff requirement c) Cannot handle this project
Complexity in relation to other products is likely to be	a) Comparable/greater b) Much greater c) Less
The predicted period and type of testing is	a) Within our scope b) Can be arranged c) Impracticable/difficult
Requirement for technical publications is	a) Routine b) Can be met with difficulty c) Likely to involve specialists

Table 4: Compatibility between company and product: finance

In relation to existing marketing, production and design resources, the new product	a) Can be absorbed without difficulty b) Will require some extra support c) Will substantially increase fixed costs
The R & D programme and production tooling time and costs are likely to be	a) Short and easily recoverable b) Indeterminate c) Long and expensive in relation to predicted return
The forward commitment on special components, materials etc should be	a) Realistic in relation to planned volume b) Heavier than average for the company c) Disproportionate in relation to volume
The period estimated to be required to recover development/production/launch costs should be	a) Less than 3 years b) More than 3 years c) Probably irrecoverable against predicted sales
Finance to meet predicted development/ stocking costs is likely to be	a) Readily available b) Can be made available c) Not available internally
Contingencies, as far as foreseeable are at worst likely to be	a) Easily met b) Met with difficulty c) Disastrous

development of a project which may not satisfactorily meet the criteria for compatibility with company and market requirements. If it is the only hope he has for survival, he will cling to it come what may; whereas if he has other options open, he will investigate them to see if they offer a greater probability of success.

It can be inferred therefore that it is dangerous to allow a situation to develop in which the options open to the management are unduly limited, and that probability of correct product selection will be greater in proportion to the number of choices available. This can best be achieved by a policy of providing excess capacity in the areas of ideas, project conception, product development and product evaluation. Investment in this area invariably pays off; it is the engineering of innovation.

Engineering

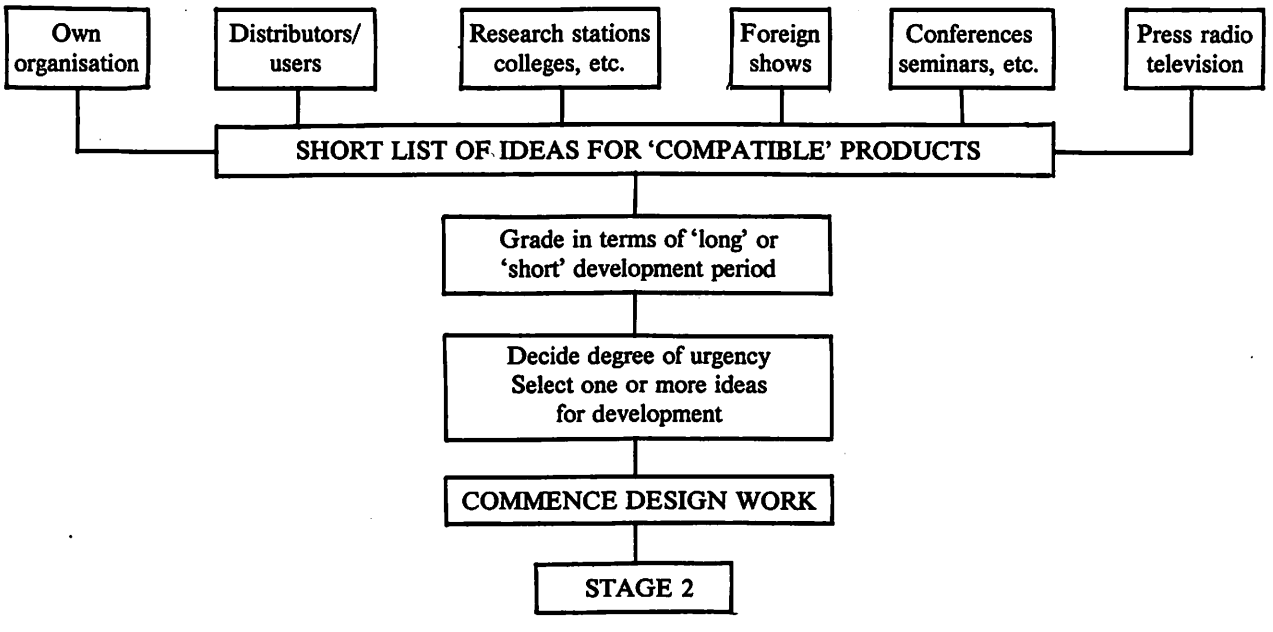
Whereas the mechanism of turning ideas into commercial hardware can be reduced to a relatively straightforward science, albeit involving a certain art, there is no such convenient method of dealing with the acquisition and recognition of ideas. It is possible however to rationalise the process to some extent by identifying potential sources and keeping the channels to them open and functioning. Figure 4 suggests a number of sources and shows the sequence of events from acquisition to the commencement of design work; there are two crucial elements, the first being the recognition that an idea may have potential, and the second being a sufficient amount of market research to support that view, of which more will be said later. So far as the recognition of a good idea is concerned it should be noted that initial ideas come in two main forms: the usual form is that of a problem seeking a solution, but less often it can be that of a solution seeking a problem. The secondary stage of each form, however, can be confusing because both appear to be similar, ie both components (problem and solution) will be present in the hypothesis. When presented with an idea in the secondary stage it is therefore essential that equal attention be given to each component; the problem must be researched, tested and verified just as carefully as the proposed solution, since it is all too easy, from personal experience, to produce a machine to deal with a problem that no-one has, or that no-one is prepared to pay to solve.

Figure 5 indicates the sequence of events where an idea has passed successfully through this initial evaluation and is considered to be worth serious investigation and expenditure. If the project involves new and untried techniques, then a programme of basic research will be required to establish their feasibility and develop the necessary mechanisms. This is very much a pre-prototype stage and the work is normally undertaken with rigs on which individual components are operated in an environment closely related to working conditions. It may be desirable or necessary to call upon the specialist facilities of research stations or universities to assist or even to carry out parts of the investigation, and it is worth noting that in recent years there has been a very marked and welcome reapprochment between academia and industry in this important area, with the result that such facilities are readily available.

Once the feasibility of the concept has been established, it is essential that great care is devoted to the details of the specification. Ideally, this should be initiated as a draft technical specification, drawn up by the designers, and then it should be subjected to critical scrutiny by the departments responsible for marketing and manufacture, with feedback to design, so that when the final specification emerges it should incorporate all the features required in the product by the eventual user. It also should be capable of being manufactured in the most cost effective manner possible in relation to the projected volume and the production facilities available.

The process of feedback must be allowed to continue during the design, construction and test of the prototype. Features which appear to the sales staff to be so obvious as to be not worth mentioning can be overlooked by the engineers, and limitations in performance which the

Fig 4 Stage 1: some sources of ideas for new products



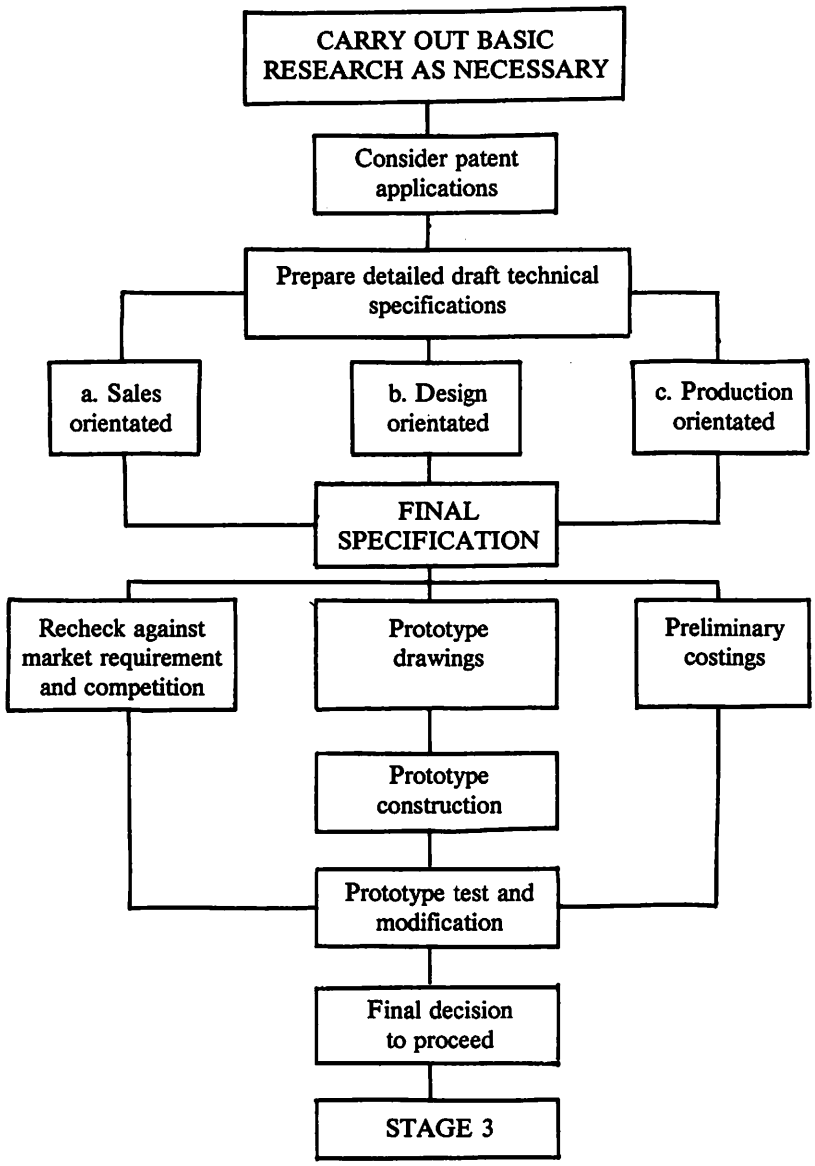


Fig 5 Stage 2: product design

engineers assume to be self-evident may not in fact be apparent to others. It follows therefore, that full and detailed communication is essential in optimising product quality and performance and in reducing time-wasting and costly oversights and misunderstandings. In practice, this is inherently very difficult to achieve, since the staff involved all have other urgent day-to-day tasks to perform, and it is impracticable to hold constant meetings to discuss each of perhaps half-a-dozen projects which may be proceeding concurrently. A great deal therefore depends upon the skill and the feel for the job of design management, so that possible problem areas can be identified and singled out for special attention.

The design task can however be considerably eased, and speeded up, by the use of Computer Aided Design (CAD), which enables components and assemblies to be visualised, checked and, if necessary, modified, more easily than by conventional drawing. A typical component is drawn five times: initial conception, first prototype, final prototype, pre-production and production drawing. Occasionally, it may need to be drawn still more times, because modifications invariably have a knock-on effect on associated parts. Using CAD, the co-ordinates are put into the data-base once, and all subsequent changes are very simply and quickly incorporated, the only re-drawing required being that actually involved in the change itself. A further immense advantage lies in the reduced opportunity for errors, which are liable to occur whenever information is transferred manually from one document to another. CAD at least ensures that the errors are original input errors, and once they have been eliminated the information can be transferred and reproduced as often as necessary without any risk of new ones creeping in. When it is considered that even a simple drawing may contain a hundred or so discrete items of information, it is apparent that a drafting accuracy of 99% implies at least one error per drawing, and the importance of this feature is clear.

At a certain stage during the development period, it is necessary for a decision to be taken to proceed with the manufacture and introduction of the product, at which point the involvement of production engineering becomes predominant. The benefit of their inputs to the project from its earliest stages should now be realised in the form of relatively minor and few changes being required during the period of jigging, tooling-up and computer numerical control machine programming. A further significant benefit will arise from a full CADCAM (Computer Aided Design-Computer Aided Manufacturing) system where manufacturing is able to access the CAD data-base directly to obtain the co-ordinates which are required to program production machine tools. Once again, input time is saved and another important source of transfer errors is eliminated.

Figure 6 outlines the processes involved in taking a project from the final prototype stage to product launch. It is essentially a painstaking and time-consuming task since the manufacturing process, if it is run efficiently, must work to relatively long lead times. Components and materials must be sourced and placed on order, tooling designed and built and jigs and fixtures constructed. There will then be a pre-production run to test the whole process and ideally this should be followed by a gap of some three months before full production starts. The gap is important because the need for changes in material specification or components may not become apparent until assembly is complete, and if the ordering of production quantities of bought-in items can be delayed until that stage the risk of wastage or unplanned delay is minimised. It is also inevitable that quality checks will reveal significant numbers of minor changes to drawings and tools that

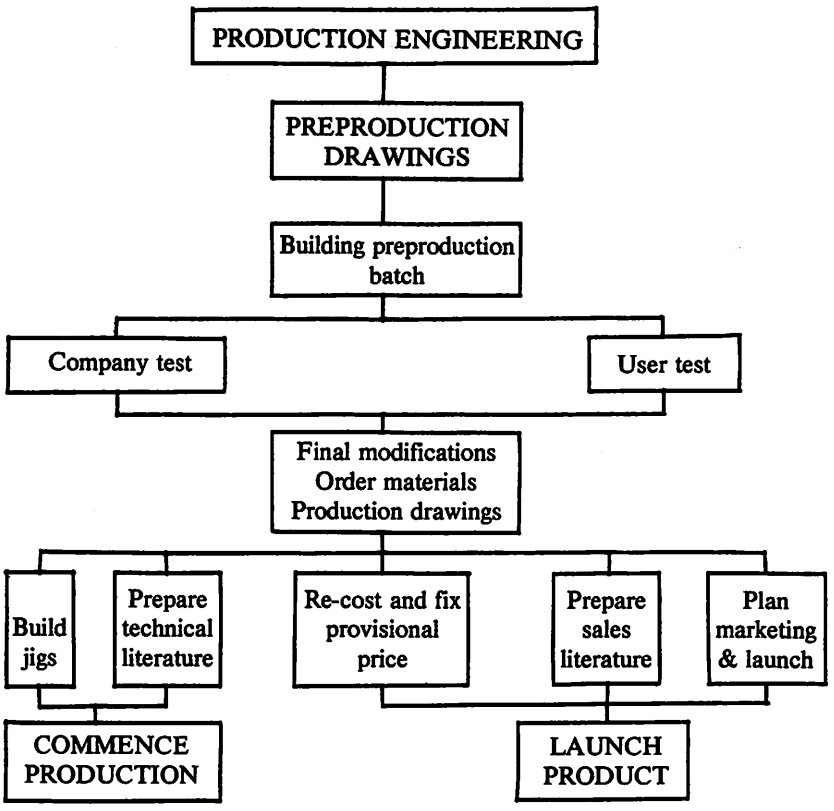


Fig 6 Stage 3: production and launch

are needed, and time must be available for them to be carried out. Figure 7 shows a typical bar chart. In practice, however, it is more usual for the factory to end up as the compressed meat in the sandwich; there is a deadline for product launch, usually a major exhibition, and unforeseen snags occur during the final prototype tests. There is nowhere in the programme to lose the delay, which inexorably eats into the pre-production schedule. This can result in work for the first production batch being fed into the works before the pre-production batch has been completed, and it is a sure recipe for some very harassed and disgruntled production engineers and some costly late order changes on the materials side. It also puts at risk the most vital ingredient: product quality. Such a situation cannot be attributed to bad luck, it is quite simply bad management, although it must be added that research and development is both an art and a science and as such cannot be rigidly tied to times and numbers. However, such considerations quite rightly cut no ice with the hard-pressed factory management who need aequate time to do the job right and expect to be given it.

The work that has so far been done to produce an exciting, shiny new product is just the preliminary part of the job; it has cost anywhere from £50,000 to £0.25 million for a machine of moderate complexity but it has not earned a penny. Making sure that it recovers its costs as fast as possible and starts earning profits is the vital part, the part where marketing takes over.

Marketing

The involvement of marketing staff

Fig 7 Typical bar chart for stage 3: production and launch

REF: D3	FROM: P.ENG	DATE: 01/10/84	PRODUCT: PROJECT 100	TO: MANUF. & ENG. MANAGERS	PRW/ CAW/E1

PROGRAMME	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT
FINAL PROTOTYPE 1 off			—	—								
PROTOTYPE SCHEDULES	★											
PROTOTYPE DRAWINGS		★										
PRODUCTION SCHEDULES				★								
PRODUCTION DRAWINGS				★								
PRODUCTION PROCESS SHEETS					—							
JIGS AND FIXTURES					—	—	—					
PRE-PRODUCTION 15 off						—	—	—				
PRODUCTION 40 off										—	—	—
ENGINEERING / PRODUCTION REVIEW									—			
PHOTOGRAPHY							★					
SHOW MACHINE									★			

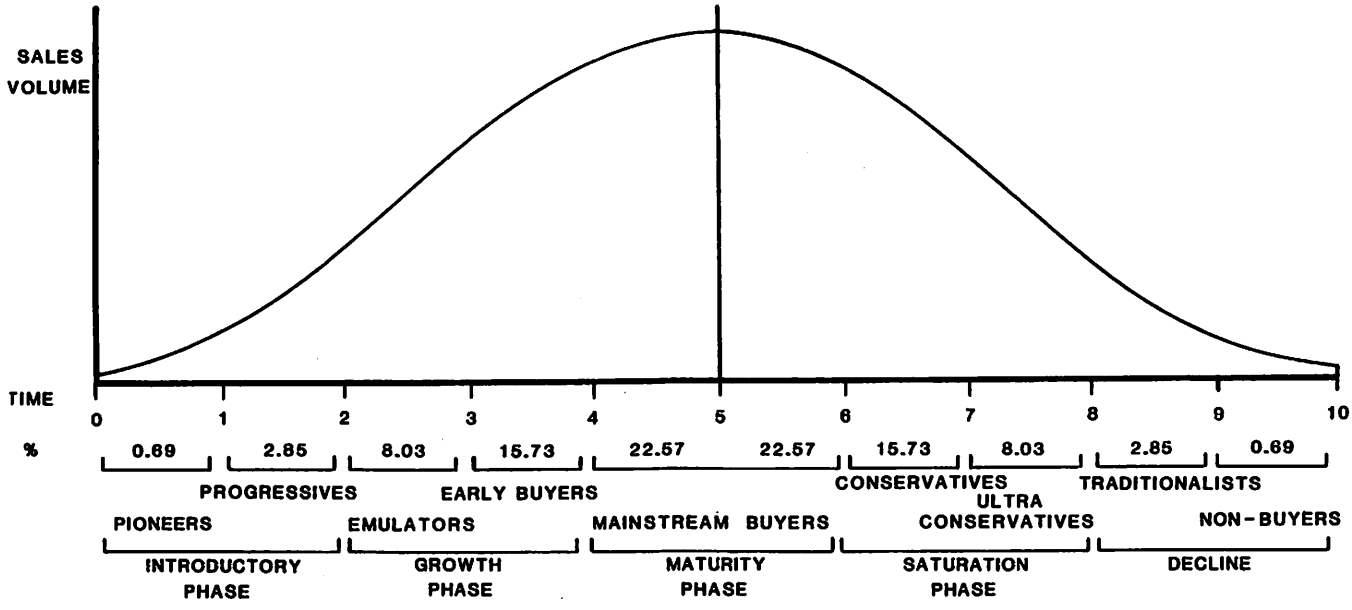


Fig 8 The product life cycle

from the earliest days ensures that they have a detailed knowledge of the product, and there will have been many months of planning and preparation for the launch. There is a great deal in a name, and much thought will have gone into deciding on it, taking account of its relevance and pronunciation in export markets and not overlooking the embarrassment that certain innocent English words can cause in the context of other languages. The question of a range of models, working widths and attachments, has had to be finalised months in advance to enable specifications, production drawings, illustrated leaflets, price lists, fitting and operating instructions, parts lists and advertising to be prepared.

The product image and the selling strategy must be planned so that there is a coherent presentation to the customer. He has never seen the new product before and the aim must be that he is presented with the answers to his questions as fast as he can ask them: What is it? What does it do? How does it do it? What could it do for me? Will it pay me to have one? What does it cost? Which model would I need? When can I get one? A potential customer who is quickly able to grasp the essential features of a product and relate it to his own needs and problems has the necessary data for a buying decision, whereas one who is confused and uncertain will turn away and the opportunity may be lost.

The launch is therefore a critical period in the life of a product and as little as possible must be left to chance. Press coverage is all-important and generally a press day or demonstration will be arranged. The authority of editorial reporting far outweighs that of paid advertising and in addition to demonstrations and shows the value of feature articles describing user experience is immense, providing of course that the experience is good. A wise marketing manager will therefore keep open his channels of communication with the press, radio and television, and make sure he has a steady supply of news items to feed to them. As in all affairs, confidence is the key, and it needs very little by way of inaccurate or exaggerated comment to cause those lines of contact to be disconnected. Good marketing and hard selling are indispensable to the success of a good product, but they cannot, no matter how expert, make a long-term success of a bad one.

Assuming for a moment that the product is a good one, it is necessary to consider what the sales pattern is likely to be. Purchasers, being people, are infinitely variable but statistically they all fall within the familiar Gaussian curve for any population. Figure 8 illustrates the typical pattern, starting on the left of the curve with the Pioneers. These are the people to whom, as manufacturers, we take off our hats — without them there would be no new product sales and, hence, no manufacturing industry; in fact, no civilisation as we know it. The Pioneers buy in the first year and establish the product in the market, and they are then followed by the more conservative elements, but it is up to five years, normally, before sales in a market-place reach a peak. Whilst the shape of the curve does not vary greatly in response to marketing inputs, its height ie the total sales volume, will do so. The number of pioneer buyers will vary according to the perceived value of the product and hence the total number sold will rise proportionally. Product profitability taken over the total product life is therefore a function of pricing strategy, which is critical in the early years. The products of a company with a respected name and reputation are less price-sensitive than others and therefore can return a better margin for a given volume of sales. Product life cannot be extended by a straight price reduction but the end can be delayed by a variety of devices, such as designating the standard product as a utility model, at reduced price, and introducing a de luxe version with extra features. In fact, this phase can be very profitable, since the research and development and tooling costs have been written off and, in effect, only the direct production costs and a reduced level of marketing support are involved in leaving the product in the range.

It is a convention in accounting terms and in general business discussion that a particular manufacturing company is referred to as having a turnover of £x per annum, as though this were a feature, like the issued share capital, which

could be determined by voting at the annual general meeting. In fact, on day one of the financial year, a company manufacturing capital goods has a turnover equating with the orders in hand at the previous year end, and its management has to accept that every user who bought one of its products during the past five years is unlikely yet to be in the market for another. The longer the product lasts, the more customers that are lost in this way; every machine sold must, with few exceptions, go to a new purchaser who has to be found, maybe demonstrated to and certainly persuaded to buy, and the more successful a product the fewer new purchasers there will be left for next year. It is a thought so disconcerting that marketing men prefer not to think about it, and concentrate instead on the total machine part and the market potential for the product. This is positive thinking but it is as well to keep in mind the fact that a company selling say 5000 units in a year has to find 5000 new customers the next year, and the year after, merely to remain static in financial terms. This is a measure of the task we set our marketing staff and if ever there were a case of running to stand still, that must surely be it. It is a perennial problem, but one which is compounded at the present time by the pressures of the economic situation. Clearly the position can be improved by offering a range of products so that a customer who has one will hopefully be inspired to buy another from the same stable, but the underlying concept remains unaltered. The introduction of a product range brings its own problems which are best considered from a management point of view.

Management

There are two kinds of company at the present time; the kind that employ so many people and lose such vast sums of money that it is politically and economically impossible to let them go down, and the other kind, the ones where the company, not the bank manager, has a problem.

Managing a company of the second kind can be likened to walking a high wire of indeterminate length, in poor visibility and without a safety net, whilst the end supports are being moved about suddenly and unpredictably. It is, in short, a position in which the wire walker, or manager, needs all the help he can get, both to provide him with means of orientation and to lower his centre of gravity. He also needs a good sense of balance.

Help is at hand, although in such a situation it can never be regarded as infallible. First and foremost it is crucial to know precisely where the company was at a given moment in the past, where it is now, and where it intends to be at a particular time in the future. This orientation can be achieved by effective management accounting, which enables shifts and trends to be detected almost before they begin and allows corrective action to be taken. It also enables pricing to be optimised, in a competitive market-place, to balance volume against margin to produce the best available return in total terms. Secondly, stability can be improved by maintaining adequate reserves and avoiding risks of a magnitude that would, if they came up, jeopardise the whole enterprise.

It is essential in management to set out to cultivate a degree of market awareness that ensures an instant preliminary validation check on incoming information. There is no substitute for this, since in its absence the manager is obliged either to accept everything at face value or to query everything, and the consequences of either in terms of correct response to fast-moving events are self-evident. To that extent therefore a successful company must specialise, and concentrate upon products and markets of which it has knowledge in depth. The limitations that this requirement imposes can be overcome by carefully controlled forays into unknown territory, allowing experience in other fields to be built up whilst containing the risks at an acceptable level. Above all, however, complacency must never be allowed to set in, and awareness of the real world outside must never be replaced by illusion. There is no substitute, either, for frequent contact with the whole organisational chain down to the end user, nor for regular market surveys to establish what real customers and users are thinking about their industry, their future prospects and their mechanisation needs. With this background, it is at least possible for a company to keep on the right track.

A product range is the basic stock-in-trade of every commercial enterprise whether in the form of hardware or of software, and its composition and management will determine the success or failure of the company. In its form of ultimate simplicity, one product is produced and sold to one customer; and at the other end of the scale, a large number of products are sold to a large number of customers. In the first case, product management is simple but the risk of sudden death extremely high. In the second case the problems of management are insuperable and death will intervene by strangulation. The objective of management therefore, must, be to find the golden mean where the risk of sudden market changes is containable yet the problems of control are not too great. This must imply a sufficient spread across different market sectors and a limited number of different products and models in the range.

Ideally, a product range should be logical, coherent and understandable by the customer. Where a product is available in a range of models, they should be presented in such a way that the customer can instantly identify his need with a particular model and can see why the others are less well suited to solve his problem. He thus has confidence, and a decision to buy follows. Contrast this with a woolly collection of machines with vague and overlapping specifications, which bewilder the potential buyer and prevent any clear idea from forming in his mind, except perhaps that these are products lacking in quality.

Essentially, a product range must be compatible with the company that produces it, in terms of seasonality, technology, dimensions and sales volume, so that the range as a whole provides as nearly as possible a steady workload for the producing factory and a constant profit margin against cost.

That is how it should be, but very rarely is that the case. The evolution of a product is analogous to the growth of a tree; it starts as a simple, straight shoot, but very soon branches begin to appear, and from them other branches grow. An untended product range rapidly comes to resemble a tangled thicket, growing strongly in some places, dying in others, beset by weed and thorn, impenetrable and defying selective control. It is a daunting prospect, and tackling it can always

be put off to another day. But eventually there is not another day, for that business, and then the blame is put on the government, the recession, the unions, the European Economic Community the Central Agricultural Policy, the exchange rate or the competition, and the thicket is bulldozed into oblivion. It happens all the time. There must be a better way. There is, and it can be described as "defensive management". In essence, it is a philosophy which sees a logical progression from the present to a future state, and accepts the need for hardship, privation or simply inconvenience today in order to prevent the future development of an irreversible slide to disaster. A small threat, ignored today, can and often does return with overwhelming force in the future, and then it can be too late. The price of survival, now as always, is eternal vigilance with the determination and courage if need be, to respond firmly and decisively to any situation which has the potential to pose a future threat. That way the thicket does not have the chance to develop, and the problem of dealing with it need never be faced.

It is of course possible to survive without being successful, but the converse is never true. Survival, therefore, must be the primary concern of management and success the second. Success in business is generally measured in terms of net profit, which is a function of two factors: gross margin and volume. If both are right: success. If either or both are wrong: failure. The problem is that the manufacturer must establish the cost parameters in advance; material costs, labour costs, overhead costs, retail prices, and trade terms. Everything which controls gross margin is therefore predetermined, and success or failure depend upon volume. At this stage what might be called "offensive management" is needed to ensure that the required sales are made to happen, and the margin for slippage is very small.

Fig 9 A recent addition to the product range

The key to consistent success in these terms is accurate forecasting; the management must know in advance what the sales will be and must keep track of progress on a day-to-day basis. It is imperative that forecasts are reliable and that they are met; the penalty, in a typical manufacturing company, for falling short of target sales by ten per cent is to suffer a reduction of net profits by 50%. On the other hand, with advance warning of that level of sales, the company could have adjusted its operations, and its overheads, to halve the profit loss.

Engineering for profit is a challenging, demanding and potentially rewarding occupation which necessarily embraces the whole spectrum of activity from the conception of an idea, through the processes I have attempted in this paper to describe, to the bottom line of the profit and loss account. It is essential to the future of our industry, and ultimately to the prosperity of our society, that those of us engaged in it recognise the responsibility we bear to sharpen our skills and to ensure, not just the survival of the British agricultural engineering industry, but its restoration to the dominant position that it once enjoyed. We have the people, we have the knowledge and experience that it takes, and given confidence in the future there is no doubt that it could be done.

The role of government

W Plowden

I WORKED for some 12 years in the civil service — both in the now defunct Central Policy Review Staff, or 'Think Tank', and in the department variously known as Trade, Industry or, as now, Trade and Industry. In both these capacities I spent quite a lot of time either thinking about ways in which the British government could improve the competitive position of British industry, or carrying out policies aimed at that objective. In my last job, I handed out many hundreds of thousands of pounds of the taxpayer's money in the form of grants to help engineering firms to modernise their processes and their products.

I did that job under the previous Labour government, although the policies I was administering had been inherited from its Conservative predecessor. Even while Mr Benn and Mr Varley were trying and failing to persuade firms to enter into so-called 'planning agreements' with the government, they and their departments had little difficulty in persuading firms to accept the various forms of financial assistance which were available with very few strings attached.

Since I left the civil service, and since the Conservatives replaced Labour, industrial support policies have continued on much the same broad lines, although with quite a lot of changes in matters of detail. The problems which those policies were designed to solve are very much still with us. Britain's competitive position, and our share of world trade, continues to decline. So the question which I have been asked to address at this conference — what is the role of government in relation to industry? — is still firmly on the agenda, not only for your industry but for many others.

Since I started to try to answer this question, I have posed an additional one for myself. How far can my question, about the role of government, be answered in isolation from the others on today's programme — in particular, questions about investment and about exports? As I shall indicate shortly, I do not believe that those questions are wholly separable. Before I explain that view, let me start by outlining what I understand to be the situation in which your industry finds itself, and to which government action might relate.

As I understand it, yours is an old-established industry, with a very high proportion of small firms producing, often for a mainly local market, a mixture of traditional and technologically advanced products. You are suffering from growing import penetration and from declining exports. The competition seems to be not so much, as in the case of other British industries, relatively low-cost producers from the Far East and elsewhere, but producers across the channel in Europe.

Three characteristics about your domestic market, here in Britain, strike me as relevant. First, for a variety of reasons the British farming industry has done very well in recent years, certainly in comparison with other sectors. In terms of improved productivity, its record is outstanding. Secondly, however, British agriculture seems likely now to be entering on a period of relative instability and change. This is partly because European governments, led by our own, are starting to rethink established agricultural policies and to conclude that their cost is insupportable. It is also partly because of growing public opposition, led by the so-called 'green' movement, to the environmental consequences of modern capital-intensive farming methods. Thirdly, the British market

is extremely small, consisting of a small number of relatively large customers, compared with the rest of the world. Also compared with them, it could perhaps be described as nearly saturated. This last fact, of course, is not unconnected with the first characteristic that I have mentioned, the prosperity of British agriculture. Through government policies and their own efforts, farmers have been able to modernise their production methods and to invest in new techniques, which have helped to generate the profits which have, in turn, financed further investment. This virtuous circle is worth noting. The irony is that, while farmers have prospered, their domestic suppliers have been in difficulties.

The questions to be answered in relation to government policy are, first, what should be the objectives of such policy? Secondly, what are the obstacles to achieving those objectives? Thirdly, how can the obstacles be removed and, fourthly, would the benefits of removing those obstacles outweigh the costs of doing so?

Especially at present the answer to the first question could be given in terms of two quite different

---

Dr William Plowden is Director-General, Royal Institute of Public Administration.

The paper was presented at the Annual Conference entitled: Agricultural Engineering Towards 2000, held at the National Agricultural Centre, on 14 May 1985.

quantities — jobs or sales. Many would argue that, with unemployment at over three million, all possible steps should be taken to preserve or increase employment opportunities in British industry. Others would reply that the main aim must be to modernise production processes, to increase productivity and to reduce unit costs whether or not the result is lower employment in the sector concerned — and would accept that, at least in the short run, there *is* likely to be less employment.

I am quite clear that whatever should be the objectives of overall economic policy, it should not be an objective of sectoral policies to increase or even to preserve jobs in a particular sector. The aim should be to achieve year-on-year improvements, not only in productivity but also in quality. Higher productivity need not result in higher unemployment in anything but the very short run; it increases incomes which can be spent on goods and services and which thus create rather than destroy jobs. At the same time, given the fundamental importance of manpower as a resource, it makes no sense to try to freeze existing patterns of employment with the result that people, especially skilled people, are kept in jobs where their output is lower than it would be elsewhere. As background, and to indicate the size of the gap which we ought to be trying to bridge, let me remind you of the — alas — incontrovertible findings of censuses of production in Britain and Germany. By the mid 1970's German output per employee in manufacturing as a whole was about 50% higher than in Britain; in mechanical engineering and vehicle production it was higher still — about 80%. These differentials have changed hardly at all since then.

On the other hand, attempts to reduce short-run costs regardless of anything else can lead to disaster. There are two main reasons for this. As I understand it, your industry is one where customer choice is at least as strongly influenced by questions of delivery times, reliability and after-sales service as by questions of price. It is traditional German, and modern Japanese, emphasis on quality control which makes them such formidable competitors. That costs money, both at the production stage and afterwards.

A second reason is that reducing the labour content of manufacturing costs by itself is not enough. A report published by the National Economic Development Office last year suggested that investment in British industry had been disproportionally directed towards cost-cutting and labour-saving mechanisation, rather than towards the exploitation of new design, improved technology and higher value added. The result of such policies may be to preserve, for a while, traditional industries and traditional processes: but these are precisely the sectors which are most vulnerable to the major competitive threat posed by the newly industrialised countries. If we try to compete with the latter simply in terms of unit costs, we can never win. If it is agreed that the objectives of policy should be to improve productivity and quality and to increase sales, the questions remains, sales to whom? It is clear that demanding, efficient, technically sophisticated customers such as British farmers provide an admirable basis for a supplier industry such as yours. An ounce of practical feedback from a satisfied (or a dissatisfied) British user is worth a pound of theoretical market research. For this reason alone, there must certainly come a point at which the continued erosion of your home market ought to become a cause of keen anxiety for you.

But two major qualifications should be attached to any statement about the significance of the British market. First, the British market alone should never be regarded as a British industry's exclusive or even principal target. This is both because of its relatively small purchasing power in a world context; and its state of development; for some products in future it seems likely to be mainly a replacement market. Dependence on a single market is also extremely risky, especially where that market is a producer of primary products, and thus exposed to fluctuations both in the world and domestic economies and in government support policies.

So though I must not venture too far into Mr Thorneloe's territory, I must say at this stage that it seems to me to make no sense at all to discuss either the fortunes of your industry, or government policies towards the industry, in terms of the British market alone. As Mr Evans said at this conference last year, a presence in export markets is not only a desirable but a practically essential option, especially for the smaller firm. Without the capacity to sell successfully overseas as well as at home, the long-term prospects for the industry look poor indeed.

This brings me to my second reason for not exaggerating the long-term significance of the British market. It is a familiar argument that overall economic prosperity is increased by the interpenetration of national producers in each other's markets. If the Germans sell to the French, the French to the British and the British to the Germans, we are all better off. The economic growth of the Organisation for Economic Co-operation and Development countries has been based largely on their success in trading with each other (which accounts for some 70% of the world trade in industrial products). That argument is given particular force in the European context by the fact that Europe for us now is, in a technical sense, a single market. I recognise that in many other senses, and senses that matter, even countries as relatively familiar as France or Germany are foreign: they are slightly further away, they speak different languages, they have different farming practices and requirements and they are unlikely to be convinced that your products will suit them unless they have actually seen them at work (which is of course much harder to do with a seed drill or a fertiliser than it is with a machine tool or a printing machine). But these, I suggest, are obstacles to be overcome, not reasons for neglecting these non-British parts of the European market. I was interested a couple of weeks ago to hear some valedictory remarks made by the retiring commercial adviser at the Japanese Embassy in London. He commented that if he were the economic adviser to the British government his first advice would be "Make more use of European Economic Community Markets". Cynics might comment that if this advice were followed it would, of course, ease the pressure on the Japanese market — but I think that it was given in all sincerity. Dr Ichikawa added that if we followed this advice we could offset one great advantage otherwise enjoyed by Japanese manufacturers over their European competitors, namely that their home market was roughly twice as big as that of any single European country.

But although I think that special arguments do apply to Europe, the

same general point applies to the world at large. I have just been to China. That is obviously a very difficult market to penetrate, for a wide range of reasons which I need not elaborate. (The difficulty of securing a booking on an internal flight is one reason, for a start.) The costs of establishing a foothold there would be considerable but so would be the benefits. It is a country of one billion people, with a very large rural population and a largely agricultural economy. The Chinese goverment are making enormous efforts to modernise their country. As far as I could see, the only mechanical agricultural equipment in regular use was the occasional tractor and a much larger number of little two-wheeled motors which seemed to be mainly used for towing loads on roads. So, unless the Chinese decide to do it entirely themselves — and they are in general very open-minded from taking from other countries what they need — someone, sooner or later, is going to sell in the Chinese market a very large quantity of agricultural machinery. The technology will have to be appropriate of course.

You may feel that I am taking a very long time to come to the proper subject of this talk — the role of government. I am sorry if I do seem to be going an unnecessarily long way round, but, as I shall explain later, I think it essential to be clear about the points and problems to which government intervention should be directed, and to be able to show that there is something specific for government to do which could not be better done by others. It is also important to distinguish symptoms from causes: many would argue that much of government industrial policy in recent years has been directed towards symptoms, leaving the underlying causes virtually untouched.

At the casual level, I suspect that your industry has a problem in the form of the large proportion of small firms. That does not matter in itself, except that I would expect it to be reflected in a problem at another level, namely relatively low levels of investment in research and development, and in new technology. It is perfectly possible to make a living for a while with low volume production, and low value added. But as I have already said, the market for such products is likely to be eroded at both ends. More sophisticated users will demand, will be willing to pay for, and will get the more advanced products which you cannot produce; while new low-cost producers entering your market will beat you on price and will capture your business at the other end.

I have to admit that my remarks about the application of new technology are based on anecdotal evidence only. But my boldness in making them is based in the disturbing evidence of surveys of British manufacturing firms in general. A report was published last year based on interviews with businessmen in Australia, Belgium, Britain, West Germany and the USA. It highlights some of the differences in attitudes between British manufacturers and their overseas counterparts abroad towards new technologies. Over 50% of the British thought that their products were the most advanced in their sector (compared with only 44% of the West Germans or 40% of the Americans). But only 18% of British thought that new technology had made much impact on their products, and only 16% on their production processes — the percentages in other countries were twice as high. Over 25% of British firms had made no significant change in their production processes in the past five years. In other words, their confidence in the technological quality of their products was simply not confirmed by their own evidence about their production processes.

One of the findings of another, more recent survey was that in the sample of British and German engineering firms visited, twice as many in Germany were using numerically controlled machines as in Britain.

Now I come to government. The survey evidence just quoted is the kind of material which has been used to justify mainstream industrial support policies of British governments over the past ten or 12 years, if not longer. Grants and allowances of different kinds have been aimed at encouraging the installation of new equipment, the development of new processes and research and development on new products. All these approaches are now open to question.

If one takes policies aimed at encouraging investment, there are two reasons for caution. The first is the general argument that very often the availability and the cost of capital reflects a considered view on the part of financial markets of the high risks attached to certain projects or activities. If a firm cannot borrow at a low enough rate to tool up for the manufacture of perpetual motion machines, that may be just as well; a policy of blanket investment subsidies which would allow that firm, among others, access to cheap capital is likely to involve the feeding of a large number of lame ducks. The second, more specific argument for governments to give a fairly low priority to policies encouraging investment in machinery in particular is that, as a whole, the stock of machinery in Britain is not, by world standards, out of date. A survey carried out for the National Institute for Economic and Social Research a couple of years ago showed that 24% of all machine tools in British plants had been installed in the past five years, compared with only 15% shown by a similar German survey in 1980 and 13% in a US survey in 1983.

The main problem pinpointed by that survey was that regardless of its age or technical sophistication the machinery in British plants was extremely inefficiently used. By comparison with Germany, machinery was poorly maintained, production control was poor and so was diagnosis of faults. Operating procedures were not followed, machines were used for the wrong purposes, and were not properly cleaned. Partly as the result, breakdowns were relatively frequent. Where this happened with imported machines, delays in getting spares meant that the machines were out of action for long periods. The underlying reason for all this, suggest the researchers, is the relatively low level of technical skills in British plants, especially among foremen and operators. Their negative conclusion, not surprisingly, was that subsidising purchases of advanced machinery, and perhaps even of advanced technology, was likely to be ineffective as long as the skill deficiencies remained uncured.

One more piece of survey analysis casts doubt on the value of greater expenditure on technological improvements in isolation. A recent study of how companies manage research and development concluded:

1) "there exists in many companies interviewed an apparent lack of interest, even commitment, to research and development at the main board level;

2) "research and development managers tend not to know their companies strategic aims: they therefore choose projects which interest them rather than projects which fit the strategy".

In other words, the need is to integrate the two functions of strategic management and research and development, so that the latter is seen, as it should be, not just as a bolt-on adjunct to mainstream production but as the key to market development five or ten years hence.

The same point is made, in rather different terms, in a recent account of British technology policy by a leading expert. But this time the point is specifically related to government policies in this context. "Too often British governments...." writes Professor Roger Williams, "have not recognised that markets are not made in laboratories or board rooms but rather by market research plus technical innovation plus professional salesmanship, the whole backed by high quality in products, high quality control in production, and speed and reliability in after-sales service".

I will come in a moment to the conclusions for government policy which, I believe, follow from what I have already said. But before I do so let me add to the mixture what I see as the developing consensus about industrial support policies in the last 15 to 20 years. It seems to me now widely agreed that it is very hard to demonstrate convincingly that such policies have had much impact on our industrial success — that is to say, in arresting our industrial decline. Too often their objectives were not clearly formulated in advance, with the result that there were no well-defined criteria either for applying them in particular cases or for identifying the kinds of changes which would show that the policy had succeeded. In addition, civil servants and ministers, perhaps unsurprisingly, were in general no better than businessmen at picking winners. A great deal of assistance was given — by myself, among others — to firms who had no need of it and to firms who did nothing fundamentally different as a result.

This kind of academic doubt about previous industrial support policies can only reinforce the generally much more rigorous approach which is now developing in Whitehall to the analysis of policies of all kinds. The slow development of what might be called government's critical faculties has been greatly stimulated by the present government, and by the introduction of techniques such as the 'Rayner scrutinies'. (Perhaps I should remind you that Sir Derek Rayner, as he then was, was brought in to Whitehall by Mrs Thatcher from Marks and Spencer, to be her 'Efficiency Adviser'. Assisted by teams of young civil servants seconded for the purpose, he set out to 'scrutinise' a large number of existing programmes, asking in effect "What is the purpose of this activity? What value does it add? Could it be done more cheaply? Would it matter if it were not done at all? This was not a very subtle approach, and in particular it does little to answer the important question "Could the job be better done in a different way?" Nor did the Rayner scrutinies usually address another question which was, in effect, regarded as out of order, namely "Would this activity be more effective if more, rather than fewer, resources were devoted to it?" Nonetheless, Rayner has helped to make it much harder than previously either to carry on an ineffective programme unquestioned, simply because it is there, or to launch a new programme on the basis of the kind of general assertions that have been adequate justification in the past). This attitude to the use of resources seems to me admirable. The technique still has a very long way to go; it does not come easily either to politicians or their civil service advisers to ask the kinds of critical question posed by Rayner, nor are they very good at answering them. But I think the general trend is clear, and unstoppable.

The last major change that will inevitably affect industrial support policies, and is indeed already doing so, is the growing scepticism about the effectiveness of unilateral action by government. Once again this attitude is rooted in the ideology of the present government, with its determination to reduce the role of the state and the amount of national resources consumed by government. But in many contexts it is increasingly accepted by people who are not Conservative supporters first, that civil servants and politicians have neither the training, the experience or the flair to make good decisions on behalf of other people, including businessmen and engineers; and, secondly, that joint efforts — between government and voluntary organisations, or private sector organisations — or between government and the consumers of government services, may often be more effective than leaving it all to government. Applied to industrial support these principles indicate that firms must show that they have done all that they can to help themselves before they can sustain any kind of claim for intervention by government.

Now, if my broad account of the agricultural engineering industry, and my speculative analysis of trends in government policies, are both broadly correct, what might follow in terms of the role of government and complementary action on the part of the industry? To summarise it very simply, I am sure that there is a continuing role for government, for three reasons: first, because despite its current problems the industry has reasonable prospects of viability; secondly, because given the future levels of world demand for its products a viable industry could have a significant future; thirdly, because the present structure of the industry is likely to hamper its efforts to gain an adequate share of those markets.

But, the mirror image of that statement is that if government is to play some positive role in relation to the industry, the industry must put itself in a position to take advantage of what government can offer. This may mean at least collaboration between firms, at most some mergers. I do not see how the present multiplicity of small firms can survive, competing not only with overseas manufacturers but with each other. I do not see how they can generate the finance or the specialised manpower required for the research and development needed to keep them up with world leaders and out of the secondary league of low-cost producers. Nor do I see how small firms, acting independently, could effectively tackle the export markets in which they must in future establish themselves. Mergers are one way of achieving this, but less drastic steps

can also be effective; market sharing agreements, cross-licensing arrangements, collaborative research, buying in of foreign technology. (I exclude from this list mere agency arrangements with overseas manufacturers; these are clearly advantageous for individual firms, and from a short-term cash-flow point of view may be necessary, but they cannot provide the basis for a viable manufacturing industry in the longer term.) One can easily envisage applying to the mechanical engineering field the basic principles of the 'Alvey' approach to information technology, whereby desirable developments of this kind are encouraged by financial incentives. Current government policy, rightly in my view, is now encouraging the application of new technologies by traditional manufacturing industries. In the higher technology sector differentially high rates of financial assistance are available for collaborative reserch schemes involving several firms; this approach seems to me to be more widely applicable. A development which both seems consistent with current trends in policy and promises a more cost-effective use of resources is a shift from specific cash subsidies to general services. I am thinking in particular of enhanced export advisory services, advisory services relating to the application of new technology, even — though it sounds undramatic — advisory services relating to good practice in engineering. These last might have some effect on the bad practices mentioned in the National Institute for Economic and Social Research report that I mentioned earlier.

There is a very interesting model in the Business Improvement Scheme launched earlier this year, which provides a comprehensive package of help to small businesses — diagnosis, market research, business planning, installation of financial control systems, and so on — but, so far, only in areas affected by the decline of the textiles and shipbuilding industries. It is not hard to envisage the extension of this scheme to the whole of the UK, and indeed I note that Professor Brian Wilson of Cranfield has suggested that this might be one of the single most effective ways in which the government could help smaller firms. You may say that advice is all very well, but what about direct assistance? I would not rule out future selective schemes of financial assistance, relating either to the development of new products or the application of new processes, specific to the agricultural engineering industry, provided that in the first place they were seen to relate to a view of the future shared by a majority opinion within the industry and, secondly, that the industry — or once again a majority within it — was demonstrably ready to take parallel action to improve its competitive position. This would be in some ways similar to the 'consensual' approach to sectoral development so successfully practised in Japan by the Ministry of International Trade and Industry.

In all these contexts it is up to the industry itself to find out what is available; for understanding who does what in government, where information can be obtained, and so on. Especially where small firms, understandably, find this hard to do, a particular responsibility rests on the industry's trade association to provide an effective central service. The association should also play a central part in developing and putting to government the kinds of industry-wide forward-looking consensus that I have mentioned just now. Another context in which this joint approach would pay off would be public purchasing. I do not have in mind the familiar but utterly unconvincing demand that British public sector users should buy British products virtually regardless of cost or of quality. For one thing, the vast majority of public sector purchases are already British. For another, this kind of concealed subsidy is liable to penalise the user, by foisting on him products that do not meet his specifications, while doing nothing to improve the competitive position of the supplier. But in the case of the British farming industry, the situation of British farmers is already so artificially dependent upon government support, and the links between farmers of all kinds and government so close, that this is one sector where it would be justifiable to keep alive some version of arrangements to encourage users to buy, use and evaluate British products and so to help in their development to full production stage. I wonder, too, whether more of the sort could be done by the government's own farms, whether operated by the Ministry of Agriculture or by the prisons department of the Home Office. There is an object lesson in the close and effective relationship built up over the years between the National Coal Board and the British suppliers of mining equipment. Finally, and not frivolously, I wonder whether more could be done in this connection by ministers. I do not mean in their capacity as members of a cabinet but in the capacity that many of them have as landowners. Why should not those ministers, of whom in any government there are several, who are fortunate enough to own a farm make a particular effort in their private capacities to act as discriminating purchasers of British agricultural machinery?

But none of these forms of assistance would, by themselves, solve the underlying problems of which the current weaknesses of the industry are mainly symptoms — the whole question of skills and attitudes, whether on the shop floor or among management. The important things here are first to develop the necessary skills and then to use them. Development is, of course, largely a matter of training and education. Clearly there is a basic responsibility here for government whose implications go far beyond any single industry such as yours. But do not neglect the chances of yourselves taking steps within your own context. Some very large firms are already active in training for their own needs — GEC, IBM, Plessey. Though this option clearly is not open for small firms it certainly is for an industry as a whole. The joint research scholarship scheme sponsored by the Department of Industry and the Agricultural Engineers Association strikes me as a most encouraging example of an approach that would be worth extending in future. Some support by goverment for industry-based training would be justifiable, if only to offset the inevitable leakage of trained people to other sectors.

In brief summary, then, my view is that despite the current slow retreat by government from intervention in many sectors of industry, there is a continuing role in relation to the agricultural engineering industry. The shift from cash support to services sometimes supported by cash seems to me broadly correct, and likely to continue. I would rather

you made the decisions about products and markets, and turned to government for some of the help needed to put those decisions into effect, than that politicians and civil servants tried to make them on your behalf. Many of those decisions must relate to export sales, despite the difficulties that those words conjure up; the British market alone cannot for long sustain a viable British industry. If government is to help, the industry must put itself into a posture which will enable such help to be effective: the disadvantages of fragmentation can and I think probably must be offset by combination or collaboration, within the industry and with outside bodies such as academic research departments. As far as it is within the industry's competence to tackle the fundamental problems of skill shortages, at all levels, this will produce results more rapidly than waiting for government to deal with the country's educational and training systems at large. Finally, both for its own purposes and for the purpose of carrying on a constructive dialogue with government, the industry needs to develop a realistic view not only of the short-term but also of the longer-term future. The more clearly it can anticipate its own future opportunities and future needs, the better able it will be to advise government on what government's role should be.

Agricultural Engineering towards 2000

Discussion at the 1985 Annual Conference

Opening remarks by the Chairman, G H Evans

Wealth of a company is generated by long-term planning. The strength of industry occurs by developing products, markets and careers. Unfortunately, the creation of wealth is not considered by everybody as having any priority. Moreover, Agricultural Engineers are not regarded sufficiently by wealth and recognition. The industry may now be on the recovery line in the UK viz:—

tractor production: +12% (exports +23%, >70% exported)

machinery production: +15% (however 15% on only a very reduced production is not as good as it sounds)

employed numbers: -6%

Questions following Paper 1 (R L Dodsworth — Investment prospects and needs)

H J Carnall (Carnall & Associates)

Q I am surprised you did not mention quality assurance.

A *I had to make a number of omissions including quality assurance, to which we do give high priority, and also investment in people. We believe in improving the quality of people at all levels and we are now recruiting people probably of a higher calibre than ever previously.*

M J LeFlufy (Cambridge University)

Q Should investment in people and their training be increased as we are in an era of the specialist as implied by the speaker? How does the speaker see the effective training of such people taking place and what provision should be made for career development?

A *It is important to have people properly trained academically. One difficulty is lack of shop floor experience with such people. Our company find it more useful to have staff proceed through an apprenticeship first and subsequently attend college. Our traditional apprenticeship scheme has already changed from being craft based to technology based.*

W W James (Rycotewood College)

Q Could you please add to your comments regarding the necessity of keeping the time scale short from product conception to its release onto the market.

A *We used to think of the standard five years from conception to launch but we have now reduced this to three years, below which we feel it will be difficult to go. It does however depend on the nature of the development – an entirely new product obviously takes longer than a minor product improvement.*

D Elder (Griffin Elder & Co Ltd)

Q The speaker stated that there was not an expanding market for implements, but surely such a market can be created by the right product.

A *I agree that a good product can make inroads on a specific market at the expense of its competitors. I was generalising in my paper on the size of specific markets as a whole.*

T C D Manby (Silsoe Consultants)

Q Could you please give examples of your use of simulated testing to reduce time scales.

A *We have, for example, fed details of different soil conditions into our computer and then used these in simulated tests on ploughs.*

Questions following Paper 2 (J V Fox — Engineering for profit)

J C Jeffrey (F W McConnell Ltd)

Q How did your company justify the installation of a CAD/CAM system on economic grounds? Has its use in practice equated with your projected economic costing?

A *We have no detailed assessment of its value. Its installation was more an act of faith rather than a calculation. We decided that to be in the forefront of design and manufacture we had to get into the electronic era fairly early. In hindsight we are sure that we made the correct decision as it has enabled us to do things with CAD/CAM that we would not otherwise have been able to carry out. Advertising is another example of giving no clear cut answer on the return of investment, but without it product sales do not begin.*

H J Carnall (Carnall & Associates)

Comment. After-sales service has not been mentioned. This aspect needs more attention both by colleges and by manufacturers. → *Foot page 110*

Exporting successfully

J Thorneloe

What do we mean by success?

ALL businesses exist to make products, or to supply services, and to do so in such a way that they make as high a profit as possible. The first priority in exporting is that it should contribute to the long-term profitability of the business, otherwise it is not worth doing. Anyone can give machines away, even badly made machines. Some machines are only sold because they are virtually given away, but that is not successful exporting. For instance, a company would hardly rate as highly successful an exhibition where they sold their machine for little more than the cost of return freight.

Profit, however, reflects different circumstances in different companies. For some, volume is the key; for others, it is regular cash flow. Some businesses have large sums of money periodically which they can invest in new ventures or markets, and others find growth beyond a certain point unacceptable if family control of the business is threatened by such growth. What I am acknowledging is that profit is the main motive for any business venture, but it is not the only one. The chairman of the board may regard the dealership in Barbados as the only one which justifies his personal attention and support, and he may be prepared to give that support most generously by visiting Barbados for four weeks each January. Such a business trip may be well worthwhile to all concerned, and no-one should ignore the human factor which is crucial to all exporting.

For most firms, however, exporting not only contributes to profits, it spreads risks and increases the volume of factory output. No manufacturer of milking machinery needs to be told what excessive reliance on one market can do to a business. By spreading risks overseas, you are helping to safeguard your business at home. At least as important as that, by increasing the volume of product which you manufacture, you can spread the cost of research and development more widely.

What is exported?

If success means profitability, what exactly is it that we are exporting so profitably? In most instances, we are talking about the same product as is sold in the UK market, but this is by no means always true.

Some of the most highly respected names in British agricultural engineering sold maize shellers throughout the world long before maize was grown in the UK, and much of the plantation crop machinery sold from the UK was developed in Essex, Worcestershire and Wiltshire, but certainly not on local coffee, tea or cocoa plantations!

Less dramatic examples of modified designs abound. Sometimes adjustments are made to machines to take account of different local conditions, and sometimes local traditions make what we regard as perfectly sensible machines unsaleable. For years tractors have been made to different specifications for different markets. A cancelled Turkish order cannot necessarily be re-directed straight away to a Spanish customer, let alone a Greek one. These are, however, the finer points which do not affect the majority of smaller British companies.

For many businesses, the item to be exported is the final product. The world is not always an ideal place, however, and there may be a tariff wall which precludes such a sale, or it may simply be that shipping the final product is uneconomic because of the ratio of weight to volume and freight cost structures. Under these circumstances some local content may become more attractive. The local content may simply be enough labour to assemble a kit shipped from the UK, or it may include the supply

of simple steelwork. For example, a slurry tanker contains a lot of air when finally made up, and it may be more attractive all round to supply the sub-frame, axle, pto, pump and design, with the local assembler buying subsidised steel to make up a simple tank to go with the higher value imported parts.

As in so much else, exporting is increasingly an area where know-how is as much in demand as products. Many developing countries go through a phase when local industry is encouraged and protected, indeed some never emerge from this state. In truly developed markets such as the EEC, the USA and Australasia, it is usually possible to sell finished products, just as it is in the least developed countries where there is no local industry anyway. However, as shown in reports such as the one from the United Nations Industrial Development Organisation (UNIDO) entitled "The Agricultural Machinery Industry: An Appraisal of the Current Global Situation, Production and Market Outlook", the fastest growth in farm mechanisation in recent years has occurred in countries such as Brazil, Mexico and India where imports of finished products are effectively banned.

In countries, such as these, know-how is saleable, as are designs, machine tooling, components and spare parts. The whole debate about machinery exports often ignores the fact that sales of components and parts are often more valuable than

John Thorneloe is Chief Executive, British Agricultural Export Council.

This paper was presented at the Annual Conference entitled: Agricultural Engineering towards 2000, held at the National Agricultural Centre, on 14 May 1985.

sales of the original machines. However, it is undoubtedly true that some UK companies have had bad experiences investing in countries such as Brazil, but unless we sell designs that require British components we will not sell those components. This is certainly an area of the exporting business that requires extremely careful analysis.

Other know-how sales are less risky, I am glad to be able to say. Advice on mechanisation and management services to local companies both come under the general heading of consultancy, and the provision of training can be a valuable revenue earner in its own right, quite apart from the part it plays in exposing young engineers from overseas countries to British products at an impressionable age.

How does exporting work?

If you have a product and you know what you want to do with it, how does exporting actually work? In an ideal world, the first step is to research the market in order to identify a potentially profitable marketing strategy. Having done that, the next stage is to set up a marketing system to achieve it. This is the stage which takes the time, costs the money and too often comes to grief. In most countries it is a question of appointing an agent or distributor who will get the product to the final consumer. A mistake at this stage will haunt you for years after.

Having established a marketing system, it is necessary to promote the product through demonstrations, advertising, exhibitions and other such methods with which you are all familiar.

If ever you feel these stages are not necessary, consider a foreign manufacturer selling his product to the UK. If he relies on leaflets in Italian, or Finnish, will farmers buy the product? If he appoints an agent in Norfolk and leaves him to it, will he capture a worthwhile share of the UK market? If he never shows his product at Smithfield, the Royal, the East of England, or whatever, who will know about it? Will *Farmers' Weekly* or *Power Farming* write about his machine unless it is a real world beater?

Unless you have a really good agent you must expect to have to help him to sell your machine, at least initially, and having clinched a few deals you must deliver precisely as agreed, on time. Having done that you must get paid and repeat the process, gradually leaving everything to the agent except the manufacture and supply of the product.

That, of course, was the ideal world. In reality, what happens is often rather different. The export salesman is under pressure to deliver evidence of success. He receives an enquiry to which he replies, and then he receives a further encouraging response. Having got to this stage, he wonders what sort of country he is dealing with, does some market research and finds he has got it all wrong, by quoting an agent who will never win business, has no showroom and can do no more for him locally than guarantee to wreck his name in the eyes of end users.

Some swift footwork can often undo the mess, but having established a need for his machine in the country concerned, the export salesman then has to go through all the stages he should have covered before with a bad taste in his mouth, and still under pressure to come up with results.

What is needed for successful exporting?

The fact that an export salesman is operating under this sort of pressure shows that his board of directors did not know what they were letting themselves in for when they appointed him. Being a long-term business, exporting requires sympathetic support from the boardroom to the shop floor over a long gestation period. Nobody expects a design engineer to invent a new machine and have it on the market in six months, and exporting is no different.

Just as design, prototype manufacture and testing require funds which are at risk until the second wave of sales comes in, exporting requires a commitment of personnel and funds that many small companies will not make, even though they are virtually wiping themselves out of business within twenty years by so doing. Firms that do not export will not survive at home. The European farm machinery business is now so transnational that scale of manufacture is essential to survival. We are moving to a situation in which only large companies and very small ones survive, and the employer of 20–50 persons has no more future than the 15 hectare farm.

What I feel increasingly, as I see who gets the business and who goes to the wall in the agricultural engineering industry, is that *people* are absolutely cruical to success. The right people can sell most products, and only the very best designs sell themselves.

Export sales require sensitivity to local conditions. I know export salesmen whose attitude is "point me in the right direction and I'll start selling". That is not the right strategy. You cannot sell until you know what the customer needs. It is unlikely that an export salesman will be successful if he is not the sort of person who reads the foreign news pages of a quality newspaper, who knows that not all Latin Americans are ruled by tin-pot generals, who knows that not all Arabs are gamblers and drinkers, who knows that there is more to the Far Eastern market than sweet and sour pork and downtown Bangkok. Attitudes fostered by these stereotypes can be tremendously damaging to a company's chances of winning export business. Most foreigners are actually quite sensitive. Again, think of the problem in reverse, and consider the Scotsman who is thought to be English, or the Englishman who finds himself described as an excitable Mediterranean type.

As well as being sensitive to how things are done overseas, some language ability is important. Very few salesmen can be expected to master two languages and understand a complicated piece of engineering product, but some effort is the least that can be expected. If you decide to make do with English you are reducing very substantially the pool of potential agents and customers open to you, and reducing equally your attractiveness to them because you are demonstrating quite clearly just how far you are prepared to put yourself out in support of exports.

Export salesman must have reasonable powers of decision taking. If that means sending a director, then send a director, but do not expect a potentially vital customer to hang around while a decision is wheedled out of head office by a salesman who clearly does not have the confidence of his board. This is not the way our competitors

do things, and it is one of the factors that is referred to by that hackneyed phrase "the British are not sufficiently aggressive in our market".

Presentation is also important. Writing a letter which says "these are our prices, these are our terms, we look forward to receiving your esteemed order" is useless. At the British Agricultural Export Council, we deal all the time in contacts with people who have not actually expressed a desire to place an order for machine x, or pesticide y, or animal z, but who are prime candidates for an intelligent soft-selling approach. They should be written to in a manner that will attract their interest, by explaining what your machine has done for another client in similar circumstances, by inviting him to respond with more details of his farming operation or by asking whether you can visit him next time you are in the country.

If you stop and think about it, all these are obvious points, which encourages me to think that more British agricultural engineers could succeed overseas.

Finally, your export salesmen need to be resourceful. This brings to mind an example of a company exhibiting in the British Agricultural Export Council pavilion at a recent overseas exhibition. When I took a potential client of considerable standing and buying power to the company's stand, his interest in the product and the company was such that he invited the salesman to visit his engineers and workshops about one hour's flying time away.

I felt that this was an excellent opportunity for soft sell. It is true that there were travel restrictions in this particular country, but they could be overcome by being resourceful and not giving up without a struggle.

The result was that this particular exhibitor, who was a first rate engineer and salesman in normal circumstances, just could not rise to the occasion and chance his arm or ingenuity with the travel problem, so he did not go. I took the same client to another exhibitor with a totally different product who jumped at the chance to visit the client "in situ" and as a result he is "doing very nicely, thank you".

Agricultural Engineering towards 2000

Discussion at the 1985 Annual Conference continued

Forum discussion opened by F Moore (Howard Rotavator)

W W James (Rycotewood College)

Q Can you advise educationalists on the type of training required for marketing personnel? Secondly, are colleges producing too many trained people for the industry to assimilate? Should colleges have an annual quota of students and concentrate on quality rather than quantity?

Discussion. **J Thorneloe** *Salesmen should learn to put themselves in the position of their customer by making him feel that he knows as much about the problem as the customer does. The Continent of Europe was not really considered to be an export market 15 years ago, but now we were involved to a much greater extent. Certainly, export salesman's mastery of the French and German languages had improved but we should now learn languages such as Russian and Arabic.*

J Fox *Being an engineer, being employed in agriculture and being a salesman are all very worthwhile careers and the general public should be made aware of this.*

R L Dodsworth *Two or three foreign languages are desirable for salesmen, who should be made more aware of markets outwith the UK. There is a need to improve the status of salesmen within the UK professions.*

E D Quick (A C Bamlett Ltd)

Q Will there be companies in the future in the 50–60 employee size range?

Discussion. **J Thorneloe** *suggested that overheads are too high for companies to be viable at that size.*

F Moore *disagreed, saying that the best financial returns as recorded in the ICC lists are from a company of just forty employees: Micron Sprayers, an outstanding example of a company sticking to its specialty.*

Mr Shelborne *said that his company had gone through this barrier to be at a level of 160 employees now. He agreed that the fifty-sixty range is the most difficult because, at that size, a company cannot afford a full management team. The government must give help.*

J Thorneloe asked Mr Shelborne what would have been his reactions if he had not been able to expand.

Mr Shelborne *said that there are many variable factors — including the degree of commitment of the leading personalities in the company, the strength of the competition, etc.*

A Whitehouse (Bomford & Evershed)

Q I do not agree with the last questioner that a barrier develops to further company expansion at a level of 40–80 employees. In industry as a whole this barrier occurs at 200–300 employees.

A **J Thorneloe** *There are many barriers which occur throughout the development of a company. The first one occurs, as soon as one employs the first man. Government aid at any time often is the 'kiss of death' for a company.*

P Hughes (J Mann & Son Ltd)

Q What are the three main qualities required for a firm to be successful in the UK agricultural engineering industry?

Discussion. **F. Moore** *To have a product that has a better performance than those of its competitors, that is sold in the best place to sell it and that has the best salesmen to promote it.*

R Dodsworth *Companies should not rest on their laurels when their present product range appeared satisfactory otherwise competitors might suddenly market an even better product and leave one without anything to counter their inroads into your market.*

J Fox *We cannot compete with firms producing 30,000 units or more per annum. We must make products with a better performance than those of our competitors. More foreign languages should be learnt by salesmen and after sales service must be good to engender confidence.*

Chairman Do you agree with these answers?

P Hughes *Twenty years ago most combines in use in the UK were produced here, now not one is made in Britain. I do not think the conference has identified the root cause(s) for the decline in the British agricultural engineering industry.*

J Fox *The UK market was protected for far too long after World War II, when initially we had a supremacy following the cessation of hostilities.*

F Moore *We must have products with superior performances to compete with the large manufacturing runs of our competitors in Europe.*

Chairman *Many companies have not made a conscious decision to attack the markets of foreign competitors.*

J Fox *It is not all a one way business of foreign firms having monopolised the sale of individual types of machinery. For instance the market of hedge cutters is monopolised by a UK firm.*

J W G Young (Wolseley — Hughes Ltd)

Q Current Government policy is for a free market economy, does the panel think that this the right one to stimulate exports from our industry?

A **R Dodsworth** *I'm for a free market economy, as any barriers will reduce our own efficiency, which is exactly what occurred before we entered EEC. Some stability on the exchange rate of sterling would be helpful to exporters.*

J Fox *I agree with R Dodsworth in sterling exchange rate stability and also consider that Government financial assistance is often a long-term road to disaster.*

J Thorneloe *The Government has cut the finances to the British Overseas Trade Board, which is most unfortunate. This Board is one of the best institutions to aid the exporter as it encouraged him without detracting from his efficiency. Our competitors, however, have enhanced their activities in this field as they realise that the wealth creators should be encouraged.*

F Moore *The free market economy is the correct procedure. There is still a role for Government to play, but we have not yet learnt the best possible role that Government should take.*

Concluding remarks at the forum discussion by F Moore

It must be emphasised that our whole industry depends on people. Manufacturers must help their distributors to sell their products. But our concentration must be on increasing sales because thereby we preserve and create more jobs.

I welcome the emphasis on exporting and commend the suggestion that a company which does not export is unlikely to survive. However, a company must concentrate on its specialties both in terms of products and on what it manufactures itself.

Innovation in agriculture and British Technology Group's role

H G Stirling

Introduction

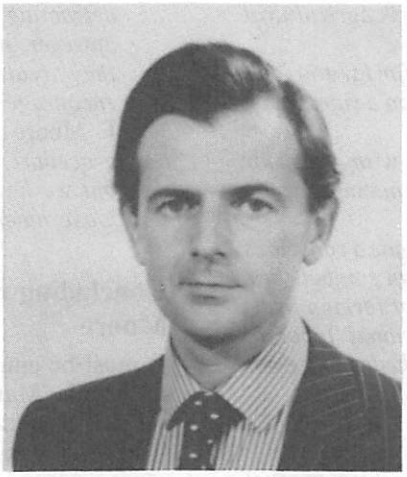
INNOVATION has been dealt with at conferences in the past and indeed at the Institution's own Annual Conferences in 1981 and 1984, where the topics were "Innovation in Agricultural Engineering (Its Encouragement and Utilisation)" and "Agricultural Engineering towards 2000". Without in any way trying to "cap" or rewrite these previous sessions, I would like to focus your attention on the following points.

I What is innovation?
II Where does it come from?
III How do we go about exploiting it?

I Innovation

We do not have to look far for definitions of an invention. My favourite dictionary, published in Edinburgh in 1934, quotes invention as: "Contrivance of a new mechanism or design and the application of it to the industrial arts". Quite astute isn't it? Note the inclusion of the word "application". Nearer the mark, we can talk about growing two ears of corn where only one previously grew; of carrying out a task with one man which previously took two; of wilting grass in three days where it used to take five; and of using an 80 kW tractor where 100 kW was formerly required. Agriculture itself, and its requirements from the engineering sector serving it, impose no limitations on the scope for creativity — for seeking economic solutions to technical problems.

It is not generally difficult to decide if someone has taken an innovative step forward — alas, the difficulties come later!



II Where does it come from?

However, before we get into the problems and pitfalls, I would like now to examine my second topic of where inventions come from, and I would suggest three distinct sources:

A public sector;
B companies;
C farmers or other private inventors.

A Public sector

Farm machinery research in the UK is mainly carried out at two grant-aided institutes, the National Institute of Agricultural Engineering (NIAE) at Silsoe and the Scottish Institute of Agricultural Engineering (SIAE) near Edinburgh. Agricultural research, not necessarily orientated towards machinery, is also conducted at the various Agriculture and Food Research Council (AFRC) institutes and research stations, universities, Silsoe College and other agricultural teaching establishments.

All these are prime breeding grounds for innovation and, in the UK, we have a proven track record of international success from the public sector. To quote just a few examples, we have pioneered:

Pyrethroid insecticides (Rothamsted);
X-ray potato sorters (SIAE);
Grass mower conditioners (NIAE);
Hormonal weedkillers (Wye College).

The British Technology Group (BTG), operating as the National Research Development Corporation under the Development of Inventions Act (1948), has historically played a key role in supporting and commercialising agricultural innovation in the public sector. This role is at present undergoing some changes, but these should not affect our long term commitment to the agricultural industry.

Another hitherto untapped source of public sector innovation is defence research establishments which, for obvious security reasons, have not allowed the commercial world access to their technology. The problem is compounded by the fact that in many cases defence scientists are unaware that their work could have important non-military applications. The Government has recently promised some changes in this, naturally with suitable safeguards, and it is hoped that BTG could prove to be an acceptable link for commercialisation.

B Companies

Let us now consider the position of the manufacturer as a source of new ideas for farm equipment.

Our industry has an unusual and unique structure in that it consists of 6 large tractor manufacturers with a workforce in excess of 750 each, counterbalanced by 300–400 equipment companies employing, on average, 20–35 people. Generalisations are therefore risky.

The tractor companies have been losing money internationally on a large scale for a number of years, although there are signs of an upturn.

A number of the small companies have successfully located profitable niches in the market place. Smallness for some has meant good adaptability, quality of product, and quickness to develop new equipment — all important factors in surviving a recession.

Hugh Stirling is the Senior Executive (Agricultural Engineering) with the British Technology Group, 101 Newington Causeway, London SE1 6BU.

This paper was presented at the North Western Branch Conference entitled "Innovations in Agriculture" and held at Stokes Hall, Leyland, Lancs on 21 November 1984.

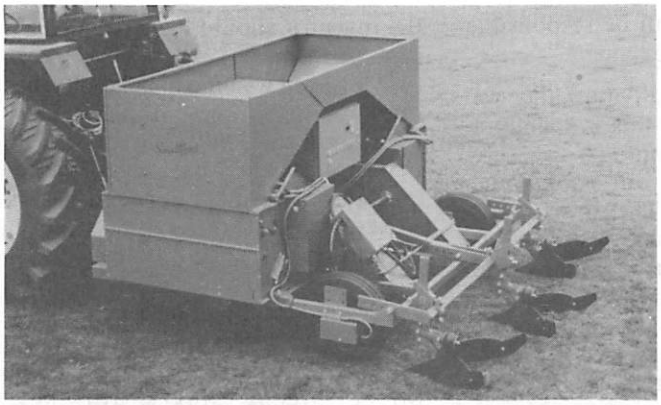


Fig 1 SIAE high speed potato planter – the first field machine to incorporate a micro processor

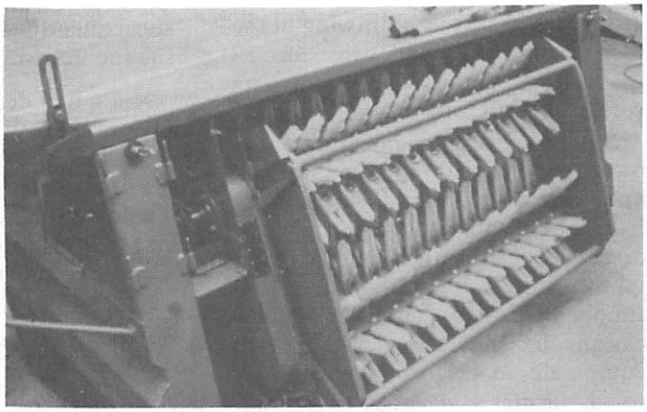


Fig 2 NIAE brush conditioner – a radical departure from existing hay and silage making equipment which has still to reach full commercial potential

But very few, large or small, can describe their businesses as flourishing.

How therefore can they play a useful part in innovation? Do they necessarily need to? There are plenty of ideas around — why re-invent the wheel?

Of course, for a company to develop independently its own new product from scratch gives enormous pride, it may even lead to a Queen's Award, but sometimes it may also indicate that the company is spending too much on research and development. Such expenditure takes courage these days.

It has been estimated that, on average, the small UK equipment manufacturers spend 1.3% of turnover on research and development which gives us a figure somewhere between £15M and £25M per annum. It may be more; I know some of my clients spend five to six per cent. Public sector expenditure in agricultural engineering totals about £9M/annum, £2.25M of which is a Department of Trade and Industry contribution to manufacturers' research and development.

Assuming that this estimate of 1.3% is reliable, it is so absurdly low that if a company makes an important innovative step as a direct result of this sort of expenditure, it is probably good luck and nothing more. And bear in mind this expenditure tends to be on "Development", not "Research".

I am not pointing a finger of accusation at our industry and urging them to spend more on research and development, because I do not think this is necessarily right in the present financial climate. But one cannot expect new products to materialise from nowhere, and if the money is not being spent to make inventions in the first place, they must be bought in, usually under some sort of licensing agreement. And the cost of such a licence should not necessarily be loaded entirely on to the new product — part of it must be attributed to the company's research and development budget.

Lack of research and development does tend to result in unsophisticated products which has earned the UK agricultural industry the reputation of — "exporting cheap, importing dear".

But inventions and new products you must have, of that I am firmly convinced. A farmer will always find the money, somehow, for that piece of technology which will enable him to grow the proverbial two ears of corn. He will sometimes even pay for "novelty" in a new machine, but perhaps for the wrong reasons.

Nonetheless, if a company genuinely does have a good idea and wishes to reduce or at least share the financial risk, there are ways of achieving this, including funding through BTG's joint venture scheme. This is often structured in conjunction with grant aid from the Department of Trade and Industry.

C Private inventors

And now we must look at the third main source of ideas, the private inventor, which in our case, generally means the farmer inventor.

Now the inventor is a great character, frequently maligned and the subject of good-natured humour.

Fig 3 Tea Harvester developed by Silsoe College for Michael Cotts — a new product creating a new market

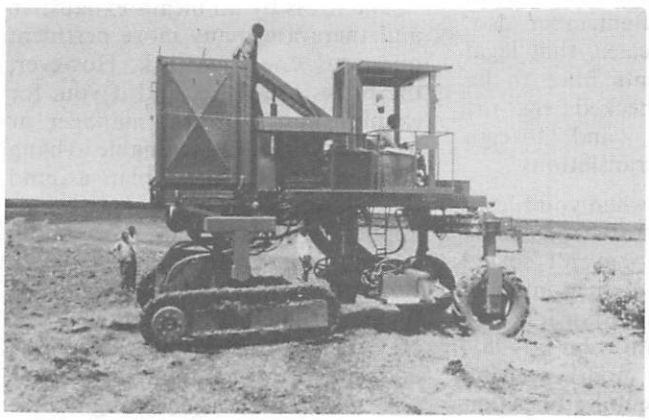


Fig 4 Field Master Aircraft — a company design dedicated to aerial spraying

Ask Giles to pen us a drawing of the farmer inventor and we can all instantly visualise what the caricature will look like.

But agricultural engineering is one part of industry in which knowledgeable private individuals have a better than average chance of coming up with practical innovations. Sometimes, these will simply be design details or modifications to enable a new piece of equipment to perform satisfactorily to a farmer's particular requirements, soil type, and unpredictable environment. These modifications may, or may not, have universal application. At other times, there will be genuinely novel approaches to age-old problems.

One characteristic of the farmer inventor is that his idea is unlikely to be daft, and it may well be partly proven in the field.

Another characteristic is that the chances of his having adequately gone through all the other necessary steps in assessing the viability of his invention are remote. This inevitably means that if the prospective exploiter of the idea turns it down for whatever reason, the inventor, being by nature a sensitive animal, becomes very disillusioned and disheartened. It is a sad fact of life that the private inventor rarely makes any significant money from his invention.

Nevertheless, inventors can often link directly with a manufacturer and agree satisfactory terms for the exploitation of an idea. I should just mention that I use the word "exploitation" to mean the successful utilisation and commercialisation of the invention for the mutual benefit of both parties, and not in the Victorian work house sense! In this case, BTG can often assist by providing joint venture finance to the company, and the project would be led by the company, not the inventor.

In the absence of early commercial interest, another role BTG can play is to fund further development on the private inventor's behalf. I like to regard this in accountancy terms as "adding value".

We take in the raw idea, we fund further testing usually at a research institute, we have a report written and a video film made. We pay for the patenting, and decide on the overseas territorial protection. At the end of the day, we then have a complete package with which to try and attract a manufacturer, and subsequently we will be responsible for the licensing agreement.

Not a bad deal really but, alas, we are no charity and this is strictly a business proposition — we are required to balance our books, one year with the next! The drawback is that the inventor has to assign his rights in the idea to us absolutely, and we do not pay for this. Our approach is that the inventor will start to make money when we start making money, and the usual arrangement is to share net income with him on a 50:50 basis.

But apart from just "adding value" to a basic concept, the advantages to the inventor can be considerable, in that the skills of our own legal department are utilised in structuring what hopefully will be a watertight licence, (and bear in mind this could be a complex overseas agreement), and the responsibility for looking after and perhaps defending the patent becomes BTG's.

The question is often raised of when should a private inventor approach us. The ideal time is soon after he has filed his first patent application, at which stage his expenditure is unlikely to be much. We will look at ideas pre-patent filing, but we cannot act as his patent agent, or offer a free advisory service (as many inventors hope). If we take the idea on, we become financially responsible for his patents, but still use his originally chosen patent agent. The worst time to approach us, (which incidently is when everybody always does), is eleven months after the first filing date. It is at this point, with the first anniversary approaching, that all the expensive patent decisions have to be taken, and the foreign territories nominated. The inventor takes fright and needs help. Alas he has left it all too late, since we are not going to commit ourselves to this expenditure without carrying out a proper assessment which cannot be done in the time available. Remember also, within these time scales, that legal assignment documents have to be drawn up and checked by the inventor's solicitor, and foreign filings may require translations.

Never forget that when you file an application, you start the clock ticking, and if you haven't sorted your ideas out by the sixth month you are cutting things fine. Bryn Jones, in his paper to the Institution in 1981, defined five and ten month decision points, and listed the milestones that the inventor should have reached by each of them.

Whilst not wishing to belabour this question of sources of ideas, it is interesting to identify the origins of new equipment that has become available to farmers in recent years:

Research institutes	40%;
Industry	25%;
Farmer/private inventors	35%.

I would stress that this is very much a "guesstimate" but is probably of the right order. In the Silver Medal stakes for new equipment, BTG has been associated with seven winners over the last five years, as well as Queen's Awards to both the NIAE and Rothamsted.

III How do we go about exploiting it?

Our agricultural engineering industry, proud as it may be of British achievements, is just not in a position to take on Concorde-type risk levels, however attractive the technology looks.

We don't necessarily want high technology — what we do need is *good* technology which is commercially viable.

The technology is just one ingredient of a complex recipe. Most of the other ingredients have to be present in approximately the right proportions for the innovative cake to rise to commercial fruition.

In many cases, failure of a new product can be ascribed to a lack of this at inception, and if all the ingredients are not present at day one, you cannot simply trust to luck, and hope that miraculously they will all be there when the product eventually comes on to the market.

So what are these ingredients? By way of illustration, I would like to show you the guidelines I give to companies who approach us for help with a new idea. This is attached as an appendix to the paper.

The list is by no means exhaustive and there are many more pertinent questions one could ask. However, the bones are there, and if you, for example, as a project manager or technical director, are unable to hang a convincing business plan around this skeleton, then forget it. This applies whether you are simply seeking approval from your own Board for a new project, or looking for external help from finance houses, BTG or the Department of Trade and Industry.

I, too, have to go through these

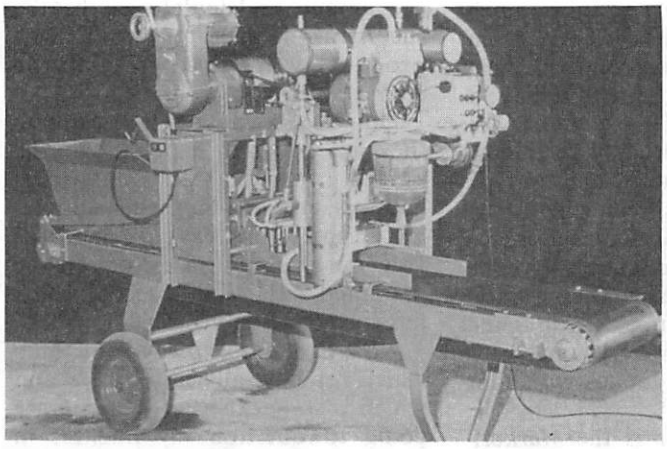


Fig 5 NIAE fluid seeding machine – a new product entering an existing market

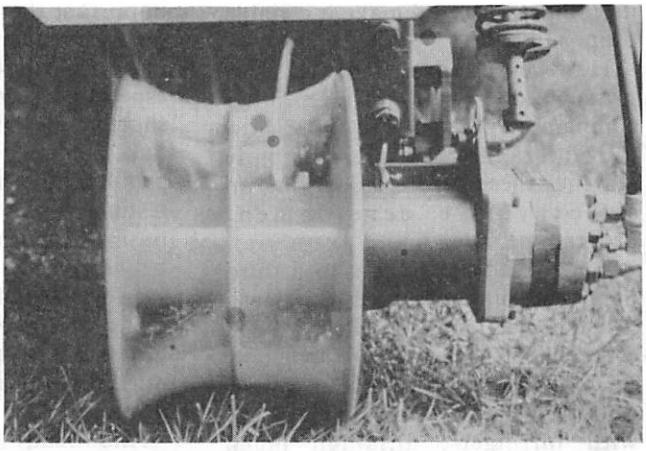


Fig 6 NIAE sugar beet topper – a good design concept with long term potential

steps in accepting inventions, on BTG's behalf, into my portfolio, although obviously the company aspects are not present with Research Institute inventions in the early stages.

But even with these, I like to go through three thought processes.

(i) What sort of a manufacturer is going to take the idea up?
(ii) What will the new product contribute to the company's turnover?
(iii) Can both licensor and licensee make a living out of it?

If projections do not indicate a contribution to company turnover of let's say £100k/annum by year three, it is unlikely to be worthwhile taking it on.

But bear in mind I am not a manufacturer, I am an exploiter — a peddlar of ideas — and in taking inventions on to BTG's books, I can afford to take risks where a manufacturer cannot.

Indeed I have to, because I need to start with a very broad based portfolio, from which a small percentage, perhaps only five per cent, will eventually become high flyers. And because I am in at the beginning, I have even less idea than a manufacturer, as to whether or not I am picking a winner.

But the steps must be gone through, the ingredients must be weighed up — there is no short cut at this stage of the assessment. I would be the first to admit that an element of luck may also be involved, but don't believe anyone who tells you he can pick winners "riding by the seat of his pants" — that's strictly for the racing tipsters.

I would also like to mention the importance of continuously monitoring a new project. In analysing failures, and it is valuable to do so, I wonder how often a technical director could place a finger on his bar chart and say: "I had absolutely no right to proceed beyond that point with the confidence that I did". Rather frequently I suspect.

Now this is not wisdom with hindsight, this is merely appreciating that the ingredients, and risks, change as the new product is being worked-up. Luck has no reliable part to play in exploiting new technology; if it does, it should at least be contrived luck, and not gratuitous luck.

Could we now quickly look at the points on my "punch" list. First of all note that I suggest a total length. Whereas I am a great believer in the Churchillian maxim of "Pray tell me on one side of foolscap" I think in fact five sides is about right, with appropriate appendices.

Always start with a *Summary*: Board members are busy people — assume it's the only bit they are going to read.

Background — How many people bother to write an adequate background, especially for an internal company proposal? But it is important. Imagine putting up a proposal for the first ever direct drill without talking about winter cereal varieties, current thinking on minimum tillage and new generation herbicides. But people do — they land on my desk every week — marvellous design of new drill d'you know! Can you come and see it tomorrow? And companies are just as guilty as farmer inventors!

The Invention — Obvious, one would have thought, but not everyone remembers to tell you *how* it works — perhaps they don't always know themselves! And how often do people give glowing descriptions of what their inventions do, yet fail to convince you of the technical and commercial merits of doing it — of why it is better? And how easy is it to manufacture?

Patents — Now patents are important to me since they form a key part of the package I hope to sell on to a manufacturer. I would not like to say that I would automatically reject an invention which was not patentable, but it does mean that an essential ingredient is lacking, and the risk factor rises accordingly. Patents are equally important to the private inventor for similar reasons, and so often they disclose their invention before seeking patent advice, thereby jeopardising the chances of obtaining adequate protection.

Quite often I will try and build up a family of patents covering different aspects of the same ultimate product. This adds to the value of the package I have on offer, and makes infringement by unlicensed companies more difficult. BTG is in a unique position here in that patent families can be built up from different sources, different research stations, and can even be a blend of public and private sectors, yet all be the property of one organisation for exploitation purposes.

We currently have an agricultural engineering portfolio of well over 100 patents or applications, and some 50 licensees. In the context of general innovation covering all areas of technology, this is considered to be a fairly successful ratio.

On the other hand, I do not think the absence of a patent should deter a company from developing an in-house invention. A company can rely on speed of product launch and its own know-how, to steal a march on

its competitors, and make it a viable proposition.

However, do ensure that one's new product does not infringe other companies' patents. I wonder how diligently the average company searches these before embarking on an expensive development programme.

And royalty payments to a third party can play havoc with the cash flow projections of the project, especially if the patents are owned by BTG, and I'm pitching the royalty rates!! We are not known for leniency with infringers, although much depends on how deliberately the infringement has been conducted.

The *Company* section is fairly self-explanatory, but again I would pose the question of how often would a company do a note on this aspect for an in-house project. I think it important because it is a self-discipline which can focus the mind on how this new product is going to fit in with the overall company structure, its manufacturing capabilities and seasonal bottlenecks, market niches and future aspirations.

I also like to know a bit about the people who will be working on the project. A good team can make a success of really quite a mediocre idea, but the converse is not necessarily true. The opportunities for a second rate team to make a disaster out of a brilliant idea are legion, and although I shall refrain from doing so, examples are not difficult to quote.

Then we have the *Project* itself. Quite simply, what do you need to do to take the invention from its present state to market launch? How long is it going to take, and what is it going to cost? I like to see bar charts and objectives. It becomes increasingly important these days to move much faster in reducing the cycle time from project inception to product launch, especially as products tend to have a shorter sales life. This is not easy in our industry, especially with the problems of seasonality in prototype testing, but a one year slip in the business plan can mean the difference between success and failure. Never be afraid to abandon a project if it starts going wrong. Never soldier on in the hope that it may work out — it might do, but it might cost you a lot of money.

And finally there is the *Market*, possibly the most important ingredient of all.

I have actually put financial projections in the company section; you may find it more logical under the market heading.

It is not unusual to see sales potential argued along the lines ... "there are 'x' million back gardens in the UK large enough for a greenhouse therefore the market for my new improved greenhouse is 'x' million". It sounds laughable, but it is true, not, thankfully, from companies but frequently from private inventors.

What of course they should find out are the current UK sales by existing manufacturers, establish whether these are expanding or declining, project forward for the next five years, and work out a cash flow on the assumption that they could capture 10% of the market from their competitors by year three. Overseas sales at this stage are merely a bonus. This does not take long and you don't need a degree in marketing; if the cash flow is negative, forget greenhouses and find something else; if it's positive, rework the whole thing rather more seriously, looking at profitability, with the help of an accountant. And don't forget that the successful launch of your new product will sharpen up the competition.

Don't believe anyone who tells you they are going to capture half the British market. It sometimes happens, and ride-on garden mowers are an interesting example, but it is very rare. It is rare too to be presented with a skilful survey which has tried to assess customer reaction.

Now I'm going to say something which you have all heard before, and which is so hackneyed, that you are going to question my intellect in repeating it today. Nevertheless, it is simply this.

You can launch a new product into an existing market.

And you can launch an existing (or slightly modified) product into a new (or different) market.

But to launch a new product into a new market is a totally different game and a far higher order of risk. For a start, the market appraisal reverts to the greenhouse/back-garden syndrome, and the sales projections become infinitely more difficult.

When it comes off, it can be spectacularly successful, but it takes courage and don't underestimate the chances of failure.

It is surprising that almost every new, or so-called new, product from all areas of technology fits into one or other of these categories, from Paraplows to computer games; but were they identified in that category on day one of the project appraisal and did anyone try and quantify the risks? If, in turn, a *new* company is involved, in any of these categories, the risks are compounded. This was analysed very clearly in David Elder's paper to the Institution in 1984.

Fig 7 Racal air stream helmet – not originally designed for agriculture but enormously successful as a new product in a new market

Fig 8 sugar beet cleaner – a NIAE improvement to an existing machine from an established company

Conclusions

We have looked at what innovation is, we have identified where it comes from, and we have gone through the stages of how to assess its value. I can show you successes and failures; farmer's inventions and research station inventions; products where the innovative step was small but the team behind it good, and even the ultimate risk of launching a new product into a new market with a new company; and, finally, equipment which has succeeded without patent cover, and others whose commercial success depended entirely on strong international protection.

And I would just like to leave you with the thought ... can you pick a winner?

References

Bryn Jones D (1981). Patents for home and export markets — advice to the small inventor. *Agric Engr*, **36**, 75–78.

Elder D I McA (1984). Starting a new company. *Agric Engr*, **39**, 94–97.

Appendix 1 Guidlines for submitting an agricultural development project to the BTG

(Suggested length — five sides of foolscap)

Summary

A brief abstract (100–150 words) of all the important points you mention below.

1 Background

A general description of how the invention fits into current agricultural practices, how its function is performed at the moment, (with what equipment), and why a farmer/contractor might buy it.

2 The invention

Who designed it and whereabouts?
What it is?
Please describe how it works (in your own words, not the patent specifications).
What are its technical and commercial advantages?
Has a prototype been built and tested?

3 Patents

Are there any patents or UK patent applications?
If so, please enclose.
Who owns the patent rights?
Do you know of any competitive, third party patents?
Can we talk to your patent agent?

4 The company

Short history of your company.
Main activities, products and any special expertise.
Employees and manufacturing facilities.
Financial position.
(Please send most recent audited and management accounts and annual report).
Financial projections: (monthly breakdown of receipts and payments over development period or two years, whichever is the shorter).
Annual projected profit and loss accounts and balance sheets over 5–7 years are appropriate. Please identify project costs and revenues separately.
Very brief curriculum vitae of any key personnel who will be closely associated with project, eg inventor, technical director, marketing manager.

5 The project

Technical objectives.
Time scales (eg bar chart).
Total costs (with breakdowns).

6 The market

What is the size of the market and what proportion do you hope to capture (a) in the UK (b) overseas, in your first year of manufacture, and in the subsequent five years (eg a simple sales graph)?
At what price will you sell the equipment (at today's prices)?

7 Proposal

Please indicate the amount and type of financing which you are inviting us to consider.

8 Referees

Please suggest three independent people we can approach, in confidence, to discuss the technical/commercial merits of your proposals. At least one should preferably be from a publicly-funded research organisation, eg the National Institute of Agricultural Engineering.

9 General

Please indicate your company's acceptance of our Conditions of Assessment:

a BTG will not be liable for any loss or damage resulting from disclosure of any information concerning a proposed project.

b BTG will not be liable for the acts or omissions of any assessors or consultants whom BTG may have approached for advice regarding a proposed project.

c BTG will incur no obligation for the support of a proposed project or for the payment of any associated expenses except by means of a formal agreement or contract between BTG and the applicant, signed by their duly authorised representatives.

Chart your way into new design freedom.

Because our welded steel tubes find their way into almost every aspect of modern industrial activity, from simple structures to high technology applications, we have decided to chart our involvement in pictorial form.

The chart lists 22 different agricultural products in which welded steel tube is typically used, and there are many more. Basic data about the grades, shapes and sizes of tube available are also detailed.

As a stimulus to the design engineer's imagination, this wall chart provides a constant reminder of the versatility and range of applications of welded steel tube and of the wealth of technical information and advice available from BSC – The Tubemasters.

Return the coupon for your own free copy of the chart. Please complete the coupon legibly as it will be used as your address label.

To: Publicity & Promotions, BSC Tubes Division, Corby, Northamptonshire NN17 1UA. Please send me the Tubemasters Agriculture chart

Name _____

Position _____

Company _____

Address _____

_____

Other charts also available: ☐ *Engineering* ☐ *Energy* ☐ *Public Works* ☐ *Construction* *(Please tick requirement)*

WELDED TUBES FROM BSC TUBES DIVISION
THE TUBEMASTERS

Corby, Northamptonshire NN17 1UA
Telephone: Corby (0536) 202121