I AGR E

Volume 26
Number 3
Autumn 1971

SELECTION AND DEVELOPMENT OF NEW PRODUCTS

Management Control of Design, Research and Development
Finding and Exploiting New Products for a Small Company
Product Planning and Development in a Specialised Company
Necessity is Still the Mother of Invention

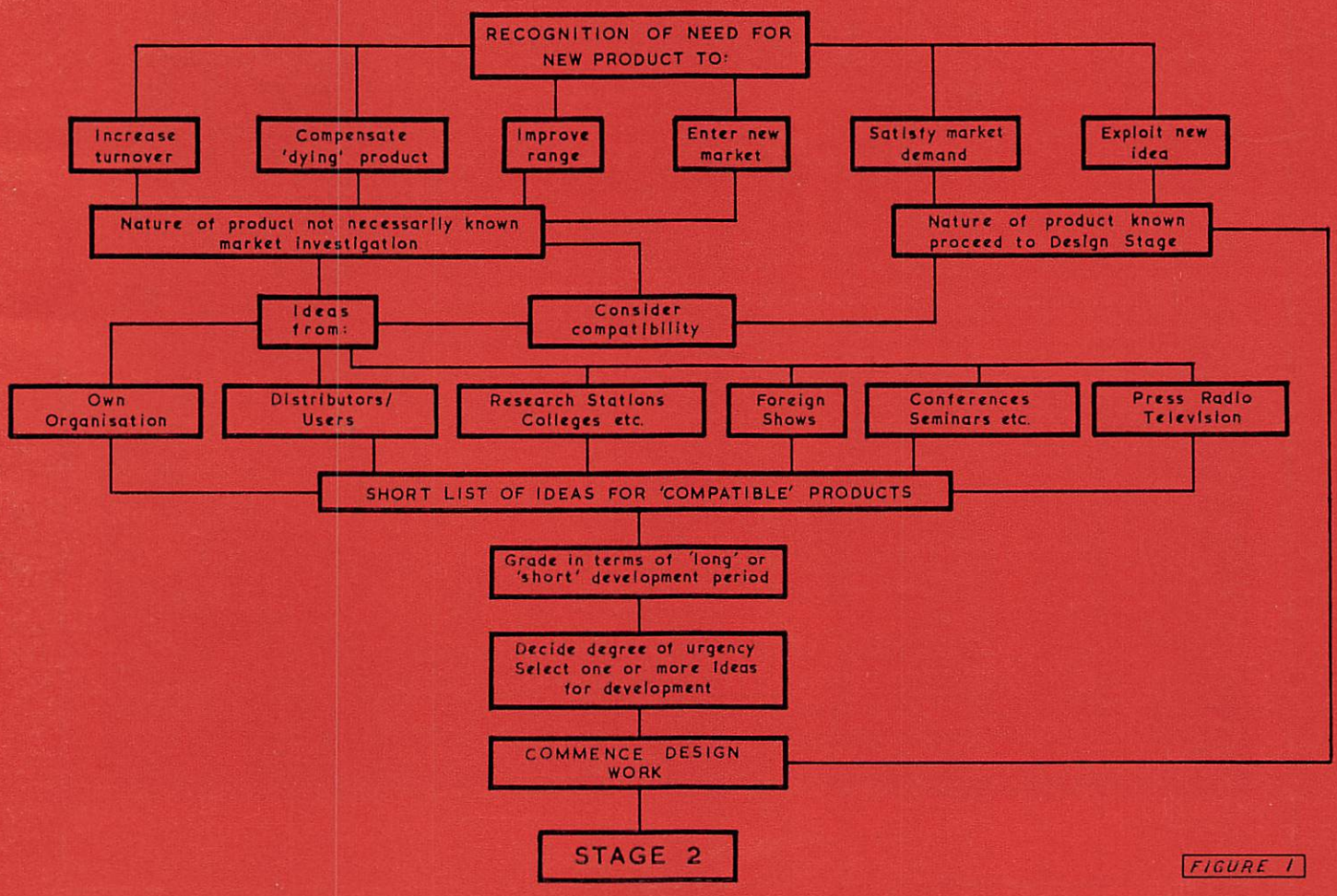

FIGURE 1

JOURNAL

and Proceedings of

THE INSTITUTION of AGRICULTURAL ENGINEERS

AUTUMN 1971 **Volume 26** **Number 3**

The Front Cover illustration is from Figure 1 of the paper by J. V. Fox

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THE INSTITUTION OF AGRICULTURAL ENGINEERS

AUTUMN NATIONAL MEETING 1972

COMBINED WITH A C.I.G.R. Section III meeting

SUGAR BEET & POTATO PRODUCTION IN EUROPE

to be held at the NATIONAL COLLEGE OF AGRICULTURAL ENGINEERING Silsoe, Bedford.

on 2–3 and 4th October, 1972.

Programme Convenor Professor P. C. J. Payne N.C.A.E.

Part I 2nd October PAPERS DAY

Aspects of Sugar Beet Production
Survey of European Production
Trends in Plant Establishment
Harvester design and system
Performance assessment

Part II 3rd October PAPERS DAY

Aspects of Potato Production
Survey of European Production
Soil Preparation and Planting
Harvesting and Handling
Performance assessment

or

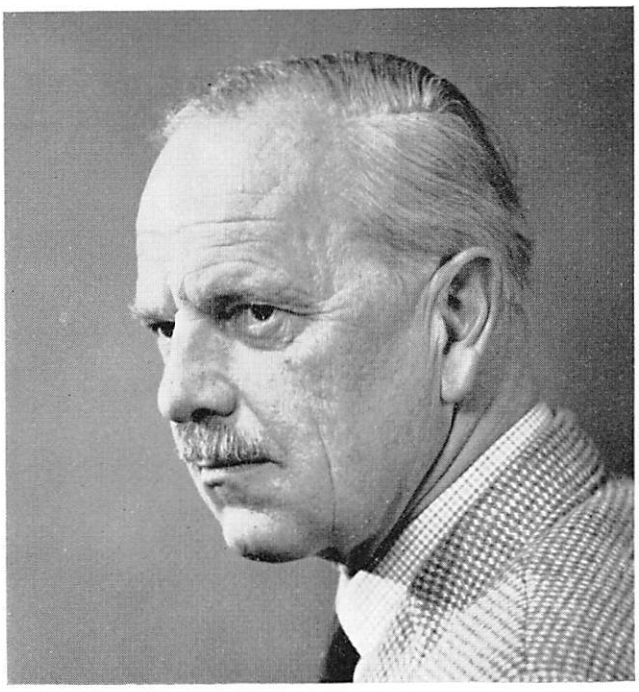
Visit to Sugar Beet growers and factories (mainly for continental visitors).

Part III 3rd or 4th October

Visit to Potato Marketing Board
Harvesting Demonstration, Driffield, Yorks, (mainly for continental visitors).

It is hoped to produce full programme details and conference fees by March 1972.

GUEST EDITORIAL



T. Sherwen, a Fellow of the Institution of Agricultural Engineers and President from 1967 to 1969, is a consultant concerned primarily with agricultural engineering.

He has a strong leaning to irrigation—the design and installation of large systems requiring little or no attention for a long time. He has designed and developed a water weed cutting boat, and specialised in hydrostatic transmission systems.

A member of the Council, he represents the Institution on the Engineers' Registration Board.

A NEW APPROACH

by T. SHERWEN, C Eng, FI Mech E, FI Agr E, MSAE

Our recent conference at NCAE which had been postponed from March owing to the GPO strike marked a new approach to the way papers and knowledge are presented.

It must be remembered that only ten years ago our conferences contained papers on widely different subjects and it is only since then that a theme or main subject has been used to hold the day's proceedings together. That change, like the latest one, was not planned, it happened more or less by chance after a suggestion by myself at a Papers' Committee meeting. However, successive conferences confirmed that this theme motive was popular with our members and visitors and was one of the factors that helped balance the financial side of these events. Similarly, it was very gratifying to see such a good attendance at this latest gathering based on an admittedly specialised subject, which might not have appealed to the broad range of our members. Whilst it is too early to say that we have a new innovation, it might be worth giving this idea another try, with a suitable subject theme some time in the future.

Today, when the economics of running a conference are so difficult, all new ideas dealing with the format and organisation must be carefully examined. Furthermore, the great importance of the precise subject must never be overlooked as it can have a disproportionate effect on the attendance and hence success of an event.

Returning for a moment to the theme of our latest conference "The Selection and Development of New Products", I like to think it is the vital importance of this subject to us as a nation that attracted so many people, both members and visitors. However, it needs more of these meetings by other institutions on allied subjects to stimulate greater interest in their fundamental phase of any product.

Whether one is considering the common market, the developing countries, or North America, the product and its fitness and attraction for a given market will exert a major influence over commercial success in that market. This is not to minimise the importance of good reliability and service support for a product, but the prime consideration must remain the right product for that market.

We have all come across cases where because the product was exactly right and timely, it sold in quantity at a price well above that which would normally have been considered correct, and once again this emphasises the great importance of correct matching of the product to its market, and this must include creating a demand for higher quality by really good design in the wealthier markets, especially in North America.

One of the more difficult facets of this conference as far as my job as convenor was concerned was that the authors should try and deal with examples of the problems concerned from their own experience. This is a tricky subject since it is natural that both authors and their companies should be sensitive about decisions which might not have proved to be successful. However, the frank way in which some of the examples were dealt with, both in the papers and in the subsequent discussion proved very enlightening and informative to the audience. There is an old saying that 'He who has never made a mistake has never made anything' and I do not think any person or company who are prepared to discuss and examine logically their past decisions would ever lose respect for so doing and in a great number of cases this examination of past decisions is most helpful in avoiding mistakes in the future and indicating the best course of action for other projects.

Another interesting point which was dealt with during the conference was the part played by outside sources of ideas and design in the formulation of a new product. Mr Wilder, in particular, dealt with this in relation to a range of products considered by his company and this showed how the farmer and independent consultant could contribute to the success of a project.

Turning to the continued improvement in the interest and organisation of our conferences over the last few years, I must take this opportunity of paying tribute to the contribution of our erstwhile Secretary, Jon K. Bennett, whose energy and imagination played a major part in achieving this result.

Finally I must thank the four authors who in spite of having very little spare time for such activities produced four excellent papers and still remain on speaking terms with this convenor.

□

INSTITUTION NOTES

Acting Secretary for Six Months

H. N. Weavers

Following the withdrawal of Mr D. G. W. Davis, who was due to become Secretary of the Institution on 1 October 1971, the Selection Sub-Committee at a meeting in September appointed the Institution's Assistant Secretary Mr Harold New Weavers MIOM to be Acting Secretary for a period of six months from 1 October 1971. Harold Weavers joined the Institution staff as a senior assistant in 1968 and was promoted to Assistant Secretary in 1970. His work in the sphere of conference management, liaison with branches, Journal sales and circulation and similar revenue earning functions has been of special benefit to the Institution.

The Agricultural Engineers' Manual

A new Institution publication is to be released towards the end of 1972 with the following objective:

> To collect together and keep up to date technical information of direct interest and use to Agricultural Engineers which is not readily available from other sources or is so scattered as to be ineffective.

It was recently announced in the Institution Notes of the Journal (Vol 26 No. 1) that rising costs combined with a reorganisation of Institution literature meant that the Yearbook would no longer be produced in its previous form. Much of the non-technical material in the Yearbook has found a new home in the Institution's Journal 'The Agricultural Engineer', the Guide to Membership, a leaflet on Careers in Agricultural Engineering and the recently introduced Membership Directory. It is planned that the technical data including many tables and charts which formed a prominent part of the Yearbook, will be updated and incorporated, together with additional material in this new publication. Reorganisation of publications and introduction of metrication together create an ideal moment to take this completely new look at the Institution's publication of technical materials.

The existing data have accumulated over the years largely through the enthusiasm and efforts of individual Members and organisations closely associated with the Institution. The result has been a valuable, although limited, coverage of the sort of material that it is felt Members would wish to have readily available. Much of the material is 'static' in nature and has been repeated unchanged in each edition of the Yearbook.

In planning the Agricultural Engineers' Manual, the Editorial Panel has adopted the "Subject Matter Classification" system published by the American Society of Agricultural Engineers. Although not ideally suited to our requirements the American system is ready made and closely matched to our needs: the work involved in setting up an alternative would be tremendous and could take several people many months to complete. Its adoption means that we can get down to the production and publication of data sheets straight away. We are therefore very grateful to our colleagues on the other side of the Atlantic for this flying start to our manual!

There seemed to be great merit in producing a manual in loose leaf rather than bound form. In this way, data sheets, classified according to the system, can be added from year to year, and distributed to each member. If sheets become out of date then it is a simple matter to issue a replacement. It is intended that towards the end of 1972 a plastic covered, hard-backed file will be sent to all members together with the classification system and the first batch of data sheets. Subsequently, further sheets will be issued as new or revised material is collected and processed.

Prospects for this new publication look good and the possibilities are virtually unlimited. The Editorial Panel itself will be considering a wide range of information in relation to the objective, but one vitally important feature of the preparation of the data sheets will be further contributions of ideas and material from Institution Members, and associated organisations. Much of the material available to the Panel will have been published previously and, where it is highly appropriate to the work of agricultural engineers, it will find its way into the Manual. However, new material is required too, and there must be many charts, tables, graphs and nomograms frequently used by groups of agricultural engineers which have never found their way to publication and widespread availability. It is this sort of information which will really ensure the future success of the Manual. The Editorial Panel would very much like to receive such information—and any other data, ideas and suggestions which members think ought to be included. Perhaps some letters for 'Viewpoint' would be appropriate!

The objective is set. We must now work towards achieving it. With the help of members, the Editorial Panel is convinced that really exciting possibilities lie ahead for the Agricultural Engineers'

Manual. In a few years we hope that everyone who has anything to do with our profession will want to have a copy close at hand for frequent and profitable reference.

Engineers' Registration Board

The Engineers' Registration Board's Technician Engineer and Technician sections Register opened on 1 January 1972.

The Institution has submitted a provisional list of members who are considered eligible for each of the particular grades and very shortly all these members will be circulated with the appropriate card to complete and return to the Institution if they so desire to be registered.

It is envisaged a nominal fee will be charged for the registration, the secretariat is in the process of circulating all members included in the initial register with a view of advising them that they are entitled to use the designatory letters T Eng (CEI) or Tech (CEI) as the case may be.

OBITUARY

The Council announces with deep regret the death of the following members of the Institution:

Gallacher, T.	*Member*
Glass J. F.	*Fellow*
Gough, J. C.	*Hon Fellow*
Lytle J. B.	*Associate*
Nakimoff, L.	*Fellow*
Salmon, J.	*Fellow*
Thomson, J. I.	*Member*

NEWSDESK

Guide to Preparation of Instruction Books

The East Anglian Branch has recently sent to Institution Headquarters a draft guide to the preparation of instruction books for operators of tractors and farm machinery. The guide is the result of the work of a study group set up on the initiative of the Branch to make recommendations to manufacturers and others involved in the preparation of instruction books which could lead to a marked improvement in the mental digestibility of the essential but often neglected instruction to the user of farm machinery.

The guide specifies the essential information which the operator requires, but does not always get, from his instruction book. In addition, many useful hints are given on, for example, the type of paper, layout, type of binding and indexing. The working party has obviously thought about the operator who finds himself in the middle of a field with his machine playing up, light fading, rain beginning to fall, a spanner in one greasy hand and the instruction book in the other. Would that more writers of instruction books showed this degree of imagination!

After comment by interested parties the draft is going to be handed to the British Standards Institution to provide a basis for a draft international standard which they have undertaken to prepare for the International Standards Organisation. Anyone interested in the draft should write to Headquarters for a copy.

Symposium on River Mechanics

An International Symposium on River Mechanics will be held in Bangkok, Thailand, from January 9th–12th, 1973, under the auspices of the International Association of Hydraulic Research. The symposium will be divided into three technical programmes:

Flood Investigations
Erosion and Sedimentation
River and Estuary Model Analysis.

Papers are invited and summaries are required before March 1st, 1972.

Further details available from the Symposium Secretary, Dr. Subin Pinkayan, Asian Institute of Technology, P.O. Box 2754, Bangkok, Thailand.

Farm-Electric: Grow-Electric

Farm-Electric and Grow-Electric are two phrases which the Electricity Council hope will become very familiar indeed to farmers and growers. The two words, said Mr R. H. Phillips, marketing adviser to the Electricity Council, introducing Farm-Electric and Grow-Electric in London on 17 November, are to give focus to the Council's activities in support of both industries. The Electricity Council believes, Mr Phillips continued, that electricity could prove its benefits in certain clearly defined ways; environmental control for animals, crop storage, feed preparation and material handling on the farm. It was by concentrating their information services under the two slogans that the Council hope to get farmers and growers all over the country much more familiar with the benefits that the electrical supply industry could offer.

A new Farm-Electric film about barn dried hay entitled *Quality Hay* supports the Electricity Council's Farm-Electric agricultural advisory service. It is 16 mm, in colour and sound, has a duration of 22 minutes and potential audiences are expected to be drawn from beef and dairy farmers and their advisers, farming colleges and young farmers' clubs.

The film introduces farmers from widely separated parts of the country who are said to have proved the benefits of electric drying of barn stored hay for themselves. Just how these farmers carry out their self-appointed task is shown in the film, which also shows the equipment they use, and their costings.

The film will be available from January 1972 from the Electricity Council Film Library, 1 Charing Cross, London SW1A 2DS.

International Symposium in Florence

An international symposium to be held in Florence, Italy, on the 12th, 13th and 14th September, 1972, will deal with:—

Technical and economical problems of irrigation (installation and distribution) with particular reference to surface irrigation. Soil erosion and conservation: researches and practical application.

The Symposium will be followed on the 15th and 16th September by some tours in central and southern Italy where soil conservation systems and irrigation methods are applied.

The two papers will be presented by Professor Giovanni Tournon, of the University of Turin, and by Professor Ignazio Melisenda, of the University of Palermo, respectively.

Papers concerning the aforementioned subjects are requested and should reach the Symposium Secretariate, c/o Instituto di Idronomia montana dell'Universita, Piazzale delle Cascine n.18, 50144 Firenze, Italy, not later than the end of February, 1972.

New Professional Group Concerned with Conservation

A preliminary meeting of various professional bodies concerned with the planning, management and development of the natural resources of land, air, water and wildlife, has taken steps to establish an interprofessional co-ordinating committee on conservation.

The initiative for the establishment of the Committee was taken by The Royal Institution of Chartered Surveyors following the suggestion made to the Standing Committee of 'The Countryside in 1970' by its Professional and Technical Services Liaison Committee.

It is believed that the new body is the first of its kind in the world and its aim is to provide a pool of professional information, techniques and skills and to disseminate information including sources of professional advice relevant to conservation. Although the idea for such a body came out of 'The Countryside in 1970' Committee, the inter

professional group will deal with both urban and rural conservation matters.

The Committee, which will hold its first formal meeting early in 1972, will include the former members of the Professional and Technical Liaison Committee and it is proposed that all other associated professional bodies will be invited to be full members. It is chaired by Henry Gilbert, F.R.I.C.S. and the Committee has already agreed to establish a steering group to prepare a draft constitution and to outline the Committee's course of work. Membership of the Committee will be in two categories:

'Members' being those professional bodies concerned with conservation of the environment; and

'Corresponding Member'—those bodies interested in conservation and who use professional services and techniques.

Earth moving, Construction and Agricultural Machinery

A two-day conference under the title, Earth moving, Construction and Agricultural Machinery, is being planned for January, 1973. The scope of the conference will be the application of tribological techniques to the design, construction and maintenance of earth moving and agricultural machinery (excluding prime movers) as well as consideration of user problems, and of materials, cost and economic factors.

Papers are invited on these subjects. Synopses of about 150 words length should be submitted, *as soon as possible*, to the Institution of Mechanical Engineers, marked for the attention of Mr J. Cordrey.

FORTHCOMING EVENTS

Institution Activities

JANUARY 1972

WED. 19 at 19.30—EAST ANGLIAN BRANCH

Development of Crawler Tractors by D. Winter. To be held in Ipswich.

FRI. 21 at 20.15—EAST ANGLIAN BRANCH

Sealed Storage by B. Spofforth of Howard Harvestore Ltd. To be held at The Scole Inn, Diss. This talk follows a Committee meeting.

WED. 26 at 14.00—SCOTTISH BRANCH

Visit to Honeywells Controls Ltd.

FEBUARY 1972

MON. 7 at 19.30—WEST MIDLANDS BRANCH

Basic Principles of Waste Treatment by C. T. Riley of the Ministry of Agriculture, Guildford. To be held at the Electro-Agricultural Centre, Stoneleigh, Warwickshire.

FRI. 18 at 19.00 for 19.30 —EAST ANGLIAN BRANCH

Dinner Dance to be held at the Park Hotel, Diss.

Other Activities

JANUARY 1972

MON. 3 to WED. 5—IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Optical Beam Methods for Velocity Measurement post-experience course. To be held in the Department of Mechanical Engineering of Imperial College of Science and Technology, Exhibition Road, London SW7.

FEBRUARY 1972

SUN. 6 to SUN. 13—INTERNATIONAL WEEK OF AGRICULTURE

To be held at Centenary Halls, Brussels.

WED. 9 and THURS. 10—NATIONAL POWER FARMING CONFERENCE

To be held at Cheltenham, Glos.

MARCH 1972

SUN. 5 to SAT. 11—SALONS INTERNATIONAL DE LA MACHINE AGRICOLE

To be held in Paris.

NEWS FROM BRANCHES

South Eastern Branch

A South Eastern Branch of the Institution of Agricultural Engineers was formed on 21 October and is based on the Essex Institute of Agriculture at Writtle, where many evening sessions are likely to be held. The speaker at the first meeting was ADAS Mechanisation Adviser Brian Finney, who imparted the latest information on the application of tractor power to the land in his talk entitled *The Utilisation of Tractor Power.* He pointed out that research showed that tractor wheel slip was more important in doing damage to the soil than was high ground pressure.

The chairman of the meeting was G. Mouat of the Essex Institute of Agriculture, Writtle.

West Midlands Branch

Many more farm tractors with four-wheel drives, suspended cabs for greater operator comfort, hydrostatic drive through wheel motors, and a move towards automated controls to lessen the driver's tasks, were forecast by the two experts who spoke to the West Midlands Branch of the Institution of Agricultural Engineers on 27 September, the opening meeting of the current season, at the Massey-Ferguson Training School, Stareton, near Kenilworth.

Mr John Matthews and Mr Peter Billington of the National Institute of Agricultural Engineering, told a large audience that they foresaw the greater use of powered implements, such as rotary and vibrating cultivators driven by high pressure hydrostatic motors receiving power from the tractor by means of pipes plugged into the rear of the tractor's hydraulic system.

Irish Agriculture in A Changing World

by I. F. Baillie & S. J. Sheehy (Oliver & Boyd, Edinburgh, 1971, £2·50)

This book consists of papers presented at a symposium held in Dublin in 1968, under the auspices of the Agricultural Adjustment Unit of the University of Newcastle-upon-Tyne. Much of the statistical and other information it contains necessarily dates from before 1968, but this does not detract significantly from the disscussion of the Irish agricultural policies and development, trading pattern, efficiency, research, education and future prospects.

While the major emphasis of the book is naturally laid on the implications in Ireland of these and other topics, the position of Ireland is clearly shown in the context of trends and developments in the U.K. and European countries, and the Common Market as a whole.

The contribution to be made by agricultural engineering and farm mechanisation is hardly referred to at all, so that the book is of very limited direct interest to agricultural engineers. It is nevertheless of considerable value in describing the problems which have to be considered in fostering a more intensive and more prosperous agricultural industry, seeking a place in the specialised and demanding food production economy now developing in the Western world. As such re-structuring comes into effect, the role to be played by agricultural engineers in mechanising crop and animal production will be a vital one. The book could not have been written as it is without the unspoken confidence on the part of the authors of the chapters on future development that agricultural engineering inputs will be available to make possible the developments in agricultural production they envisage. J.A.C.G.

BSI NEWS

The following information has been made available by the British Standards Institution.

Taking the Guesswork out of Tractor Operation

The new BSI publication on controls of agricultural machines points out that 'a given direction of movement of any control on an agricultural or horticultural machine should produce a consistent and expected effect'. The fact that operators can be confused by lack of universal conventions in location, operation and marking of controls makes this field ripe for standardization. The establishment of such a standard is brought a step nearer with BS 4746 *Recommendations for the location and direction of movement of controls of pedestrian operated tractors, agricultural and horicultural machines*, which deals with controls for tractor, rotary-cultivators, motor-hoes, motor-scythes and similar small pedestrian-operated machines. Although it is appreciated that it would take time for standard location and direction of movement of operators controls to be widely adopted, it is hoped that the publication of these recommendations will hasten the achievement of this objective, and that agreement to standardize in detail will be the eventual outcome.

BS 4746 takes eleven types of control, describes the function which they should perform and the movements necessary to achieve them, and recommends suitable locations. There are several additional recommendations, special emphasis being given to the importance of clear and permanent marking.

BS 4746 may be obtained from the BSI Sales Branch at 101 Pentonville Road, London, N1 9ND. Price by post 40p (subscribers 30p). Remittance with orders for non-subscribers.

First One-sheet Summary of a British Standard Published

The first of a completely new kind of publication, called 'summary sheets', is available from the British Standards Institution, entitled BS 3763Z *Summary sheet* extracted from BS 3763: 1970 *The International system of units (SI)*.

Summary sheets consist of both sides of a single A4 size sheet, on which is presented the salient points of a British Standard. Their production is a response to demands from industry, expressed mainly through the Standards Associates Section of BSI, that the 'guts' of standards should be available in a cheap and concise form, so that the information contained can readily be made available to many people, for example a company's employees, where it would not be practicable to provide the whole standard. Clearly, there are limitations to this form of publication and they will only be produced where they provide useful information without countering the sense or intention of the original standard.

Summary sheet BS 3763Z sets out the names and symbols for the base units, the supplementary units, the prefixes and all the examples of derived units given in BS 3763, which is the main British Standard providing information on the International System of Units. It also gives rules for the use of the prefixes and lists those units outside SI which are nevertheless recognized by the CIPM (The International Committee for Weights and Measures), to be of such practical importance that they must be retained for general use with the system.

This new type of publication is still experimental and comments from industry are welcome—they should be addressed to the editor of *BSI News* at BSI, 2 Park Street, London, W1A 2BS.

Copies of BS 3763Z can be obtained from the BSI Sales Branch, 101 Pentonville Road, London, N1 9ND. Price by post 25p, ten copies 115p (subscribers 20p, 100p respectively). Remittance with orders for non-subscribers. Larger discounts on orders over 100 copies.

Standard Form of Engineering Reliability Theory

For the first time, British manufacturers have available to them a standardized vocabulary of terms and the associated mathematical theory which can be used for the measurement of the reliability of any product or component. This information is provided by the British Standards Institution in its latest 'draft for development' entitled DD12: 1971 *Guide on the reliability of engineering equipment and parts.* It has been produced as a draft for development so that it can be applied on a provisional basis—after a year or so, it will be reviewed in the light of experience and, it is hoped, issued as a British Standard. To this end it is hoped that users of the draft will co-operate with BSI by supplying constructive proposals for its improvement.

The idea of a guide to engineering reliability sprang from the international work on reliability of electronics components, upon which is based BS 4200 *Guide on reliability of electronic equipment and parts used therein.* The engineering draft, however, has taken fully into account other international work, including that being carried out by the European Organization for Quality Control., and that in the International Standards Organization* on the application of statistical methods. The BSI committee which prepared the draft included representatives of the car and aerospace industries, the Ministry of Defence, trade and professional associations and the International Electrotechnical Commission's committee on electronics reliability. Thus it is felt that work in this field is moving forward on a common front and that the new draft is compatible with progress being made both in the UK and internationally.

The draft basically comprises a vocabulary of about sixty terms used in reliability measurement with exact definitions and, in another section, a guide which expresses these terms in mathematical form and thus indicates how they may be used in practice.

This framework for reliability measurement not only facilitates the use of such analysis by manufacturing companies or their customers, but also provides a basis for the interchange of reliability data without ambiguity or misunderstanding.

The measurement of reliability is obviously closely related to the improvement of reliability and therefore the long term effect of this work should be an improvement in the reliability of British products and components.

Copies of DD 12: 1971 can be obtained from the BSI Sales Branch, 101 Pentonville Road, London, N1 9ND. Price by post 95p (subscribers 80p). Remittance with orders for non-subscribers.

*The name of the ISO is now International Standards Organization.

Capillary and Compression Tube Fittings

The British Standards Institution has published BS 864 *Capillary and compression fittings of copper and copper alloys:* Part 2 *Metric units.* This is the first edition in metric terms of this standard. It does not attempt to complete dimensional standardization of any of the type of fittings specified, since the variety in the designs and methods of production already established would render standardization impracticable and would restrict further development. Dimensions and requirements essential for satisfactory installation and performance are specified.

The size of fittings is in accordance with internationally agreed sizes. The internationally agreed tolerances on socket diameters are greater than specified and adhered to in the appropriate previous British Standards, therefore full advantage of ISO tolerances has not been taken in this standard.

The standard relates to capillary and compression fittings types A and B, of copper and copper alloy, for use in conjunction with copper tubes complying with BS 2871: Part 1. The fittings specified in this part of the standard are not inter-changeable with fittings specified in the existing BS 864: 1953 which will be renumbered to BS 864: Part 1 and remain in force.

Manufacturers of capillary and compression fittings complying with BS 864: 1971 may apply to BSI to use the Kitemark. This is a registered certification mark obtainable only on licence from BSI and its appearance on an item is an independent assurance that it does comply with the standard.

Copies of BS 864: Part 2: 1971 can be obtained from the BSI Sales Branch, 101 Pentonville Road, London, N1 9ND. Price by post 85p (subscribers 70p). Remittance with order for non-subscribers.

Metric Sized Galvanized Wire Netting

The British Standards Institution has published BS 1485: 1971 *Galvanized wire netting.* This specification represents a metrication of the 1948 edition as far as this has been possible considering the variety of existing machinery for weaving galvanized wire. In this edition the control on the weight of wire netting is by restricted wire diameter ranges instead of by the minimum weight requirement previously specified in the 1948 edition.

The standard specifies requirements for galvanized wire netting having meshes of hexagonal shape, either woven from galvanized wire or woven from annealed wire for galvanizing after fabrication. Details are included of the mesh, wire diameter and width of netting, together with the tolerances. A table of types of netting which are normally available is also included.

Manufacturers of galvanized wire netting which complies with BS 1485: 1971 may apply to BSI to use the Kitemark. This is a registered certification mark obtainable only on licence from BSI and its presence on an item or its package is an independent assurance that it does comply with this standard.

Copies of BS 1485: 1971 can be obtained from the BSI Sales Branch, 101 Pentonville Road, London, N1 9ND. Price by post 50p (subscribers 40p). Remittance with orders for non-subscribers.

British Standard on Tower Silos

The Hon. Editor regrets that the word "draft" was omitted from the report of Dr. Wood's remarks on p.86 of the Summer 1971 issue of the Journal. A draft British Standard on tower silos is now available, and it is hoped that the final version will be published in 1972.

INDEX TO ADVERTISERS

Selection and Development of New Products

MANAGEMENT CONTROL OF DESIGN, RESEARCH AND DEVELOPMENT

by H. E. ASHFIELD, C ENG, FI MECH E, FI AGR E*

Presented at the Spring National Meeting of the Institution of Agricultural Engineers at the National College of Agricultural Engineering, Silsoe, Bedfordshire, on 1 July 1971

All products result from an initial single idea. The origin of many products is lost in antiquity but undoubtedly it was a single intelligent concept which gave them birth. This is not to say that in their original state they were anything like their present day descendants and undoubtedly from the moment they were made in a practical form they were altered and modified with a view to improvement.

This process of development is endless and is common, not only to engineering products but animal and plant life—in fact, to almost everything in the universe.

Now some products are developed in directions which prove to be blind alleys and in others the original idea is rendered obsolete by an improved and possibly unrelated concept which does the job in a far better manner. An example of blind alley development is the use of body armour which in the middle ages had to be increased in weight and thickness to meet the fire power of the longbow and the musket until it rendered the wearer virtually immobile once he was unseated from his horse.

An example of supersession of one concept by another is that of the compound or triple expansion engine by the steam turbine.

It is clear that during these processes, many firms would find their products uneconomic and uncompetitive and in consequence one of the most critical and vital functions in any modern company is to direct design, research and development along the right channels and thus ensure a continuing market.

Generally speaking, the larger the size of the organization, the easier it is to apply text book strategy. In the case of global companies such as Ford, General Motors and Shell, it is possible to assess the results of research and development quantitively because of the size of the operation and large number of projects involved.

As an organization becomes smaller and its products fewer, research, design and development become more of a gamble and therefore the background of the company must be carefully taken into consideration. For example, if a company has been manufacturing a product for many years and has a well established market and a proven record of reliability, then it is very unwise to make radical alterations and developments should proceed cautiously. Extensive testing should be carried out before improvements are put on the market. On the other hand a new company with an advanced product and an uncertain market, although possibly with great potential, must keep to the forefront and exploit every advantage that may broaden the gap between itself and its long established rivals. Therefore research and development must be trimmed to suit the size and background of the company.

*Technical Director, David Brown Tractors Ltd, Meltham, Yorkshire

Generally speaking, a company should put from 1% to 3% of its turnover into design, research and development if it intends to progress. The allocation of the amount will obviously depend on the situation of the company and whether it intends to pursue a policy of convergent or divergent development.

Convergent development means that efforts are concentrated on one or two types of product. For example, if a company is manufacturing agricultural tractors and believes that it can obtain enough business in this line to prosper, then all its efforts would be concentrated on projects which ultimately are aimed at improving agricultural tractors. It is important that this is fully recognized and that money is not spent on carrying out developments which could be more effectively carried out by others, i.e. government institutions, universities, component suppliers, etc.

The financing of convergent development is between 1% and 2% of turnover.

When a company wishes to diversify its products or alternatively find more applications for them, its development must be divergent and thus more research of a fundamental nature can be entered into even if the ultimate object of the research is not clear at the start. Thus we find piston manufacturers launching out into turbine blading, centrifugal casting machines and sintered metal parts. This lends itself to a central research establishment ultimately servicing a group of related companies at a cost of 2 to 3 per cent of turnover.

The decisions therefore to be made by Management are:—
1. What type of development do we wish to pursue?
2. How much money are we prepared to allocate to this end?

Let us assume convergent development and say one to two per cent of turnover.

This would allow of a fairly self-contained Engineering Department run by a Technical Director with a seat on the main board.

The detailed structure and function of the department is the responsibility of the Technical Director but the policy which determines the projects put in hand is not wholly determined by him but by a Policy Committee which can be chaired either by the Technical Director or by the Managing Director and comprises Production Director, Marketing Director, Technical Director. Executives from the three departments such as Chief Engineer, Market Research Manager, Production Engineer may be brought in to the policy meetings as required or may have a permanent seat on the committee. Reference may also be made to the Financial Dept.

This committee meets at regular intervals, say three monthly, or can be convened at any time should circumstances warrant. Both long and short term directives are arrived at. To begin with present products are scrutinized in the light of immediate events and their likely economic life assessed.

If it is possible to prolong this by facelifts or other minor improvements, then this will be considered and also its effect on the introduction of new models.

Long term specifications for new models are arrived at largely by considering requirements of all departments represented and this in itself is an extremely complex process.

The first decision to be made is in what parts of the world do we aim to market the product.

Let us assume the product to be an agricultural tractor so that we can be specific.

We run up against a large number of conflicting requirements, e.g. crops such as cotton and maize require a high ground clearance under the tractor in order that they

may be cultivated to the latest possible stage of growth. This raises the tractor centre of gravity to such an extent as to render it unsuitable for farming in hilly countries.

Tractors exported to North America, Sweden, Finland must be able to start at temperatures well below freezing point and the tractor receives far less consideration than an automobile and is usually left outside. It must run often under light load in these conditions, subjected to zero ambients, whilst maintaining a reasonable engine temperature. On the other hand machines exported to the tropics must run cool often under full load in ambients of over 100°F.

This type of conflict is not peculiar to tractors but is common to most products which are marketed globally.

Therefore, it must be decided at which markets our tractor is primarily aimed, i.e. European, American, African, etc. Having decided where our potential is greatest, we should consider the machine which would be ideally suited for this area and then, compromising to some degree, still retain saleable features for other areas where we will have prospects of doing business.

It is now required to find details of machines which are currently selling in these areas and make sure that any specification proposed is well ahead of existing products because we are thinking in terms of possibly three or four years to initial production which must run roughly five to seven years if tooling costs are to be met.

Another very important factor is the proposed selling price and this can be determined in relation to competitors' products. Whilst it is not possible to project the selling price into the future it is probably fair to say that cost increases hit all manufacturers pretty well alike and if present costs are in line with competition, future costs can be kept in the same relation.

While on the aspect of cost we should not overlook the financial stability of the various projected markets. There may be a big demand for our products in parts of the world where there is no finance to pay for them. Also apparent stability may exist but this may be transient—Cuba and certain South American countries have been good examples of this. Therefore such markets should not be allowed to influence the design of the product out of proportion to their true worth.

This part of the exercise, along with others more detailed can roughly be termed 'market research'.

On the production side it is necessary to consider plant, production know-how, shop capacity and availability of materials. The dominating question being quantity required and rate of production. On this, along with the basic design depends the type and amount of tooling.

The second question is whether or not the new model will supplant existing production or will it be additional calling for capacity expansion. Will the new model run alongside the old so that as one builds up the other phases out?

These questions must be answered to enable an estimate to be made of the likely capital expenditure and tooling costs of putting the new model into production. This may include new buildings, new assembly line, new special purpose machine tools, etc.

Tooling cost must be absorbed into the ultimate selling price and will take the form of a cost increment added to each machine. The size of this increment will depend upon the period allowed for amortisation. This is usually a period of from 3 to 7 years and is determined by previous experience.

Having now obtained the production rate and selling price from Marketing, knowing the tooling cost per tractor and being able to deduct distributors' and dealers' allowances, profit margin, etc., we are left with a figure which represents the target cost within which Engineering must keep if they are to meet economic requirements.

For their part, Engineering must disclose any new idea which they consider should be incorporated in the machine, for example, a new type of engine, a new type of transmission or improved hydraulic system.

Another most important consideration is the fact that a tractor like a truck or car, is a complex piece of machinery and it is a very bold company which will put out an entirely new machine or one that does not incorporate proven features. For example, if the company has an established range of engines, it may decide to put in an existing engine but design a new transmission and hydraulic system. Alternatively, if range of engines is obsolescent a new range may be decided upon and the first engine of the range put into the new tractor along with say existing transmission and hydraulic system. It is of course desirable to modify and improve existing systems in new models and in fact the new model can form a focal point for new marks of existing units.

From the foregoing a fairly clear picture of the new model emerges and from it a preliminary engineering specification of a machine can be produced.

Let us now examine the organization of the Engineering Department whose responsibility is to produce the preliminary engineering specification.

The department is headed by the Director and as its functions are many and varied it is conveniently split up into specialized sections. Because of the peculiar nature of research and development which involves among other things creativeness and invention, it is not possible to lay down a rigid or military type organization and some flexibility on the research side must be allowed in that the organization should be tailored to suit the temperament and ability of the personnel; in other words researchers should be allowed a certain freedom of action which, although making their terms of reference slightly indeterminate, does in fact give them scope to exercise their inventiveness to the full.

The product itself is subdivided into a number of units and it is therefore convenient to have a development engineer for each of these. For example, the agricultural tractor can be broken down conveniently into engine, clutch, transmission, hydraulics, brakes, chassis, linkage, seating and controls.

Possibly this could be sectionalized:—

Development Engineer (Engines)—engine and clutch.
Development Engineer (Transmissions)—gearbox, brakes, differential, final drives, power take off, wheels and front axle.
Development Engineer (Hydraulics)—hydraulic system, three point linkage.
Development Engineer (Ergonomics)—seating and controls.

The co-ordination of the development engineers can be vested in the Chief Engineer who would have the responsibility for seeing that the various units fit together within the parameters of the overall design.

The Technical Director and Chief Engineer can now consider the information they have obtained as a result of the Policy Meetings and basing on this they can form a rough idea of the machine that will meet requirements. Having cost, power and weight targets, the next step is to break these down into units and assess a cost, weight and size of each.

This information is then passed on to the Development Engineers who are asked to submit proposals. Obviously where existing units are available or where existing units can be developed, an accurate assessment can be presented

fairly quickly but where something entirely new is necessary, proposals will have to be gone into very carefully.

The co-ordination of all these separate schemes is then carried out and amendments may be necessary. In some instances cuts will have to be made as it is inevitable that first proposals if adopted will always result in too expensive and too heavy a product. It may even be that after due consideration the original policy committee requirements cannot be met in which case, amendments will have to be made which may result in reduced competitiveness.

I had experience of a case in point immediately after the war. Much design work and time was spent on a tractor which bore little or no relation to existing machines and was in fact far in advance of its time.

However, when investigations were made into the tooling and equipment that would be required it was obvious that the long term deliveries which then obtained rather than the cost, put the whole project outside the bounds of practicability. A re-assessment of the position had to be made and as many features of the new machine as possible were designed into the existing tractor.

For example, a six speed gearbox was introduced to replace the four speed, an inbuilt power lift and hydraulic system was substituted for the existing 'button-on' type. A two speed power take-off was introduced along with a higher horsepower engine complete with all-speed governing.

It was considered that this model would run about two years and at best would fill in the gap made by the long machine tool deliveries of the new model. In actual fact this interim model was the David Brown Cropmaster which was in production for over ten years and could be rightly called the ancestor of our present range of tractors.

The advanced project thus never came to fruition although most of its features were ultimately incorporated in the Cropmaster range.

Finally, a product specification is arrived at and the Technical Director is now required to give a ceiling cost for the project and a target date for the running of the prototypes. The ceiling cost may be exceeded but what is important is that the rate of expenditure on the project is kept within the allowable budget for the Engineering Division. In other words, if the cost is materially exceeded, the development will probably be extended which would not inflate the budget for any particular period.

Having agreed specification, target cost and development period, the Engineering Division is now in a position to commence the project and issue the necessary internal paper work to enable its various sections to proceed. The first document in this connection is the project sheet and the second the order sheet. Project sheets will be issued the first covering the whole of the machine and secondly covering more specifically the new units. These are passed through to the Chief Engineer, Development Engineers concerned and to the Experimental Engineer who is in charge of prototype manufacture and test, also the Chief Designer and Chief Draughtsman who co-ordinate the detail designs under the Chief Engineer.

The order sheet merely confirms the project and is an authority to spend the necessary money on component manufacture, testing etc. The circulation for this is much the same as the project but is extended to Financial Departments who are concerned with cost allocation.

At this stage the internal organization of the Engineering Division should be described in order to see how the various sections co-operate in completing the project.

Depending on the size of the firm, design and development may be completely split off from the Production Drawing Office and the two treated as separate organizations.

Alternatively, these functions may be carried out in the same office although they may be largely separate. It is convenient, however, to intermix the two to some extent as it prevents the design of new products getting too remote from practical realities and at the same time enables those in close contact with Production, i.e. detail draughtsmen, etc. also to come in contact with design and development problems at first hand.

Another factor that must be remembered is that the separation of design and research from production invariably puts costs up and increases the length of time required for a given project as departments tend to work rigidly within themselves, losing the flexibility which obtains when they operate as an integrated unit.

In such an integrated setup we have a Chief Engineer in charge of Development Engineers each being specialists in his own particular field. The Chief Designer and Chief Draughtsman between them are in control of all draughtsmen and designers below the level of Development Engineer and they allocate such personnel to the respective Development Engineers as required. This does not prevent each Development Engineer having a small staff of designers permanently attached to him but these can be considerably augmented when a new unit is being designed. Take for example, a new engine. The Development Engineer concerned may have six or seven draughtsmen and designers working for him while it is going through the design stage. If an existing hydraulic system is being used on the same project, the hydraulic design section may be reduced to the extent of only one or two designers working under the Development Engineer who may be devoting much of his time to field or laboratory testing and development of existing units. Thus, while keeping development engineers fully occupied, the drawing office staff can be swung to the point where the draughting work is heaviest and so used the most efficiently.

The Chief Draughtsman and Chief Designer have executive responsibility for the staff in such matters as discipline etc. whereas the Development Engineers have the technical responsibility for the project.

The Stress Section operates in parallel with the Development Engineers. The basic calculations made by the Chief Engineer and Development Engineers are confirmed by the Stressmen and the preliminary proportions of the design layouts are rough stressed to make sure that the level is of the right order. Certain parts which require accurate stressing may be fully designed and stressed at this stage although in view of the possibility of alterations this is not always advisable.

The Chief Stressman has the status of a development engineer and his section covers every aspect of the project. Over the years it is possible to build up records based on the performance of previous models which enable standard calculations to be made for most applications. It is therefore more efficient to have stressing done by a central stress section than to give this responsibility to individual draughtsmen and designers. This is not to say that they should be discouraged from doing their own stress calculations but in the Stress Section should rest the ultimate responsibility for maintaining reasonable stress levels in all components.

Designers and draughtsmen should be given the opportunity to study the methods used by the Stress Section and thus add to their total knowledge.

Now the serious business of preparing full designs can get under way. Each Development Engineer prepares layout drawings covering his own particular section but these require careful integration with the adjoining units and the Chief Engineer and Chief Designer are responsible for seeing that this is effectively carried out.

When the design for each section is complete, detail drawings are prepared from it. These form the basis for manufacture of the first prototypes which are usually limited to either three or six sets of parts depending on the circumstances and urgency of the project.

It is customary to do a rough cost and also a weight check from these drawings. There is close relation between weight and cost and a weight check is a good way of ensuring that the cost is not grossly exceeded. Suggestions for cost savings can be made.

Further sets of drawings are sent to Production Development where the methods of producing them in quantity are considered and suggestions etc. for improvements can be made.

At this stage however, it is not profitable to enter into too much detail on savings but only on savings which would accrue from relatively large changes such as substitution of castings for forgings, sintered metal or plastics for castings or pressings. Overall size of components can be carefully checked against existing machining facilities, handling facilities, etc. It is vital that this information comes back quickly as it is important to keep the time between production of drawings and testing of prototype as short as possible. In fact quite a lot of the suggested improvements or modifications are held back to the second batch of prototypes or preproduction machines because the overriding requirement is to prove the first prototype functionally.

Normal practice is to ensure that the components with the longest working cycle are first released and thus forgings and castings are the first consideration. It is possible to order forgings virtually from the layout drawing and this will save considerable time especially where alloy steels and complicated shapes are necessary. If there is any doubt about the final dimensions of the component an extra allowance can be left on the forging. Certain parts such as crankshafts or connecting rods should not be machined from hand forgings because of their different physical properties.

If at all possible production dies should be sunk for these parts, the cost being carried as a development charge until the production stage has been reached when the cost can be credited back.

Castings should also be released as soon as the detail drawing is complete in order to allow work to be put in hand on the patterns. A little extra expense on the patterns will often enable the first trial production run to utilize castings from the experimental patterns and often in the long run is an economy.

It is inevitable that a considerable amount of proprietary equipment bought from other firms will be included in the finished machines and therefore technical discussions must be entered into with them. It is usual for the Development Engineer of the section concerned to draw up tentative specifications of the requirements and possibly several firms will be approached. It may be that if some suppliers have had a long association with the company there will be little question of an alternative source but it is always preferable to have at least two possibilities.

Thus when detail drawings and parts lists are completed, the units are issued to the Experimental Shop whose function is to machine parts and build prototypes.

The experimental section is controlled by the Experimental Engineer whose function with regard to prototypes is somewhat analogous to the Chief Designer's function with regard to drawings. This department is virtually a general engineering shop but also attached to it is a laboratory and a field test department, the function of the latter being to test machines and equipment in its working environment.

Thus the prototype drawings are received by a planning and progress department who carry out planning and scheduling of the prototypes. They are also responsible for keeping an even flow of work through the machine and fitting shop.

A very close inspection is put upon all parts not particularly to ensure a high degree of accuracy but to ensure that they are in accordance with the drawings and that important dimensions, to wearing surfaces for example, are recorded so that when machines are stripped for examination, the exact degree of wear etc. is known.

The machine and fitting shops are controlled by a superintendent with foremen or chargehands responsible to him. However, the Development Engineers will have technical assistants allocated to their projects by the experimental engineer and they hold a watching brief on the prototype as it is being built. The Technical Assistants report to the Experimental Engineer but are allocated by him to the various projects and technically they then report to the Development Engineer responsible.

While the prototype is being built the Experimental Engineer and Development Engineer concerned work out a test programme and this will include laboratory test possibly on individual assemblies or components, endurance tests and functional field tests. Special test rigs may be required or existing rigs may require adapting and this work is carried out by the technical assistants allocated to the project. A word about the Laboratory—it must naturally be specialised depending on the product. In the case of the agricultural tractor it comprises engine test cells, cells capable of testing a completed tractor, hydraulic rigs capable of testing pumps, rams, valves, lift mechanisms, also facilities for running rigs of a temporary nature and to this end a supply of small electric motors, bed plates etc. on which these rigs can be constructed, is a necessity. Typical rigs built in this manner are oil seal test rigs, fatigue rigs for axle shafts or stub axles.

On completion of the first prototype it is given a rough ergonomic test to see that seating, controls, etc. are accessible and it is run light round the test track to check that the various controls function correctly. An indication as to the noise level can also be obtained in this way.

The machine is then checked for front and rear axle weights. At this stage a preliminary report is made covering building snags, comments on control positions, control actuation, noise level and weights. Oil, water and fuel capacities may also be commented upon.

Unless there is anything radically wrong, no immediate action need be taken but all deviations from specification should be considered for correction on the next batch of machines. For example, it is not unusual to find the first prototype overweight and the reason for this must be ascertained. Possibly it is due to the use of forgings instead of stampings, excessive thickness on castings or may be just a conservative approach on the part of the designers.

Fitting snags should be analysed and consideration given as to whether they warrant design alterations or alternatively, call for a special approach on the part of Production.

If the prototype successfully passes its first ordeal, it can then be put in the field and normal farm operations carried out under observation by field test engineers. The machine should be driven by two or three different people and their general opinion correlated. After a week or two an operational report is issued which again does not warrant immediate action on the prototype unless functional failures occur.

By this time probably second or third prototypes will have been produced along with unit assemblies which are required for rig testing. A second prototype can be put in

the field alongside the first and serious field testing can now go ahead. A whole range of equipment which the machines will use should be checked for operational performance and it is useful to have existing machines work alongside the new ones and if possible one or two competitors machines.

The third prototype can be used for Laboratory testing and this covers such items as endurance testing the whole machine on the treadmill where it can be run in selected gears at full load for specific periods, say 1,000 hours. Periodic strips are made to check the transmission for deterioration. Power take-off tests at full engine power will not only give transmission losses but will also give an effective check on engine cooling and detail development may be necessary if temperatures are high.

Brake and clutch tests can be carried out in the Laboratory on special rigs but this must in practice be related to performance in the field. An extension of the Laboratory facilities is the test track and dynamometer car. The track usually comprises a level strip of concrete with turning points at each end and possibly in the centre. The longer it is the better, half a mile being adequate for most purposes as the tractor is a slow moving machine. The dynamometer car hitched behind the tractor gives the control load and is instrumented to record load and speed. The test track and dynamometer car are useful for simulating road or field conditions and accelerating tests on the various units.

Automatic declutching by compressed air at specific intervals while the tractor is running at controlled speed and under load can evaluate clutch performance. Similarly noise levels under varying conditions of load and speed can be checked. Brake tests can be carried out both for the tractor light and with the loaded trailer or with a dynamometer car to simulate this.

The various units such as gearbox, hydraulic pump, valves and rams are all subjected to internal Laboratory test and evaluation. The back to back rig for gearbox testing will form a ready means of endurance testing this unit.

It is interesting to note that the results from such a rig differ materially from treadmill and field test results insofar as the prime mover usually being an electric motor, the gears will sustain far greater continual loading than when driven be a diesel engine. However, having built up prior experience and correlating performance on the back to back rig against actual performance in the field, by judicious use of a load factor it is possible to obtain test conditions which approximate to actual operational conditions.

The hydraulic lift components, rams and pumps can be subjected to endurance test, rams carrying out repeated lifts over a long period, pumps can be tested against maximum pressure or on a repeatable pressure cycle.

The co-ordination of prototype testing is of the highest importance and regular reports should be issued. All technical personnel from the Director downwards should regularly see for themselves how various tests are going both in the field, on the test track and in the Laboratory. Any failures or signs of failure must also be examined at first hand and corrective action taken.

Machines must be kept going wherever possible even if a faulty component has to be replaced at frequent intervals as information is only being obtained when equipment is running, not when it is stopped.

As these results are being put out continuously the Technical Director and Chief Engineer are able to assess the overall performance of the prototypes and decide what modification or improvements are necessary for the next batch of machines. If tests are going well, it is possible that the next batch be termed pre-production and say up to 12 may be authorized.

If a larger number of defects or weaknesses are revealed by initial tests, it may be necessary to put a second small batch of prototypes through. Consideration may also be given to reworking the first prototypes as the opportunity arises.

Let us assume that all goes well. After say three months testing demonstrations can be given to Marketing and Production. A machine can be stripped down for examination by production engineers as the component parts are often more convincing than engineering drawings.

At this time the Policy Committee should meet to review the situation in the light of progress made and the current manufacturing and marketing situation. Any revised circumstances must be taken into consideration, for example, a general slackening in world trade making sales of present product more difficult would call for the introduction date being pulled forward or if present products are selling well it may be possible to postpone the date of introduction.

Assuming the prototypes are meeting expectations it is now desirable for the long term requirements of new product manufacture to be reviewed. The Committee must therefore authorize these. Any special purpose machine tools can be ordered. Re-arrangements of machine shops, production line etc. can be authorized. Factory extensions can also receive the go-ahead.

As regards outside supplies, negotiations can start on proprietary equipment and consideration can be given to laying down patterns and dies.

All these steps are necessary to reduce the lead time and also give departments concerned the maximum possible time in which to carry out their part of the work. Meanwhile, it is incumbent upon the Technical Director to make sure that no radical changes to the product will be necessary which materially affect the production releases.

Testing on existing prototypes now proceeds with redoubled vigour and includes compatibility tests for all types of equipment both manufactured by the Company and by other companies.

When the second batch of prototype machines is available, one or two may be sent overseas for test under the actual environment.

Because of the seasonal operations for agriculture it really takes 12 months to test the tractor in any one market.

A further machine can be given to Service Dept. and others to Marketing.

By now the feedback of information, requests for changes, etc. will be reaching its maximum.

While the machines should function correctly in the field and any major weaknesses should have been overcome, there will be incessant requests for simplification of components, alternative materials, and for modifications to ease assembly and dismantling.

The Cost Committee, lately termed 'Value Engineers' will also be submitting suggestions for cutting cost. All these requests must be scrutinized very carefully and assessed in light of their consequences both from an engineering and production point of view. Very often the requests are conflicting, i.e. requests for standardization of components to simplify manufacture and reduce their number can result in unnecessary machining such as extra tapped holes which have to be plugged up or external facings on a casting which though machined are not used. These will be seized upon by the value engineers who will suggest that by creating two components and removing the unnecessary machining and facings money can be saved. It will be seen therefore that while some suggestions can go through without question, others will necessitate some form of compromise and some will need to be rejected outright. No modifications of any magnitude should be incorporated without being tried in the field as the simplest modification may have unforeseen

consequences especially if a second apparently unrelated modification is brought in without test at the same time.

Development never ceases and will intensify as testing of preproduction and prototype machines is going ahead, no doubt the Development Engineers will be discovering radical improvements which have become obvious to them as a result of constant association with the machines. The Chief Engineer and Technical Director may also have radical ideas.

However, providing the machines meet Marketing specification and seem ahead of competitors all radical improvements at this stage should be suppressed as otherwise machines will never reach finality. It is not so much a matter of discontinuing forward developments but as deciding that the machine as developed is now worthy of putting into production and the decision at some point must be taken, usually by the Technical Director, to freeze development and finalize the design. The Policy Committee of course must agree to this step and full authorization can then be given for the necessary material, etc. to be ordered so that production can go ahead.

Developments which have not been incorporated can still be considered for a Mark II version of the machine but this enables them to be dealt with in a proper manner without any hurry or necessity to cut corners.

The full production authorization for the new machine is duly set down on the appropriate documents and with the receipt of these all departments can move into gear to enable the new product to become a reality and thus commence a new chapter in the life of the company.

Selection and Development of new Products

FINDING AND EXPLOITING NEW PRODUCTS FOR A SMALL COMPANY

by J. H. W. WILDER, OBE, BA, FI AGR E*

Presented at the Spring National Meeting of the Institution of Agricultural Engineers at the National College of Agricultural Engineering, Silsoe, Bedfordshire on 1 July 1971

Introduction

A paper about the selection of new agricultural machines must, in my view, have considerable limitations. Suppose one asked a number of those skilled in the art of backing plays to give papers on how they decided on which play to back! Could they really give guidance to those, such as authors of plays, who would dearly love to know the ingredients which made a play successful? The high proportion of failures amongst plays which are put into production, is some indication of the difficulty of knowing whether a play will be a success or not through just reading it. Launching a new agricultural machine has many of the uncertainties of launching a new play. And like a new play as soon as one has formulated a set of rules for success, anyone using those rules is in danger of being a "hack", lacking in inspiration. And in the word "inspiration" lies the key to our difficulty. One can analyse Shakespeare's plays after they were written but how can one explain the "inspiration" which enabled Shakespeare to create new plays of such genius that they have lasted some 400 years; yet he had no analysis and no guidance to help him create those plays in the first place.

There is no "formula" for producing successful creative ideas. We are discussing an "art" rather than a science and all that this paper can do is answer the questions posed by the organisers of this conference in the light of the experience of one organisation and hope that this information will be of some interest, even though its general relevance must be limited.

The need for a new product

It is said that the most common reason for Contract Bridge players throwing themselves over the Embankment is through failing to draw trumps first. The other most common reason results from drawing trumps first, typical of the many "heads you win, tails I lose" situations experienced in life. I put new products in this category. On the one hand, I believe that a number of well known firms have disappeared as a result of exploiting their existing product range for too long, and failing to have new products ready to fill the gaps created when their original lines ceased to be saleable. On the other hand, I suspect that firms have failed as a result of being too inventive and never having a sufficiently stable product range to enable the development costs of that range to be recovered before further new products were marketed.

The balance between the forces favouring the existing product range and those demanding new products is a very delicate one and it is one of the most important duties of the Board of Directors to maintain that balance, no easy task in this rapidly changing world.

The forces favouring the existing product range

The temptation to continue to sell a product long after it has ceased to be leader in its field, is very great. A long established product is so much easier to produce because the production snags have been ironed out and because nearly everyone knows what to do without being told. New products make life difficult for production engineers and it is dangerous to be too critical of their attitude as the prosperity of the Company very largely depends on their ability to produce at the right price. New products use up considerable resources while they are being developed. In addition, they require instructions books, parts lists and a new inventory of material requirements. I have been conscious on many occasions of staff and workpeople alike being critical of the amount of effort and materials being consumed during the development of a new product. This can be very unnerving as at the very instant when one is most uncertain about the success of one's new product, support from one's colleagues tends to disappear.

The forces demanding a new product

Unfortunately, the forces which demand a new product are long term and intangible. Nevertheless, they are formidable because if a situation is allowed to arise when a firm's existing products are no longer saleable and there is no new product ready for production, it is too late to take action. Survival depends on predicting three or four years ahead when a product is likely to become unsaleable and on having a new product ready to sell in its place. This means that the new product must be developed while the old products are still selling well and, as has already been pointed out, this is not easy.

Sources of ideas for new products

A list of the fundamental ideas my Company have marketed since 1920 shows that there were 16 of them. The

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developments resulting from one basic idea have not been included in the list. For example, our "Pitch Pole" Cultivator won an R.A.S.E. Silver Medal as an arable cultivator and a few years later it was awarded a second R.A.S.E. Silver Medal as a pasture aerator. Both these machines are treated as one idea. The same goes for flail machines. Straw chopping, haulm pulverising, scrub clearing and forage harvesting are all one idea even though it took some time for us to adapt our designs to enable our flail machinery to do all these jobs of work.

This list is of the ideas which were considered worth developing and marketing. It does not include all the numerous ideas which were submitted and which were rejected. No record was kept of these and we can give no idea of how many have been rejected.

Of the 16 such ideas which we attempted to exploit in the 50 years between 1920 and 1970, 9 were commercially successful in our judgement. The sources of these ideas were as follows:

	Commercially Successful	Not Successful	Total
Farmer inventors who had proved their ideas by building proto-type machines	3	2	5
Farmer ideas, the designs and proto-types being produced by us	2	–	2
Inventions offered to us by inventors other than farmers	2	2	4
Our own solution to problems put to us to solve	2	1	3
Exploitation of our own ideas	–	2	2
	9	7	16

This shows that the majority of successful ideas exploited by us over the last 50 years have come from farms. However, it is an indication of the way things are going that the two most recent additions to our product range, our water weed cutting boat and our automatic grain dryer, were both from non-farmer inventors. Both use relatively sophisticated engineering concepts compared with our earlier products, one being almost entirely hydraulic and the other using automatic electric controls.

Decision to develop or reject the idea

The decision whether to develop or reject an idea for a new product is highly personal. Considerations which must be taken into account are:—

1. What is the probable market for the final product at various price levels?
2. What is the competition?
3. Can the product be patented and if so what protection will be obtained against copying?
4. Does the product fit in with the firm's existing expertise or with the firm's future aspirations?
5. Has one made sufficient allowance for development costs and has one remembered to make allowance to recover these in one's budgeting?
6. Is the product capable of being made at a price and in the quantities which will produce sufficient profit to justify the risks inherent in developing new products?

Each of these 6 main questions will now be probed in more depth but it is necessary to point out that implicit in many of the questions is a budget based on anticipated costs and anticipated revenue from sales. To engineers, such a budget may seem too inaccurate to be worth pursuing. Our training is to be precise. To make a component, one has to have exact dimensions and tolerances. An engineer is not trained to deal in what seems to him to be wild guesses.

Yet it is my opinion that it is a weakness of many engineers that they take little interest in the "art" of marketing and prefer the logic and the calculable certainty of the "science" of engineering. We should never forget that unless the product can be sold at a price which rewards initiative and enterprise as well as recouping actual costs and development costs, then the product is not worth developing.

What is the probable market for the final product at various price levels?

When an inventor offers an invention to a manufacturer for exploitation, he almost invariably will give the price at which he thinks it will sell. Almost equally invariably, it would be wise to double this price in order to get a rough idea of the probable retail price. No single factor explains the difference between the inventor's estimate and the manufacturer's estimate but rather it is an accumulation of many factors. Almost certainly insufficient margin will have been allowed for the cost of promoting and marketing the product. An inventor tends to believe that his brilliant idea will sell itself. The fact is that to exploit it commercially, it must be promoted and the costs of sales promotion are high and must be recovered. Another factor which is rarely taken properly into account is the cost of the developed product. It is most unusual for a product offered by an inventor to be fully developed. His own resources are usually fairly stretched by the time he has produced something capable of demonstrating that his ideas will work. Nearly always there is a further step to go. In the case of our water weed cutter, the step to go was to improve propulsion, the outboard motor propulsion provided by the inventor not being good enough. This final step can be a very costly one and usually adds considerably to direct production costs in wages and materials as well as total development costs.

One of the biggest traps when considering a new product is to under-estimate the costs involved. The estimated retail price is therefore fixed too low which in turn introduces a considerable error into the assessment of the market. The quantity of a product which can be sold at a price "x" is very different indeed to the quantity which can be sold at $2 \times$ "x". This assessment of the market for the product is probably the most difficult, while at the same time the most essential step, which must be taken when considering a new product. Large firms can employ experts in market research to do this for them. The small business has to do without such expert outside guidance yet it should not feel at too great a disadvantage. What the large firm has to find out using expert assistance, which can advise wrongly, is often well known to a small firm, particularly if it is in a specialist field and is on top of its job.

What is the competition?

At a recent course on "Controlling a Small Business", the point made by the lecturer which was most memorable was that one should be at considerable pains to find out what one's competitor is doing by such means as driving past his factory regularly to see if new buildings are being put up and so on. My experience is that one very rarely finds out who one's competitor is until the new product has been launched on the market and one is committed up to one's neck. Patents provide a protection against competition when the new product really does have some element of novelty about it, but the patent must be a good one and the patented features must provide advantages over competitive products. Our experience is that if the product is not patented, someone will market a competitive product within a year or two. The trouble is that one doesn't know

when deciding whether to take on a new product or not, who that competitor or those competitors will be and today they can often come from overseas. In spite of the difficulties, however, the competition must be studied. In the case of a new agricultural machine, this may be merely a different way of tackling the task which the new machine is designed to perform. In other words, the competition against the new machine is often the labour and machinery it is designed to replace. But one has to remember that the innovator pioneering the way is watched by other less adventurous but probably wiser people who will join the "band-wagon" the moment it has been demonstrated that there is a wagon to join. Examples of this in the last 15 years include the flail forage harvester, the flail mower and the rotary drum mower. In 1957, the British farmer could only buy two alternative makes of flail forage harvester, one made in Britain and the other imported from the U.S.A. In 1959, only two years later, the British farmer had a choice of 15 different models made by 11 different manufacturers.

There is so much difficulty in assessing the likely future competition that the engineer may feel that it is so like gazing into the crystal ball as to have no value. A good look at known competition is obviously essential but, although it is less obvious, some forecast of the way new competition is likely to grow after the product is launched is well worthwhile.

Patents, Copyright

A major consideration when weighing the merits of a new product is an assessment of the extent the product concerned can be protected from copying. Development and product launching costs are so great today that there is a danger that someone else will capture the market through copying the product, a much cheaper process than doing the development and promotion in the first place.

Fortunately, it is interesting to note how the trend during the last 25 years has been to increase the protection offered to the pioneer and the inventor. A man who develops a new rose is now entitled to royalties from home and overseas. Efficient organisations in most countries of the world collect royalties for records played and music performed in public with the result that composers of successful modern "pop" music can amass large fortunes. In the engineering world, amendments to the Copyright Act in 1968 make it potentially much more dangerous to copy the design of minor components which have no inventive merit than it used to be. If a non-expert can be satisfied that a component can be recognised to be reproduced from a given drawing, even if copied indirectly from a component made from that drawing, then that component can be held to be an infringement of the copyright of that drawing and the penalties are severe. The stocks of the component have to be given up by the copier and restitution made for the loss of sales of that component caused by the sale of the copy. These sums are related to the full cost of the component whereas in a patent case, damages are usually awarded on the basis of the royalty lost by the patentee which is usually about 5% of the cost of the patented article. This means that those who develop their own products of which there are proper drawings, are automatically protected from straight copying and it seems that it will become more and more difficult for firms to make a living by manufacturing spurious spare parts.

I have always considered that patents are very important to a small firm as well as to large firms. In fact, a firm of any size concerned with taking on a new product must pay particular attention to the patent position. Again, however careful the search, the position can never be completely clear cut in the way which an engineer would approve. It can take four or five years for a patent to be published and during that period, no-one knows what the patent is. It is quite possible to apply for one's own patent, launch the product based on that patent and then find that a patent is published subsequently which one's new product infringes and which has a date earlier than your own. My experience is that one can expect that someone else somewhere in the world will be taking out a similar patent application to yours at around the same time and that the fact that this has happened will not emerge for four years or so. The reason for this is not difficult to see. The point in time when a particular development becomes both practical and desirable is usually fixed by outside factors such as the application of an important piece of research or the discovery of a new material. It is probable that more than one person will appreciate the implications of this new piece of information resulting in similar patent applications being taken out at roughly the same time, often in different countries.

I have heard patents dismissed as being not worthwhile. On balance, I think they are well worthwhile provided one doesn't expect too much of them. Their value varies enormously and the really valuable patent is very rare. But they do have a value and have a very big influence indeed on our selection of new products.

Does the product fit in with the firms existing expertise or with the firms future aspirations?

I believe that it is not sufficient to make and market a product. It is necessary to understand in considerable depth the agricultural process for which the product is used and to be aware of alternative methods of achieving the same result. It should be possible to supply one customer, knowing that his use of your machine will be a better solution than any other, and, at the same time, refuse to supply another customer because your machine does not fulfil his particular requirements. Such a knowledge in depth takes time to accumulate and it is an obvious advantage if a new product is in the field of the company's existing expertise as the effort to learn about a new field is thereby avoided. It can happen, however, that the existing producers in a particular field have such an interest in continuing to exploit their existing products that the only way of getting a new idea on to the market is for an uncommitted manufacturer, new to that field, to take on the idea. The inventor of our grain dryer felt that way, which explains why we were offered it even though we had little expertise in the grain drying field. We overcame the problem of obtaining this expertise by inviting the inventor to join our staff as well as taking on his invention. The attraction from our point of view was two-fold. Previously, we produced mainly for grassland farmers and we considered it very wise to extend our range of customers by increasing the range of products we offered to the arable farmer. The second attraction was that of becoming more sophisticated. Taking on an automatic grain dryer involved being thrown in at the deep end as far as electrical control systems were concerned. I foresee small firms in the agricultural engineering business becoming less and less like blacksmiths and more and more sophisticated in their knowledge and use of electrical and hydraulic technology. The choice of new products has an all important bearing on such aspirations.

The resources of one's factory and the selling periods of existing products are also factors which must be taken into account. In the agricultural engineering business, there are seasonal sales peaks so that a factory can have many products being produced for sale in April and May or July to September but nothing for sale in the winter months. A new product which can be made at a period of slack production would be more attractive than a product which has to be produced for despatch at periods when other products also are in peak demand.

Development costs

We have considered the uncertainties of market research, competition and patents and we now come to the most unpredictable factor of all, development costs. Development is like exploration; until one has found and proved the answer, one just doesn't know how long it will take to find it. In any case, development tends to be open-ended in the sense that one step leads to another and as soon as one objective has been achieved, the possibilities of further improvement then become obvious. Refuse to take that further step and a competitor will find it easier to catch up. Take that further step and further unknown costs are added to the development bill and the marketable product which has to pay for all this, is further delayed. Anyone who has developed any engineering product must be only too well aware of the horns of this dilemma. There are no rules. Development calls for sound judgement and strong nerves.

Try something, test it, evaluate the tests and draw the right conclusions as a guide to deciding what to do next. In the agricultural field, this process can be complicated by a very short season each year in which the test under actual working conditions can take place and by the enormous range of conditions under which agricultural machines have to work. Some conditions occur very occasionally, sometimes only once or twice in 10 years. Yet woe betide the unfortunate manufacturer who launches a product in just such an exceptional year.

In spite of the uncertainties of development, an estimate should be made of the resources which will probably be required to complete the development. The wise Managing Director will then mentally double this estimate and base his plan to recover development costs on this doubled estimate. At this point, his nerves will have to be at their strongest as the projected retail sales price will probably be much too high. His faith that the product really will be exceptional is all that can sustain him. And this is not so impossible as it sounds. A really good product, giving a first class performance, saving labour, needing the minimum of maintenance and giving great reliability can command a bigger price in the market than most engineers imagine.

Can the new product make enough profit to justify the risks?

Finally, we come to the $64,000 question. Will the new product be sufficiently profitable to justify the risks inherent in developing and marketing it? These risks have already been discussed. The product may not perform as well as planned, may prove to have unexpected weaknesses and may not turn out to be the best value in its field. It may be up against strong competition and it may infringe a patent not yet published.

All these risks can be accepted provided there is the reasonable chance of an adequate reward. It would obviously be stupid to go to all this trouble if the market was so small that there was no chance of recovering one's costs. Again, it would be difficult to justify a new product if its advantages over competitive products or methods were only marginal. As I have already said, there must be a reasonable chance of an adequate reward but the reward may not only be financial. Sometimes a new product may not do more than break even financially but may be justified by giving the firm experience in a new technology or in a new market. We have even experienced the situation where the new product itself was a failure but because we were trying to solve the problem, we were able to appreciate the value of someone else's solution and launch that as a new product successfully.

An example was the Wilder Straw Chopper which we developed from our own ideas as a solution to the problem of chopping and spreading straw. I believe that it was because we had developed that machine that we were able to appreciate Mr. Rainthorpe's solution to the straw chopping problem. In the table earlier in the paper setting out where ideas for new machines came from, the Wilder Straw Chopper is listed as an unsuccessful exploitation of our own ideas whereas the Rainthorpe Straw Chopper is listed as a commercially successful exploitation of a farmer inventor's prototype machine. In reality, the Wilder Straw Chopper was not completely unsuccessful as it led to the Rainthorpe machine. All that I am saying is that, while the financial side of a new product must be viable, it would be taking too narrow a view if all the advantages were viewed in purely financial terms.

Conclusions

I wanted to conclude by saying that this paper was philosophical rather than scientific until I discovered that my dictionary defines "philosophy" as the "pursuit of wisdom". The object of this paper may well be "the pursuit of wisdom" but I hesitate to claim that the pursuit has got very far. I have already said that to launch a new product was similar, in my view, to launching a new play. Without new plays, the theatres would eventually die. Without new products, firms eventually die. On the other hand, a new play may not necessarily succeed and likewise, a new product may fail. Yet in spite of the risk of failure, new products are the very life blood of industry. The solution is to have sufficient resources to back a number of them, knowing that only a few will succeed. Certainly, this would seem to be the method adopted by the publishers of books or by record companies, to take just two examples. This paper describes some of the considerations which must be taken into account when evaluating a new product. But remember that in the last analysis, it is a person's or a committee's judgement on which the decision will be made and human judgement is fallible. Remember also that the major advances seem to contain an element of "inspiration" and that inspiration defies this type of analysis.

PRODUCT PLANNING AND DEVELOPMENT IN A SPECIALISED COMPANY

by J. V. FOX, FI AGR E*

Presented at the Spring National Meeting of the Institution of Agricultural Engineers at the National College of Agricultural Engineering Silsoe, Bedfordshire on 1 July 1971

The object of this conference is to attempt to explore some of the very many channels through which new products reach the market, and perhaps to identify some common denominator in their progress from inception to inclusion in a manufacturer's range.

There can be no question that this is the most important and critical area in the functioning of a company manufacturing finished products, and until one goes more deeply into the matter it appears surprising that it has not long been the subject of close scrutiny at conferences such as this. However, the factors involved are so diverse, and so specialised to individual organisations, that it presents a daunting problem when one seeks a common framework on which the sequences of logic applicable to all situations can be hung.

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The process of selection, therefore, does not readily permit of rationalisation, particularly since it is probably true that no two products follow the same path, but it will perhaps be helpful to examine in some detail a number of the more usual processes.

The first step in the train of events is recognition of the need for a new product, and in the majority of cases this recognition can arise independently of any definite ideas on the nature of the product. With reference to Fig. 1, of the six reasons given for which a new product may be required, only two have any direct connection with its nature. Generally speaking therefore the second stage in the process will be a market investigation to decide upon likely areas for detailed study. A vast number of factors, too numerous to mention individually, come into play at this stage. Their nature may be gauged from the following examples; existing market coverage in terms of distribution, advertising, exhibitions, sales representatives, production facilities in relation to processes and peaks of demand; capital investment in relation to the life expectancy of the product; suitability for export markets; service requirements in relation to those of other products. These factors can be summed up, broadly, as "compatibility", and this has to be achieved if the product is to carry its share of existing overheads rather than to create new ones. Already, therefore, the possible area of investigation is becoming circumscribed, and in some respects this tends to increase the difficulty of selection because many otherwise promising ideas may fail the compatibility test.

It is important during the selection process not to lose sight of the reason why the new product is required, and this is in fact quite easy to do unless a degree of discipline is imposed. There may of course be a number of reasons; if so they

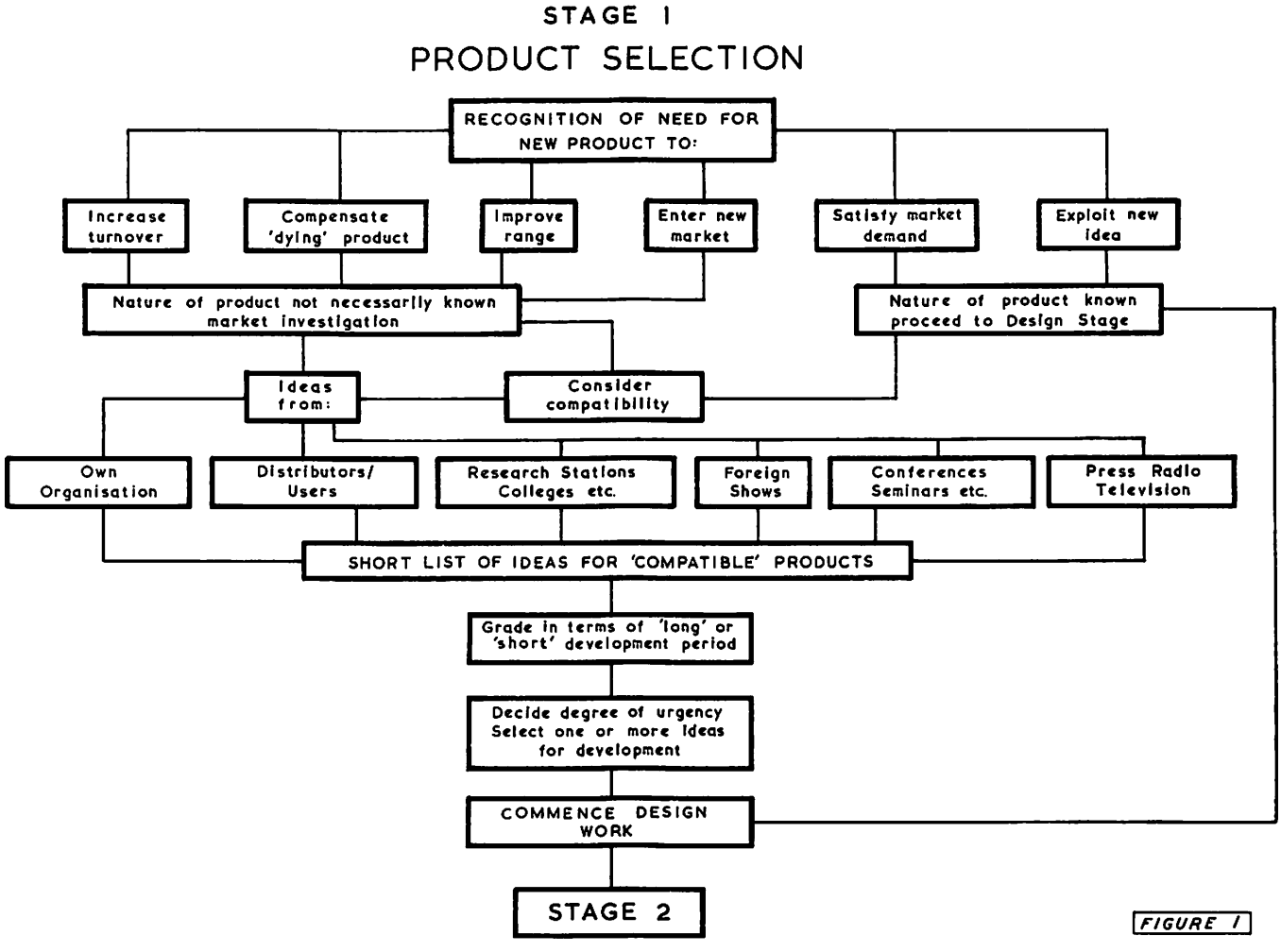


FIGURE 1

should be separately identified and kept in mind. It is important because the required characteristics or "compatability" of the product relate directly to these reasons and before proceeding to draw up a design specification it is well worth while to produce a specification of characteristics. For example, suppose a company has decided to increase turnover and to diversify its interests by entering a new market, the thinking behind the specification of characteristics might go like this:

Increase Turnover

We want to increase turnover to provide better coverage of our overheads, which will enable us to keep prices down and profits up. Therefore we do not want a product which will involve big increases in overhead costs and this means we must avoid heavy expenditure on specialised plant and specialist personnel and also if possible avoid a completely new marketing set-up. Also we only have spare works capacity during a particular period of the year and we therefore should have a seasonal product which will fit in to this gap. It should also be comparable in size and complexity with existing products, otherwise we could have expensive production and inventory problems.

Enter New Market

Our existing range of equipment is well known and we have spent many years and a great deal of money building our reputation, and we do not want to start again from scratch. The new market should therefore be sufficiently closely allied to our present one to permit our existing marketing set-up to handle it and so that our new customers can quickly assess the value of our know-how in relation to the new product. We also have some extremely competent distributors in export markets and if we could persuade them to branch out into the new field with us it would be valuable in increasing their commitment to our products and might also save some expensive mistakes as well as the inevitable high cost of finding new outlets.

This kind of thinking is of course applicable to any type of proprietary manufacture but to complete the example let us suppose we are an agricultural engineering firm manufacturing a range of tillage and hay-making machinery. The final specification of characteristics might look as follows:—

New Product:

Materials:	Steel and malleable cast-iron, plus specialised bought-in components.
Method of construction:	Welded fabrication of cold-sawn mild steel sections, profile-cut blanks, press-formed sections up to 150-ton capacity. Drilling, machining and boring, etc. no problem.
Size of components:	Indivisible components should not exceed say 1000 lb. or about 10 ft × 4 ft × 4 ft otherwise the welding bays will have to be completely re-organised and this will limit output of existing products.
Assembly:	Should not require specialised techniques or more than moderately skilled fitters. Size should not exceed 15 ft × 6 ft and weight must be less than a ton.
Variations:	Different models should be kept to a minimum and if tractor-mounted use the 3-point linkage to avoid special fittings.
Period of manufacture:	November to Mid-march, with possibility of earlier start in the autumn.
Possible markets:	Municipal, civil engineering, forestry, materials handling, road transport, airports, docks, railways.
Suitability for export:	Should pack at a reasonable density, be protected by patents if possible and be of sufficient technical merit to be of interest in sophisticated European markets
Volume/Price:	Initial output about £50,000 per annum, say 100 machines at £500, rising ideally to about £250,000 in fourth year of production.

The most interesting feature of this exercise is that by the time it is finished the broad outline of the product and its destined application is suprisingly limited even before we have any idea of what it is to be. This is of course inevitable if proper and economic use is to be made of existing resources and must form the basis of subsequent market investigations and feasibility studies.

The most important and fundamental ingredient of the new product is, of course, the idea, and Fig. 1 gives some indication of the possible sources of inspiration. Ideally it should be original, and it is a common fallacy that there is so little left to invent that this is nowadays virtually impossible. No doubt the same sort of thinking was prevalent in the days of Nero, but to say this is not to detract from the difficulty of both finding and recognising something new, and having done so of realising its potential in the form of a commercially viable product. So often the inventor does not have the capability or resources to exploit his original idea, which passes almost unnoticed until picked up and developed by an established manufacturer.

If the wholly original idea does not emerge when required, a great deal can be done by bringing an established type of machine a step nearer to perfection. This really calls for a new approach, starting from basic principles and reconsidering exactly what the requirements are. It is surprising how changes in materials, requirements, tractor power and technology generally over the years produce a substantial potential for change in a conventional machine, which can, and frequently does, go unrecognised for a lengthy period.

A case in point is the heavy-duty cultivator, which in one form or another has been known for many centuries. Some years ago, seeking a new product in the agricultural market we concluded that a machine which appeared at the time (1960) to have remained virtually unchanged over a long period was the cultivator, and the need for a new look was strongly borne out during market investigation, when it became apparent that there was a demand for an implement that would not block or bend, and which could be used directly into unploughed ground.

Looking at the required characteristics it was not difficult to arrive at the conclusion that there was scope for development, and a careful process of identifying the problems led to reasonably acceptable solutions being found. These characteristics were as follows:—

1. Three-point linkage mounting
2. Capability in unploughed ground

3. Strength to resist bending
4. Absence of blockage

The associated problems which are immediately apparent are:—

1. Three-point linkage mounting:
   a) Weight limitation due to lift capability of tractor.
   b) Geometry in relation to height of lift available and under frame clearance.
   c) Strength of hitchpoints and their effect on tine spacing.
2. Capability in unploughed ground:
   a) High strength requirement.
   b) High degree of penetration required from tines.
   c) Minimum draft in relation to work done.
   d) Good weight transfer properties, essential to ensure adequate traction.
3. Strength to resist bending:
   a) High torsional rigidity in frame.
   b) Adequate bearing area for tine mountings.
   c) Corresponding strength in tines.
   d) Safety release mechanism for obstructions.
4. Absence of blockage:
   a) Adequate under-frame clearance.
   b) Wide inter-tine spacing.
   c) Tine shape to reduce tendency to block.

Consideration of these problems produced a requirement for some basic research (Fig. 2) in that, firstly, the criteria for achieving a high degree of penetration and weight transfer were not definitely known and secondly, it was not apparent how the high strength and limited weight requirements could be reconciled with the greater under-frame and inter-tine clearances required.

A study of published work on the mechanics of cultivation led to tests with a tine having a point capable of being infinitely varied in angle between 0° (horizontal) and 45° positive rake angle, and this produced a clear indication of the optimum for penetration and vertical downward component of draft. Further experimental work established an optimum radius for a curved point and eliminated a number of other possibilities.

The outcome of practical tests and stress calculation in relation to the strength to weight ratio of the implement was that there could be no practical alternative to the use of hollow sections for both the frame and the tines, if the criteria with regard to freedom from blockage were to be met. However, a considerable amount of further investigation, using field tests to establish the nature and magnitude of the forces involved, and a rig mounted on a hydraulic press as a repeatable control, was necessary before the actual requirements were known to a reasonable degree.

Without doubt the most difficult problem of all in this particular development was the provision of a safety release mechanism to protect the implement against immovable obstructions. The matter was finally temporarily resolved by providing a shear-bolt system which it was planned would be replaced as soon as a satisfactory self-resetting release mechanism had been developed. That was over ten years ago and the shear bolt is still with us. The difficulty lies in the extremely high forces involved and in the need for low cost and consistent reliability throughout a long and arduous service life. Many attempts have been made to achieve a breakthrough but as the years have passed, progressively fewer of them, in the light of experience, have got beyond the drawing board. However, I personally remain convinced that the development of a suitable mechanism is possible.

Having then arrived at the point where the principal technical difficulties associated with the proposed product

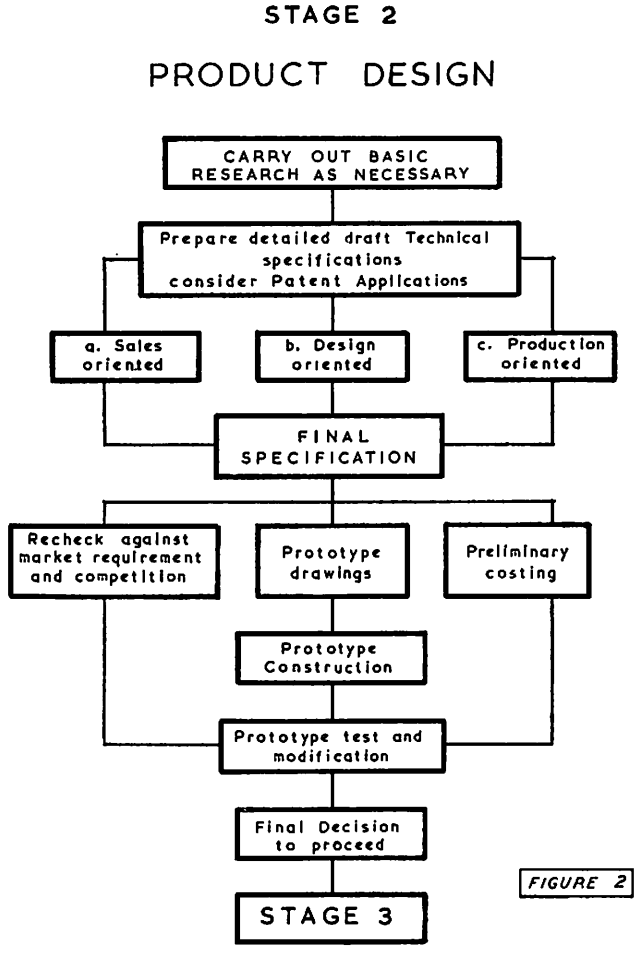


FIGURE 2

have been investigated and identified, if not entirely overcome, it is desirable before proceeding further to finalise a technical specification on which the detailed design will be based. The question of possible patent protection should also be considered with care since this can very greatly influence the commercial success of a new idea. It may perhaps be relevant and helpful to offer a few comments, purely based on personal experience, which may highlight some of the pitfalls and dilemmas which abound where patents are concerned.

The fundamental rule, based on natural principles which are known to all of us, is that if you make something vaguely similar to the subject of a patent you will be infringing it, whereas if someone else makes a machine identical to the subject of your patent there will be an excellent reason why they are not infringing. Fortunately there are exceptions to this rule, in both directions, and patents are a useful tool, provided that one does not expect too much of them.

Generally speaking if a device is worth patenting it will be decided that in addition to a British Patent Application it will be wise to make foreign applications, in order to obtain protection in the countries where the machine would be likely to be manufactured or sold. The obvious dilemma here is in deciding which countries to go for, and the difficulty is greatly increased if the potential of the device is not fully known when the decision has to be made. It is frequently an expensive mistake to rush in a patent application as soon as the idea has been born, because although a "provisional" is cheap the International Convention lays it down that overseas applications must be made within one year of the original application date. When due allowance is made for the delay involved in patent agent's offices, translation and postal services, the final decision regarding foreign applications has to be made

in about eight months, and in practice this is often far too short a time even to have completed prototype tests, especially with a seasonal machine.

From this point of view, therefore, unless one has good reason to believe that a competitor is hot on the trail, it is wise to delay filing for as long as possible. On the other hand, of course, if a similar application is filed only hours before your own, anywhere in the world, it will have priority, although this may not be known for a couple of years, during which time a great deal of money may have been spent. It is very much of a gamble, but if it does nothing else a provisional serves as a useful deterrent to competitors and makes it certain that an application filed subsequently by a competitor would not succeed.

With reference to Fig. 2 it will be seen that it is suggested that the draft technical specification of the product should be vetted and modified by the three departments concerned, that is Sales, Design and Production, before it is finalised. This will help to ensure that there are no important sales features which have been ommitted, whilst if major production difficulties seem likely to arise they can be reduced or eliminated at the design stage.

There is nothing more inimical to success than design by committee, but if the designer is not briefed as fully as possible before detailed work commences a great deal of time can be lost and the finished product is likely to suffer either from deficiencies or from having extra features tacked on as an afterthought. This basic product planning is therefore both necessary and of direct value, and it is also additionally valuable in that when the Sales and Production departments have played a decisive part in the planning stage the staff concerned develop a personal commitment to the success of the project. There is no substitute for the enthusiasm of a team working together to achieve a goal which it has in effect set for itself, and the aim should always be to work in this way as far as possible.

The final specification is then passed to the designer and at the same time it should be re-checked against the market requirement and a preliminary costing prepared. Any areas of doubt having been resolved at the research stage there should be no question as to whether or not the prototype will work, and the critical factor will be performance, in terms of quality of work, output and cost. It is relatively easy to set standards where there is competition in the market, since it is only necessary to be better, but it can be quite difficult where the machine is of a type which was hitherto unknown, or is performing an operation in a totally different way.

An example of this difficulty occurred fairly recently when we were developing a scrub-chopping attachment for a hydraulically driven flail mower. This attachment is intended to pulverise brushwood up to an appreciable thickness, and it appeared to perform extremely well on trials and demonstrations in this country, where the technique was, for practical purposes, new. However, on the European continent, where competitive equipment exists and certain standards of performance are regarded as acceptable, the initial trials proved to be very disappointing and resulted in several major modifications. In the outcome, the home market had the benefit of a much better product, very much sooner than would otherwise have been the case.

This is probably a typical example of one at least of the benefits of competition to the user: the first machine of a type on the market sets a standard and those which follow, if they are to succeed, must progressively improve on it.

The prototype having been tested and modified and re-tested, the moment arrives when the final decision to go ahead must be taken, and if it has failed to come up to expectations or has grown enormously in cost and complexity it may well at this stage be relegated to some overgrown spot at the back of the factory while more thought is applied to the problem. If, however, it is to proceed, then a great deal of work lies ahead.

The processes which go to make up this final stage are set out in Fig. 3 and appear for the sake of completing the picture, although some of the detailed considerations involved are perhaps outside the scope of this paper.

Some of the greatest difficulties are often encountered when preparing the pre-production drawings, since they must incorporate all the features which the prototype tests have shown to be necessary. The modifications to the prototype have necessarily been carried out piecemeal and by the most expedient means in the field or experimental shop, and its appearance is unlikely to bear any resemblance to a finished product. The process of "tidying up" is far from straight forward and it is frequently the case that certain features of the prototype are fortuitously contributing to its good performance. Where this happens they are likely to be ommitted from the pre-production machines and an inexplicable loss of performance can result.

Where the new product has any degree of complexity it is highly desirable to build a quantity prior to full production, so that machines as nearly as possible equivalent to production models can be subjected to tests in the hands of users. It is generally desirable, if possible, that such machines should be sold rather than loaned to the user, albeit on special terms and with the assurance not only of normal warranty protection but also free-of-charge up-dating if modifications or improvements are incorporated in the production machines. The principal reason for this is that the attitude of the user who has paid for his machine is totally different from that of a loan situation. He is likely to ensure that the machine works to full capacity and will be quick to complain at the first signs of trouble. By contrast a loaned machine is frequently left standing idle for long periods when it should be working, and the user is unstinting in his praise.

STAGE 3

PRODUCTION AND LAUNCH

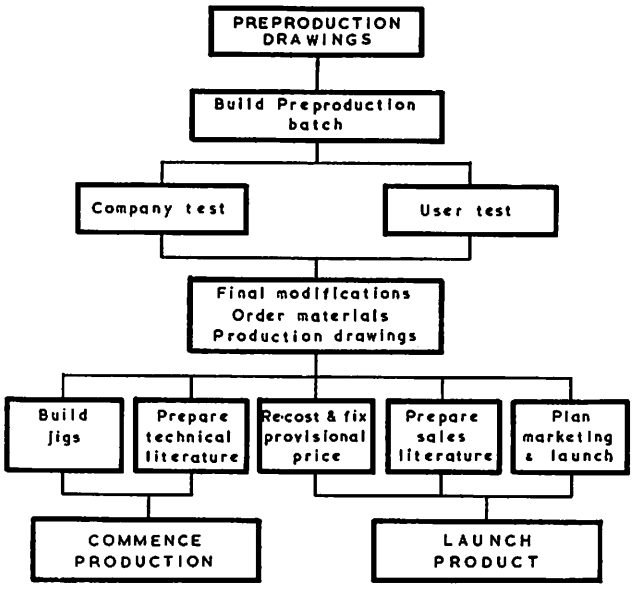


FIGURE 3

PRODUCT: Cultivator			1971											1972				
			DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1	PRELIMINARY DESIGN & DRAWING	A	X																	
2	PROTOTYPE DRAWING & TEMPLATES	B		X																
3	PROTOTYPE BUILD	G			X															
4	PROTOTYPE TEST	H				X														
5	DEVELOPMENT & TEST	C				X	X													
6	PRE-PRODUCTION DRAWING	D					X													
7	PRE-PRODUCTION BUILD	J					X													
8	PRE-PRODUCTION TEST	K						X												
9	PRE-PRODUCTION USER TEST							X	X	X	X									
10	FINAL DESIGN DRAWING	E										X								
11	JIG BUILD	L											X	X	X					
12	FITTING/OP. INST/PARTS LIST	F													X					
13	SALES LITERATURE														X					
14	PRODUCTION															X	X			
15	INTRODUCTION														X					

FIGURE 4(a)

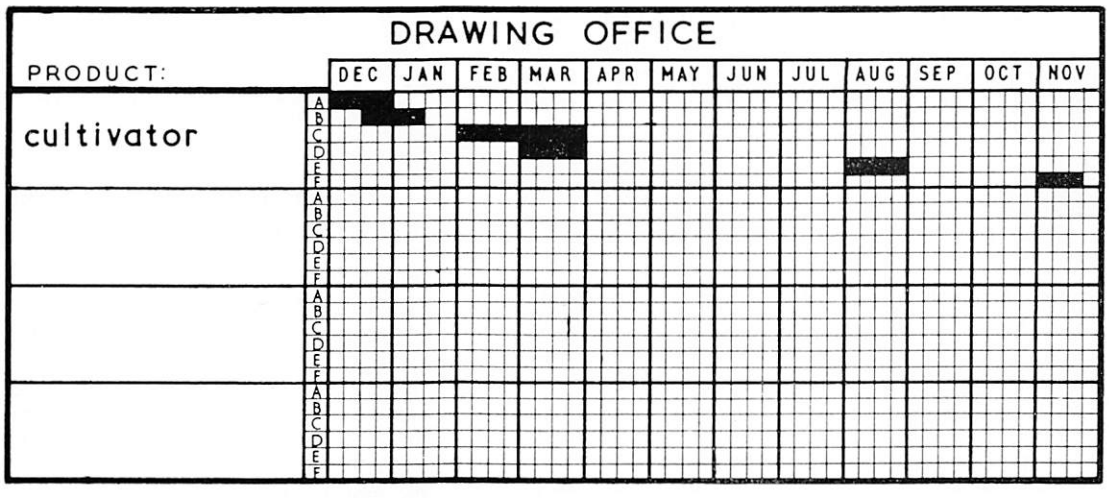


FIGURE 4(b)

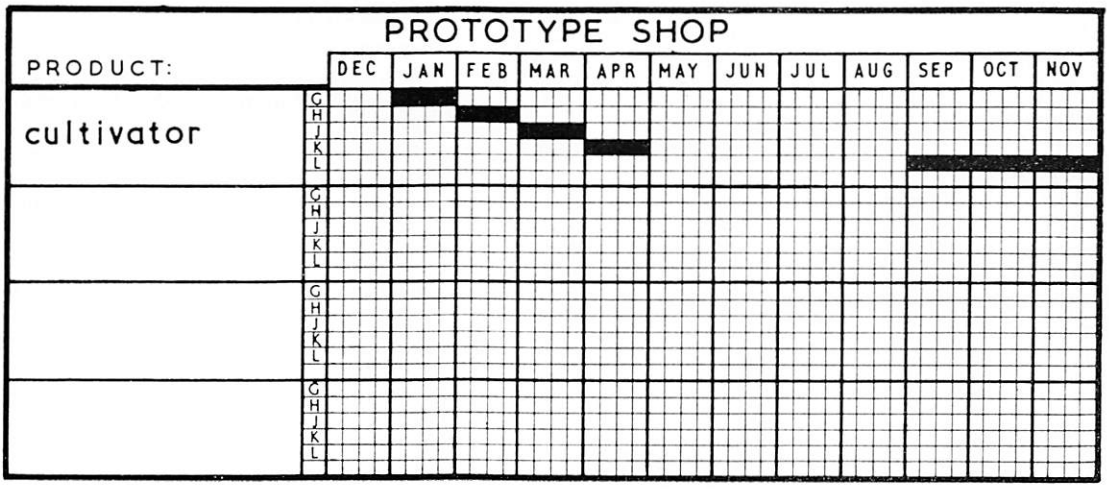


FIGURE 4(c)

As soon as there is a reasonable certainty that all necessary final modifications have been made, work on construction of manufacturing jigs and fixtures can commence, and concurrently with this the forward ordering of materials, preparation of technical and sales literature, re-costing and market planning can be put in hand.

It will be appreciated that the introduction of a new product is a lengthy process and it is always hard to forecast the time-scale which will be required in any particular case. So much depends upon the unforeseen difficulties which by their nature are wholly unpredictable. However, for reasons of sales strategy it is necessary to endeavour to impose deadlines; for example a seasonal machine intended for autumn use is best introduced say at the Royal Show in July and one for spring or summer use at the Smithfield Show.

The necessary control can be provided by means of a programme which will give an indication at monthly intervals of progress relative to the critical path which must be followed to ensure completion of the project by a fixed deadline. An example is given in Fig. 4 and it is fair to say that whilst such programming does not necessarily speed up development it does give rise to a situation of urgency much earlier in the process than can otherwise be achieved. For instance, if at the end of month 3 on a fifteen month programme the work is already falling behind, effective steps taken at that point to accelerate it are very much more likely to be successful than if the urgency remains undetected for nine or ten months.

I hope that the foregoing account of some of the more generally applicable processes in the development of a new product will have been of interest, and from my own point of view I feel that this conference has already been worthwhile in that it has encouraged a rationalisation of thinking on this very diffuse subject. I feel certain that the discussion will bring forward many new and important ideas which will be of value to all concerned in the manufacture of finished products.

Selection and Development of New Products

NECESSITY IS STILL THE MOTHER OF INVENTION

by W. T. A. RUNDLE, FI Agr E*

Presented at the Spring National Meeting of the Institution of Agricultural Engineers at the National College of Agricultural Engineering, Silsoe, Bedfordshire on 30 March 1971

New products in the agricultural engineering industry are probably created from a very much more diversified number of starting points than many other manufacturing industries. It is probably true to say that most of our relatively smaller manufacturing units in this country all started business from early beginnings with various farming connections, farmers themselves or early blacksmith-engineers, etc. Many of our currently successful products have started from farmer-born ideas and several production units have certainly been created by farmers.

Four main channels of input of ideas spring to my mind when thinking about the thought processes which lead to management decisions with regard to the introduction of new products or updating of old ones. These are not necessarily given in the order of relative importance because in my experience there are many factors which influence such thinking and their importance to any individual company must depend on various other factors which build up the environment from which the thinking has to take place, i.e. the size of the company concerned; is it starting in business; is it well-established; is it entering a new field, etc? Does it need to expand? Are present lines becoming out-dated?

(1) Farmer idea, manufactured by an existing production unit.
(2) Farmer idea, farmer produced.
(3) National Research—ideas from this source are always welcomed by industry and these obviously need the same management decisions as would apply to ideas stemming from any other source.
(4) Established manufacturer producing new ideas from internal development of either a new product or a redevelopment of an old one.

*Managing Director, Wright Rain Limited, Ringwood, Hampshire.

The decision making which has to be done naturally becomes more and more complicated as the size of the manufacturing unit involved increases. Our largest manufacturers must have enormous problems to face when considering, for example, a new tractor range or altering an existing one. The consideration of such a problem must start from market research, development research and the development programme which stems from this. Then various exercises have to be completed—production costs, capital requirements, cash flow—and I can well imagine that quite often the scheme that goes forward from the market research and research and development stage can look quite a different animal by the time the project has completed the management decision gambit which must take place in the capital and cash flow areas.

My experience in these fields has been very varied and I think the following case examples will serve to illustrate the points I have been making in my introduction.

1. Farmer Idea, Manufacturer Produced

A typical example of this was a vegetable washer, (Fig. 1) which was invented by two growers, and the first was built by using an ordinary 200 gallon, 8 ft. long galvanised steel cattle drinking trough. A wooden slatted drum, approximately 3 ft. long and 2 ft. in diameter, was suspended in vee belts from a wooden frame bolted into the tank, the frame being made from a rough sawn 4 × 4 elm. There was a simple delivery chute to feed vegetables into the drum and a final elevator and bagging off attachment. The original unit was driven by a $1\frac{1}{2}$ hp petrol engine through an old hay elevator rotation gear.

The vegetables were fed down the feed trough into the rotating slatted drum and the speed at which they left the drum—and therefore the degree of cleaning—was regulated by controlling the size of the aperture, which was adjustable by hand at the outlet of the cleaning drum. This control was in fact the breakthrough in design which gave this particular machine an "edge" over existing types. When ideas like this are created and there is an embryo of a concept, the next step of how the idea is put forward to a manufacturer and how that manufacturer makes his decision is not always clearly defined. However, in this case the idea was offered to a company which had engineering capacity that was at that time—just after the Second World War—mainly orientated towards the running and maintenance of a big earthmoving and farm cultivations contracting business, with a local agricultural equipment supply and repair business operating from the same premises.

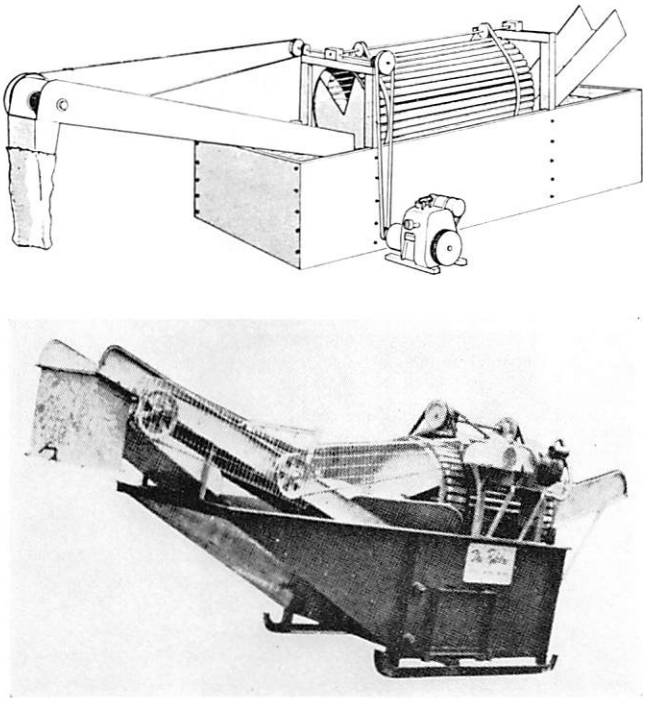


Fig 1

The owner of the business at that time was concerned that it was conceivable that his general business could begin to run down because: (1) farmers were beginning to equip themselves for all the heavy work needed on their farms, and (2) various large earthmoving contracts created by the effects of the last war were beginning to run out, and therefore it was becoming quite important to consider alternative work for the business. It was from this background that the decision was made to consider the manufacture of the vegetable washer, the idea for which had been offered to the owner of the company.

The following steps were then taken (there is nothing unusual in these steps but they serve to illustrate the case). A great deal of effort was put into the engineering design of the unit and a one off prototype was built, which proved to have an excellent performance and therefore was beginning to show that provided there was a market outlet then the idea could well be successful.

The next decision, therefore, was how many to make in the first batch so that accurate costs and selling prices could be established. A batch of 20 was produced for this purpose, a cheap simple leaflet was created, and marketing commenced. There was no dealer network available but a "hard sell" on the first 20 soon showed that the idea was acceptable to growers, and gradually the marketing and manufacturing facilities were developed and established.

This work started in about 1950 and the standard vegetable washer is still being successfully marketed today. This one idea naturally led to development of larger and smaller machines for the purpose and also created alongside a facility to make special purpose machines for other facets of finishing market garden produce prior to packaging and final market presentation.

The contracting side of the business has since been completely run down, therefore this company might have found life very difficult unless a new line had been introduced.

2. National Research

The number of products from various sources of national research have been many and varied, but one example with which I had considerable personal experience was the system of drying grain in sacks, which became known as "in sack drying".

The NIAE developed this principle and in so doing various manufacturers were obviously involved in the development, i.e. oil burner manufacturers and fan manufacturers, and there were several types and varieties of in sack driers which were eventually produced and successfully marketed.

For the purposes of brevity I can only quote one example to illustrate the decisions which were made; this concerns one particular oil burning equipment manufacturer. I find this example to be extremely interesting in that it seemed to me that it was not necessarily the logical point from which such a development project would take place, but it so happened that at that time the company concerned was at a stage of its development where it was becoming well-known and established for its oil burning knowhow and prowess.

The company looked at the possible potential for in sack drying units and saw this as one way in which it could build up a demand for its oil burning units, but to do this management had to decide to invest in extra manufacturing equipment and facilities to enable them to produce the necessary wind tunnel and fan connections, etc. They also, of course, had to make arrangements with a fan manufacturer for the supply of fans, and with other manufacturers for electrical equipment, motors, vee belts and pulleys, etc. They took their various decisions step by step and ultimately sold thousands of these units, as indeed did several other firms who took up the idea and developed it from different starting points.

The point which I think this example illustrates is that the decisions to enter a particular market with an item or range of equipment obviously is not confined in management minds necessarily to existing lines of thought, but rather to the possibility of diversification and expansion of the business involved, as indeed it certainly happened with this particular line, that certain fan manufacturers took up the idea and developed it from the point of view of being able to sell more fans.

The first firm cited in this category has since added quite a large range of agricultural machinery products to its range, both by diversification within its original company and by the acquisition of other companies.

3. Farmer Idea, Farmer Produced

This case history is one with which I am particularly familiar, but I think it is typical of many such cases within our agricultural machinery industry. It concerns irrigation equipment and the development of a range of equipment and its marketing.

The concept of sprinkler irrigation for this company was created when the founder visited the States on a Nuffield Scholarship and studied various aspects of agriculture. When he returned to his farm in this country in 1952 there were two ideas uppermost in his mind, one was the possibility of sprinkler irrigation, the other the possibility of grading and pre-packaging of farm and horticultural produce.

The first decision made was that the idea of sprinkler irrigation should be given priority. This led to the introduction on his own farm of a lightweight portable aluminium system of sprinkler irrigation equipment. To produce the first items of equipment local engineering firms were used and everything was done on a sub-contract basis, but still the decision to form a company and commence marketing had not been made.

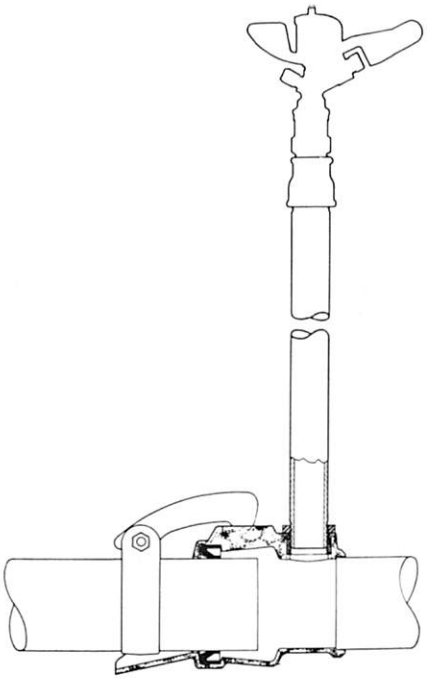
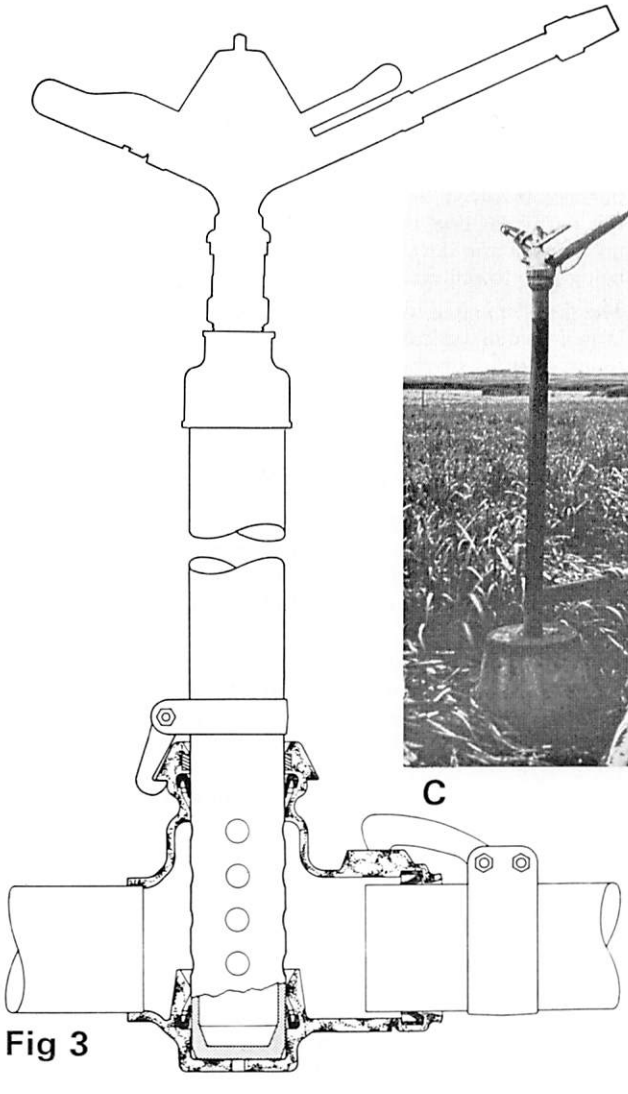


Fig 2



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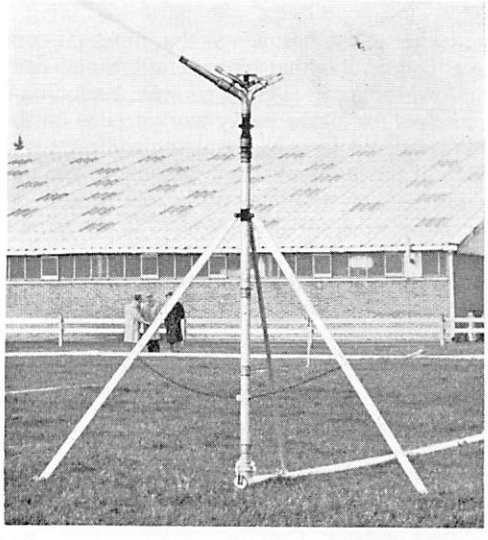


B

A

Fig 3

The first steps of decision in this direction came during the visit of a friend from America, who pushed the idea of marketing and the world potential to a point where it was decided to form a company and move off in this direction. The next steps were the normal ones of collecting a team and building up a small organisation.

In the early years of the development of this company all manufacture was sub-contracted, and I well remember the firm resolve that this must be the right way to do it, but I also remember the dramatic "volte-face" on this decision in due course as gradually demand out-stripped the supply from the various sub-contractors involved, and in 1956 it was decided to undertake many facets of the production required to meet the demand.

The first visit overseas led to the next decision, which stemmed from a full realisation of the international market potential for such a system. It was therefore decided to set up an overseas marketing organisation parallel to building up a dealer network and marketing outlet in the U.K.

Having created a dealer network to sell and service this range of equipment it was, of course, obvious that U.K. dealers needed trained staff to handle the technical aspects of this particular line. Unfortunately, the equipment range as it stood could not provide an all year round load, and subsequently considerable thought was given to the possibility of equipment which could be sold and used during the winter season, which led to the introduction of hydraulic techniques for handling farm effluent.

This particular range of equipment was therefore introduced for the two reasons: (1) to provide an all year round work load for the dealer network, and (2) the need to balance the year's intake of work both for the sales and the manufacturing units of the company.

Rapid progress was made with developing market outlets and this in turn led to very strong demands for the company to create new types of equipment to deal with problems of irrigating particular crops, such as sugar cane. A considerable amount of time had to be spent on the development of new pieces of equipment to handle special situations.

The three examples of equipment illustrated show the original sprinkler coupler (Fig. 2), which would support a sprinkler at a height of between 3 and 4 feet. This is followed by a self-supporting riser and (Fig. 3A) which would carry a fairly large sprinkler at a height of up to 12 feet—suitable for tall crops, mainly sugar cane. This particular fitting enables the riser to be removed from the stand prior to moving the sprinkler line itself, but the design obviates any requirement for a tripod (Fig. 3 B) or other cumbersome support (Fig. 3C) which was common in the field prior to this particular design.

The third unit, the pedal-operated riser stand (Fig. 4), illustrates a system which overcame problems to do with much slower precipitation rates than could previously be achieved with conventional equipment, and it also led to the possibility of more economic operation of an irrigation system in the field.

All three concepts illustrated still necessitate a labour requirement in the field and are all based on hand-moving the sprinkler lines periodically during the irrigation cycle.

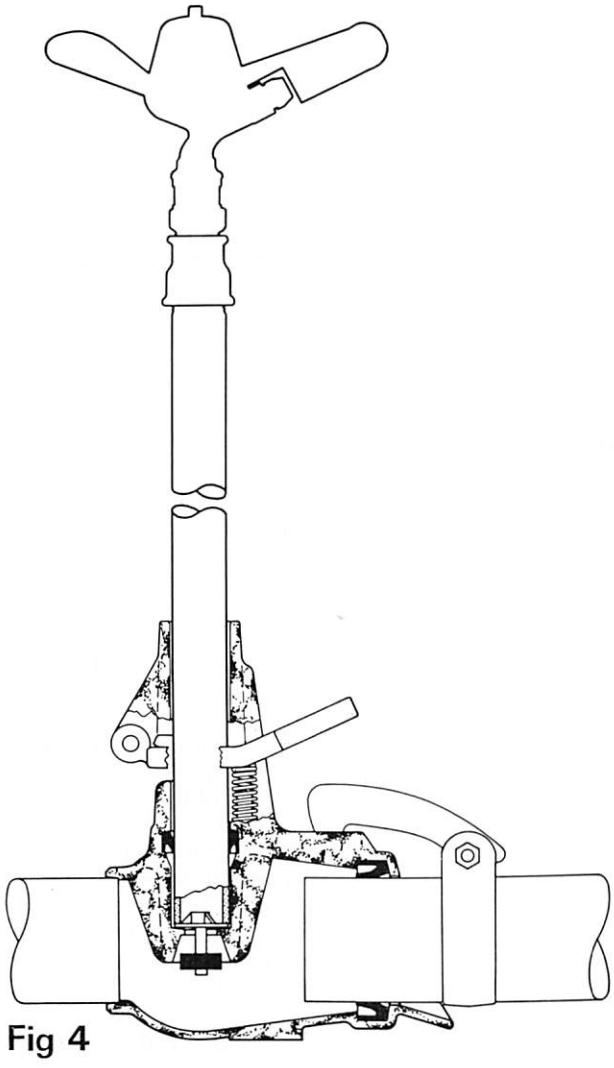


Fig 4

Although these systems were acceptable in the majority of markets concerned, it seemed to the company's management that gradually the problem of hand-moving equipment would become more and more difficult to achieve, and therefore the decision was made to investigate the possibility of designing a system which would eliminate to as great an extent as possible the necessity for hand-moving equipment during the growing season. If at all possible this system design should be such that it could be added to conventional portable irrigation systems. Due to pressures of business in other directions this problem was not considered for many months and management eventually decided that something positive had to be done as a matter of urgency.

A group comprising management, salesmen, engineers, farmer-users of existing equipment, was brought together for intensive discussions, visits overseas were arranged, and gradually the concept of and equipment required for a semi-solid set arrangement of equipment was evolved, put into production and marketed. The two illustrations (Fig. 5) show the conventional hand-move layout alongside the semi-solid set arrangement. From these illustrations it will be seen that the Portagrid System is such that there are permanent irrigation lines set over the irrigated area for the duration of the crop. During the irrigation season the only movement which is made in the field is that of one sprinkler per line, and the system eliminates all movements of tube. This technique used more capital equipment per acre but greatly reduces the labour requirement to operate it.

Many patents have been registered during the history of the company, and because of the nature of its activities they also have to be registered in many overseas countries. This is a particularly expensive business but in my view is a necessary evil.

It is extremely important to understand the function of patent cover and what can or cannot constitute an item or subject for patenting. There are many extremely good patent agents operating but the difficulty is to find one who has the background knowledge of your particular subject in patent thinking. I am pretty sure that I have had my wits sharpened much more keenly either when I have been in a position where my company has been accused of infringing a patent, or where we have been in a position of accusing another company of infringement, than they have ever been when we have considered taking out patent cover for a specific subject.

New ideas and developments are very difficult to bring to successful commercial conclusion and can be very expensive in the process. It is therefore important that very careful thought be given to the details of patent cover before commitment to expenditure.

Five years ago the company became part of one of the major groups of companies in the country and has greatly benefitted from being able to work within such a group. During this time it has grown considerably and has become well-established in its world markets with a range of sprinkler irrigation and farm effluent equipment, and the decisions which face it today are no longer peculiar to its own product range and early growth in the way that the various steps just described above have shown. It now faces decisions which must be parallel to any other company in the agricultural engineering business, i.e.

(1) What return on capital employed is needed by the group?
(2) At what rate does the company require to expand or extend its marketing outlets to avoid stagnation and yet retain a controlled growth rate?
(3) At what point does its present range become obsolete and need updating?

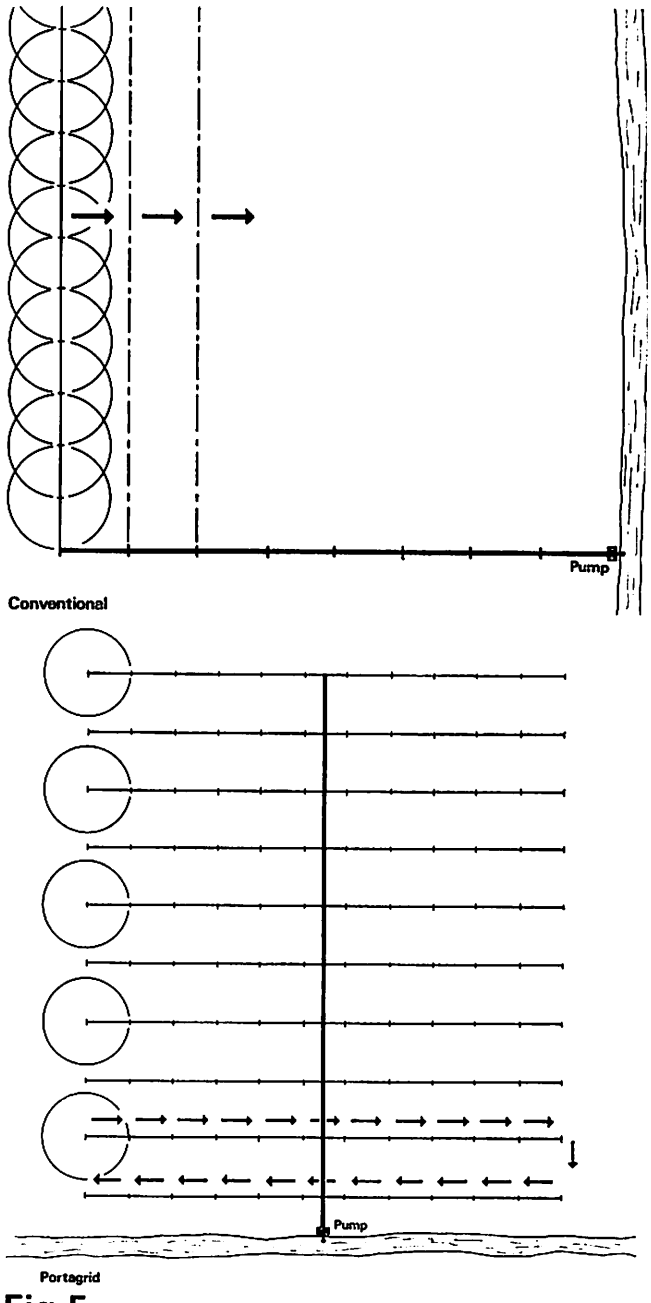


Fig 5

(4) At what point will the competition produce changes in product range which will show either mechanical or economic improvement to a point where the company would begin to lose its position in world markets, and hence not achieve the norm required in (2) above?

Until quite recently development work was more or less done by management, using engineers when available from other work. To meet current situations, however, the company decided that a strong research and development programme must be followed in order that new techniques and equipment could be made ready for marketing in due course to ensure the continued progress of the company. The result of such a development programme will (it is hoped!) eventually lead to new products and ideas which will in themselves pose very difficult questions which must arise with any other type of product, i.e. at what point in time should a new concept be introduced to the market?

Has the existing range outlived its usefulness to the company or is it sensible to continue with the existing range for a further number of years? Will the new product itself be useful in a sufficient number of marketing

outlets to ensure production runs which are economic in size? etc.

These are the kind of decisions which are, I believe, the most difficult for any company to make, and are the ones which face all established companies today.

This company has been able to keep up a satisfactory rate of growth without the need to seek a wide diversification from its original product line. There are, however, very many companies who make a limited range of equipment—for example, possibly cultivation equipment only—who may well find that the outlet for their product range will not allow for a satisfactory growth rate, and then other ideas or lines are sought.

The decisions which are involved in such cases revolve around the questions: would the proposed new line fit in with the existing product range in such a way that existing marketing arrangements would be satisfactory? Or would these need changing? Would the existing production equipment and facilities suit the new range? Is sufficient capital available to provide new facilities if they are required, or indeed simply to finance the new product range?

It is these kind of circumstances which create the very tortuous path of decision which manufacturers, large or small, have to tread before a new line of equipment can be successfully introduced.

It may seem strange, but to me it is a fact, that until the kind of decision-making which we have been considering at this Conference today has been drawn to positive conclusions, then nearly all decisions on other aspects of a business cannot be sensibly made. From this it follows that the very survival of our industry depends almost entirely on the correct moves being made in the thought processes which we have been discussing.

CONFERENCE ON SELECTION AND DEVELOPMENT OF NEW PRODUCTS

(Edited summary of Discussion)

Mr R. M. CHAMBERS (Massey-Ferguson Ltd.) asked how much weight should be attached to the marketing view of costing, especially at an early stage of development. It was sometimes difficult for the marketing division to estimate the value of a new development, and Mr Chambers quoted the example of the introduction of a differential lock as an optional feature on a particular large tractor, at an additional cost of £10. When the demand subsequently arose for a similar feature on a smaller tractor it was not possible to charge more than £10, although it so happened that the manufacturing cost was considerably more. Reference has also been made to prototype testing in overseas conditions. Mr Chambers emphasised that for this to be done properly in all likely conditions was a very expensive business, involving perhaps 50 or 100 prototype machines.

Mr J. H. W. WILDER, answering Mr Chambers, said that the engineering and marketing divisions of a company were always in disagreement, so that decisions on price had to be made at a higher level. The character of the decision then depended on the training and experience of the man taking it—whether he was an accountant, an engineer or a salesman. It was possible for marketing or engineering people to be quite wrong in their assessments of the price the market would stand and the minimum cost at which products could be made to a satisfactory level of performance. There were no general rules, and the right decision depended on the instinct and experience of the man at the top.

Mr J. V. FOX said that such decisions depended a great deal on whether there was competition or not. For example, there was fierce competition in selling cutter-bar types of hedge-cutting machines at one time. His company then designed a flail type of hedge cutter which pulverised the cut material and found no difficulty in selling these machines at 3 or 4 times the price of the cutter-bar type of machine.

Mr W. T. A. RUNDLE added that pricing decisions depended entirely on the flair and 'feel' of the company's chairman, marketing director or whoever had to take the decision. Too often the development of a new product was discontinued at an early stage simply because the cost structure began to look unfavourable from the marketing point of view. The whole question was a very delicate one.

Mr H. E. ASHFIELD, referring to Mr Chamber's example of pricing a differential lock, said that he could only confirm the desirability of treating the product range as a whole, so that the cost implications were worked out not just for individual machines, but for all machines likely to be affected, before any price figures were announced.

Referring to the testing of prototype machines in overseas conditions Mr Ashfield said that his company exported to 100 different countries. It was not possible to test new products in all these conditions, so that machines were sent to selected countries, initially, for testing. Production machines were then released gradually to other countries, so that a certain amount of testing was done in fact on production machines.

Mr W. T. A. RUNDLE said that overseas testing was a necessity, and the problem was to decide how much a company could afford to do. Obviously it was not feasible to send out several hundred pre-production models of large machines like tractors, but this could be done sometimes with smaller types of equipment.

In one case, Mr Rundle's company had sent out 200—300 prototype sprinklers to various countries, and a problem had arisen with locally manufactured standpipes, which did not match exactly with the British-made bases. It was not until these components were put into operation that the mis-match was discovered.

The difficult question was how much the company could afford to spend on overseas testing. Mr Rundle believed that most companies including his own, did not allocate a sufficient sum for this purpose in the development budget for new products.

Mr V. AUSTIN (National College of Agricultural Engineering) said that many overseas markets were developing countries with both foreign exchange and unemployment problems, and were anxious to consider local manufacture or part-manufacture of products at present imported. He thought that manufacturers might consider at the design stage the possibility of part-manufacture overseas, which would include questions such as making two small pressings rather than one large and complex pressing, and using fabricated parts rather than drop forgings. Such considerations could become important factors in influencing an importing country in choosing between competing products.

Mr H. E. ASHFIELD said that local manufacture was a continual problem for British companies, although

worldwide companies with manufacturing plants in several countries were in a less difficult position.

Developing countries usually began such a programme by importing complete machines, such as tractors. Then the next year they would make their own tyres or batteries, and continue with the local content increasing, until after five or seven years the whole machine was locally made. In return, the British manufacturer would be given certain facilities and guarantees as a sole supplier.

Difficulties might well be experienced due to the interactions of parallel and series development, with agreements negotiated with other suppliers. For example, his company had agreed to supply tractors for assembly in India, with some parts to be manufactured locally. They then discovered that an agreement had been made with Perkins to supply the engines, and Perkins discovered that they had to fit Bosch injection equipment instead of C.A.V. These changes led to great manufacturing complications and expense. However, sooner or later such countries would be wanting to engage in manufacture, and the British supplier would then have to decide either to comply with their requirement or withdraw from that market.

Mr W. T. A. RUNDLE said that his Company's products were easier to deal with than complex units such as tractors, and at the design stage alternative techniques of manufacture were considered, with the production facilities likely to be available overseas in view. The danger in this was that one could finish up with a manufacturing process that was too long or expensive for manufacture either overseas or in the U.K.

Mr J. H. W. WILDER said that Mr Austin's suggestion about design for local manufacture overseas was not new. In fact, his own relatively small company had exactly such arrangements in respect of certain products. However, he was convinced that the correct approach was to design for the best and cheapest method of production in his own factory, and to ensure that the cost of adaptation was carried by the adapted products sold overseas, without being spread over home sales as well.

Mr J. V. FOX said that Mr Austin's question has implied that in principle it was desirable to arrange for local manufacture overseas wherever possible. Undoubtedly this was the case for the overseas countries concerned, but it was not so for the British manufacturer. The returns from local manufacture were only in terms of royalties, which could not cover overhead costs. Also problems arose over patent rights in many developing countries, where such protection of registered designs might well not be available. Part-manufacture overseas was something that could be done if necessary but his company much preferred to sell complete machines.

Captain E. N. GRIFFITH (formerly of Howard Rotavator Co. Ltd.) said that he disagreed with Mr Fox. In his experience, factories employing up to 500 people were free from labour troubles, and local manufacture overseas had increased the demand for British-made products. It was important to have one's own sales organisation overseas, as well as local factories, so that control of the whole operation was in the hands of the parent company.

In this connection, Captain Griffith emphasised that the agricultural engineering industry should regard itself as international and that its whole effect for the next few years should be concentrated on the European farm machinery market of £600 m. a year compared £38 m. in Britain.

Mr J. V. FOX replied that he endorsed this view completely provided that the British company set up its own manufacturing facility in the overseas country. This was entirely different from exporting designs or part-finished machines to independent overseas companies, or relying on people who were not one's own employees to sell one's products.

Dr J. G. M. WOOD (Consultant) said that reference had been made to changes in the sources of ideas for new products, to the effect that farmers could not in future be expected to remain the primary source. It was important to try to identify the quality that such farmers possessed which enabled them to innovate. In many cases this was because they were engineers as well as farmers. "Farmer-inventors" were not rustics crawling out of some back shed, but creative people first and farmers second.

The farmer's real value lay in his ability to identify problems, and it was the engineering industry's task to do the creative work needed to solve those problems. In conditions of rapidly-developing technology, the farmers' ability to solve the problem as well as identifying it must decrease, and the trend in development lay much more in handling, livestock feeding and farmyard equipment rather than in tractors. It was much more difficult to consider a whole system of buildings and the operations associated with them than to devleop a single machine.

Mr J. H. W. WILDER said that development of new techniques, like everything else, required more and more resources as problems became more complex. He did not agree that the most valuable ideas had derived from farmers who were also engineers. They were basically men who knew what they wanted to do and set about finding ways to do it.

An example at the present time was to be found in bale handling. Various methods of handling were available, none of which overcame all the problems, and the stage was set for a major revolution. Mr Wilder did not think this would develop from a farm background, but that it would need considerable resources and a wider range of expertise than would normally be found on farms.

Mr W. T. A. RUNDLE said that Dr Wood's point was a very interesting one. His Company, which was relatively small, was moving towards the establishment of a well-staffed research and development team. But a large proportion of the new ideas on which they were working still came from farmers. Farmers were the people who actually used equipment and tries to make farming pay, and the manufacturing industry was really secondary to them.

In the irrigation equipment field, all manufacturers were likely to produce more complex equipment, using new techniques and materials. Hydraulics, electronics, plastics and other materials would be used which were no longer within the scope of a basic engineering workshop with machine tools and welding and cutting equipment. The future of the industry would depend on its ability to develop projects by this rather different and more expensive method, in circumstances in which profit margins were decreasing.

Mr P. HEBBLETHWAITE (Massey-Ferguson Ltd.) said would like to congratulate the Institution's Papers Committee on the choice of subject for the conference, which he believed was extremely timely. Mr Wilder was much too modest when he described his remarks as relevant to a small company. Mr Wilder's logic and much of Mr Fox's was entirely relevant, independent of the scale of the company.

The subject of the conference was also relevant because of the gap which existed between the inventor and the manufacturer. This gap existed not only between manufacturers and private inventors, or those in Government research organisations, but also some of those in the manufacturer's own engineering team. The problem was to tell the inventor why, in some cases at

least, management did not always welcome the inventor's ideas. The Institution had made a contribution towards closing the gap through inviting the day's papers, which showed something of the problems of management. Perhaps another conference could be held of the problems confronting the inventor and initiator.

Very often management had to say "no" to what appeared to be good ideas. A senior executive of General Motors once said that if he said "no" to all new ideas he would be right in 98% of the cases, but because he missed the other 2% his company would slowly go out of business. It had also been said that new product development was like marriage to a film star—very easy to say "yes" to, very difficult to live with and very, very expensive to get out of.

Mr T. C. D. MANBY (National Institute of Agricultural Engineering) said that Mr Rundle's paper had drawn attention to the place of research on a national basis, and Dr Wood had emphasised the very high cost of technological development. Mr Manby had recently become concerned with the selection of projects for research at a national level, and the way in which public money should be spent on such work.

As he saw it, one of the main functions was the provision of basic data in these areas of high levels of technology and development cost, for use by manufacturers' development departments. One such investigational process was concerned with grass mowing and conditioning, for which the cost was very high indeed. The logical starting point was to take 18 or 20 mowing and conditioning systems and to evaluate them thoroughly in a wide range of conditions. Drying rates, losses of bulk and of protein and other factors had to be considered. After two years' work it was possible to see the natural and logical path for future development work to take.

From this stage the initiative and inspiration referred to by Mr Wilder had an increasing part to play, because there were still many alternatives to choose from. In the case he had quoted there appeared to be two or three such possibilities. The task for national research was to pick out these alternatives and provide information as a basis for commercial companies to assess the merits of the alternatives.

Mr MANBY went on to say that in his experience the projects which had been most successful were those in which one or more farmers were virtually prepared to put down their money if someone would make a prototype machine. This was particularly true of small, specialised markets, rather than in the tractor field. He believed that farmers had a very important part to play in the selection of projects for development. He asked if it was desirable to establish a formalised pattern of thought which utilised the farmer's contribution, in making decisions on projects to pursue.

Mr W. T. A. RUNDLE said that he agreed with Mr Manby in many respects, except that the pattern should not become too formalised. In practice, different groups of farmers were needed for different developments and even at different stages of the same development, and it was essential to remain flexible. However, he had no doubt that development thinking must include a contribution from the farmer-user. Another reason for avoiding formalisation was that the decision process could take too long, so that one could miss that particular market.

Mr J. H. W. WILDER said that it was also possible to perform a valuable service by building special machines for farmers who wanted them and were prepared to pay for them, even if only one or two machines were actually built. An example of such a special machine, which his company had constructed to special order, was a harvester for Christmas trees.

Mr H. E. ASHFIELD said that he was anxious to maintain a constant flow of information from farmers and relied for this partly on the dealers and distributors, who were in closer touch with farmers both at home and overseas than the main company. In one case, close attention to customers' requirements had led to a one-off order for a machine to wind cable round reinforced concrete tanks, which involved a tractor being driven round a vertical wall, with the rear axle turned through ninety degrees. This was constructed at a relatively slack period and no problem arose until some 15 years later. Then a repeat order came in and nobody at the factory could understand why someone should want a tractor to work round a vertical surface.

Mr B. P. POTHECARY (Consultant) said that he was more concerned with equipment than tractors, and would like to ask two questions. The first was to ask if there was still room for Britain as a base for the design, development and production of equipment for less developed countries. The second was the desirability of a change in the role of research institutes and universities in the design and development of equipment, possibly associated with a move towards sponsored research.

An earlier speaker had said that the industry should be adapting itself to meeting the requirements of the European Common Market. Mr Pothecary thought the Common Market and other countries with a temperate agriculture posed considerable problems, compared with developing countries. Their agricultural equipment markets were subject to saturation and were extremely competitive, and their manufacturers had made significant inroads into the market in this country, which might well become greater if tariff barriers were lowered.

In less developed countries, on the other hand, Britain had unrivalled contacts, mainly through the activities and penetration of the tractor manufacturers. Secondly, Britain was in an unrivalled position as an exporter of tractors. Thirdly, Britain was the acknowledged leader in the development of agriculture in countries of this type. He felt there was a strong case for maintaining efforts in this market as well as in the Common Market countries.

With regard to research, he was well aware that the British agricultural engineering industry was composed mainly of medium and small-size companies, whose difficulties in developing equipment had been referred to in the day's proceedings. He asked if there was not scope for more sponsored research at research institutes, etc.

Mr J. V, FOX said he was quite sure there was and would continue to be a task for firms in Britain to design and manufacture equipment for developing countries. There were, however, many problems — of which testing and finance were two — especially for smaller companies. A further problem arose in the developing countries themselves, where there was very little money available for the purchase of equipment to be used by the ordinary farmer, so that the economic attractions of such development were rather sparse. There was undoubtedly a role for colleges and universities in carrying out research on requirements in overseas countries, but there was a wide gap between the man who could identify the need and the man who had to translate this into an economic, viable production item.

Conversely, although the market in Britain and Western Europe was well supplied and perhaps theoretically saturated, it still offered enormous opportunities for the right equipment. Mr Fox said that he felt there was no reason to be at all concerned about the effect of joining the Common Market and that British firms could design

and manufacture farm machinery and equipment at least as well as their European counterparts. There would be a tremendous and growing market in Europe, expanding further as European prosperity increased.
From the purely commercial point of view it would pay in the short to medium term to concentrate on the European market, while at the same time endeavouring to provide equipment suited to the needs of developing countries. But it was unlikely that any relatively small equipment manufacturer could survive by catering for developing countries only.

Mr W. T. A. RUNDLE said that he believed we should assist developing countries to make simple items of equipment, but that it would be essential during the next few years for more complex machines to be made in industrialised countries.
Sociological and ecological factors were of great importance, and the basic problem was that the whole economic structure of developing countries was not improving quickly enough to allow a high rate of technical development and the development of manufacturing facilities. Aid from western countries was simply of short-term benefit, and what was essential was to increase the ability of the people in under-developed countries to develop their own economies, to produce more and to find an outlet for the product.

Mr J. H. W. WILDER said that there might well be no very great problems with competition from the U.S.A. or European countries, but he felt certain that in the far eastern market Japan was becoming completely dominant. If Britain was to retain a foothold in this very large market, price competition with the Japanese would be a most important factor. On the question of national research and sponsored research, Mr Wilder thought it would be very valuable if a Churchill fellowship, or some such award, could be made available for someone to spend a year in the U.S.A. studying the system there.

Mr P. G. FINN-KELCEY (consultant) said that he had been interested in the remarks made by the speakers on the pricing of new products. Farmers were now becoming accustomed to appraising the value of investments in farm machinery in terms of discounted cash flow, leading to a figure for the gross return on the money invested. This might be perhaps up to 24%. In the absence of any other technique for fixing prices, he suggested that the discounted cash flow technique, used in reverse, might provide guidance. Such calculations could take into account savings accruing to the farmer through increased productivity, etc.

Mr W. T. A. RUNDLE said that price figures were always difficult to arrive at, and it was always necessary to consider the prices of competitive products, unless one had an entirely new product for which there was no competition. Discounted cash flow predictions were all very well up to a point, but it was not always possible to ensure that predicted economies would work out. His firm has once sold £50,000-worth of irrigation equipment on the basis that it was a labour-saving system, since one man could handle the aluminium tubes in each unit. This was physically possible, but on the second night of operation two men, each working alone on his unit, were attacked by lions. It proved to be essential to retain the second man on each unit, simply to watch for lions. From the manufacturer's point of view the selling price had to cover costs, overheads and a reasonable profit, and it was difficult to be more scientific about fixing selling prices than this.

Mr RICHARD EVANS (Opico Ltd.) asked what were the most important aspects to consider when establishing a product in an overseas market.

Mr H. E. ASHFIELD said the most important factor was a good line of distributors, backed by adequate dealers.

Mr J. H. W. WILDER referred to an excellent symposium on the subject run by the Agricultural Engineers Association. From this the advice was: pick one market in which the product in question will sell, then go there personally and establish effective communications with the people on the ground who will sell the product.

Mr J. V. FOX agreed that personal contact was vital, and that it was essential to keep in close touch with the distributors and dealers responsible for selling the product.

Mr G. E. E. TAPP (County Commercial Cars Ltd) asked for views on the importance of styling in the design of a product.

Mr H. E. ASHFIELD replied that styling was a comprehensive subject. With a tractor, styling was subordinate to function, but apart from that his company regarded styling as important because a well-styled product caught the eye of the customer. However, good styling was useless with a good product.
The importance of styling varied with the type of product. A Wedgewood vase was 99·9% styling, while a sewer buried underground required a negligible styling content in its design, because nobody saw it.

Mr J. V. FOX reminded the conference that the subject under discussion was the selection of new products and not the design of them, but then went on to say that his company attached great importance to styling. A product with a good appearance—provided it was adequate in specification and performance—would always sell better than one with less eye appeal.
The conference then closed, after an exchange of views between **Captain E. N. GRIFFITH** and **Mr H. E. ASHFIELD** on the subject of longbows. Mr Ashfield had referred in his paper to the crossbow and the longbow, and Captain Griffith felt that the silence of these weapons was a most desirable feature. He put it forward that the battle of Waterloo could have been won with only eight British casualties, had some of the musketry regiments been replaced by longbowmen, preferably Welsh. Unfortunately, we had become preoccupied with devices which made a noise, culminating in nuclear weapons.

Mr ASHFIELD replied that his company was making a contribution by doing its best to eliminate the smoke and bangs which emanated from diesel engines. Unfortunately, he pointed out, to fire a longbow it was necessary for the operator to stand up, which presented an excellent target to the man equipped with the noisy and smoky musket.

THE CHAIRMAN (Mr T. Sherwen) then expressed to the speakers the very great appreciation of all present not only for their excellent papers, but also for baring their souls—at least in a commercial sense. His remarks were accompanied by a fusillade of applause from an appreciative audience, notwithstanding Captain Griffith's commendation of the virtues of silence.

admissions and transfers

At a meeting of the Council of the Institution on 22 July 1971 the following candidates were admitted to the Institution or transferred from one grade to another, as stated below.

ADMISSIONS

Member

Baird, J. H.	*Essex*
Frampton, F. R.	*Sussex*
Jenkins, G. W.	*W Germany*
Pyke, W. J.	*London*
Tapp, D. R. F.	*Surrey*
Twum, A.	*Ghana*
Woodliffe, P. W.	*Bucks*

General Associate

Baxter, P. W.	*Kent*
Beck, J. G.	*Berks*
Cooper, A. D.	*Warwicks*
Engelse, R. A. den	*Norfolk*
Evans, K.	*Essex*
Fairbrother, E.	*Warwicks*
Forrester, E. A.	*Salop*
Harris, C. A.	*Kent*
Kularatne, P. K. D. H.	*Ceylon*
Lacey, R. D. J.	*Glos*
Law, B. W. H.	*Devon*
Lewis, B. A.	*Hants*
Makin, R.	*Co Durham*
Marwaha, R. S.	*London*
Potter, B. R.	*Kenya*
Read, R. J.	*Warwicks*
Sansom, A. V.	*Essex*
Valente, P. E.	*Italy*
Williams, W. F.	*Hants*
Wylie, G. M.	*Ghana*

Technician Associate

Arnold, C. H.	*Yorks*
Banks, I. D.	*Warwicks*
Brazil, M.	*Eire*
Corbett, R. L.	*Hants*
Fryer, J. T.	*Bucks*
Lock, W. T. R.	*Lincs*
Morgan, W. T.	*Warwicks*
Pitkin, F. J.	*Bucks*
Rimes, P. H.	*Staffs*
Roberts, E. E.	*Warwicks*
Smith, A. J.	*Lincs*
Stansfield, C. B.	*Lincs*
Tring, I. M.	*Lincs*
Verity, J. H.	*Warwicks*

Graduate

Boyce, B. H.	*Wilts*
Delgoda, R. S.	*London*
Kumar, G.	*Beds*
Muir, B.	*Som*
Ofori, R. T.	*Ghana*
Rogers, J. A.	*Hunts*

Student

Ellis, N. E.	*Berks*
Matthews, M. D. P.	*Devon*
Ollier, L. B.	*Ches*

TRANSFERS

Member

Blake, T. J.	*Oxon*
Butterworth, W. R.	*Essex*
Chadborn, A. G.	*Zambia*
Coye, P.	*Eire*
Kane, D. F.	*Hants*
Kathirkamathamby, S.	*Ceylon*
Maddison, D.	*Salop*
Mundy, M. J.	*Sussex*
Roberts, P. D.	*Essex*
Skinns, D. A.	*Lincs*

Technician Associate

Day, M. J.	*Beds*

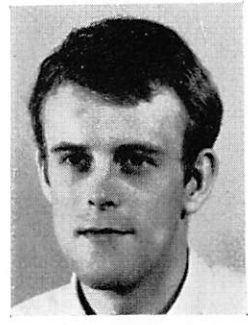
Affiliated Organization

Farm Buildings Association

SCHOLARSHIP AWARDS IN AGRICULTURAL ENGINEERING

The following awards have been made in the gifts of the Institution to the following full-time students of agricultural engineering during the academic year 1971–72.

THE DUNLOP SCHOLARSHIP



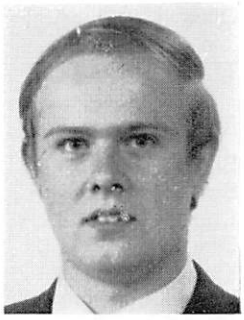
B. G. Sims

A Dunlop Scholarship was awarded to **Brian G. SIMS** (28) who from 1968 until August of this year was running the farm machinery department at Jimma Institute of Agriculture, Jimma, Ethiopia. After graduating from Reading University in 1967 he felt that his knowledge would be best applied in developing countries and with this in mind he went to the University of the West Indies in Trinidad to study tropical agriculture. From here he was sent to Ethiopia—to assist in Britain's programme of technical assistance

to Africa—where he ran a farm institute workshop and taught Ethiopian students the rudiments of mechanised agriculture. He returned to England in August to take a Master of Science degree in tropical agricultural mechanisation at Reading University.

SHELL-MEX AND BP BURSARIES

Left: G. Hardie



Right: J. S. Cooke

John S. COOKE (21) of Kirton, Boston, Lincs., who was apprenticed to D. T. Gratton & Sons Ltd, Boston, Lincs., has 'tinkered' with engines all his life, working his way up from model engines to full size car and tractor. He is enthusiastic about mechanical horticulture and took his City and Guilds 260 course at Boston College, and his 261 at Rycotewood, obtaining credits in both. He also obtained the Best Student of the Year award at Rycotewood. He is now studying for the National Diploma in Agricultural Engineering at the Essex Institute of Agriculture.

Gordon HARDIE (22) comes from a farming environment, his parents and grandparents having been farmers in Galashiels, Selkirk. He left Galashiels Academy at 16 years of age and started work as an apprentice agricultural engineer with West Cumberland Farmers at St Boswells. During his apprenticeship he attended Galashiels College of Further Education and gained a higher grade in engineering drawing. At Napier Technical College, Edinburgh, he gained the Ordinary National Certificate (Mech.) and has now started his National Diploma in Agricultural Engineering course at the West of Scotland Agricultural College.

G. Hemmings

Geoffrey HEMMINGS (21) of Downend, Bristol, attended a technical high school up to the age of 16, when he went to work on a farm for one year before studying for the National Certificate in Agriculture at Lackham School of Agriculture, Wiltshire, and followed this with studies for the City and Guilds 260 and 261 courses, and interspersed the two courses working part of the time as a fitter for a John Deere agent. He is now studying for his National Diploma in Agricultural Engineering at the West of Scotland Agricultural College.

Institution Activities

The following Institution officers will gladly keep you informed of sessional activities in their areas.

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6. INTERNATIONAL TECHNICAL AGRICULTURAL MACHINERY FAIR

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The 4th
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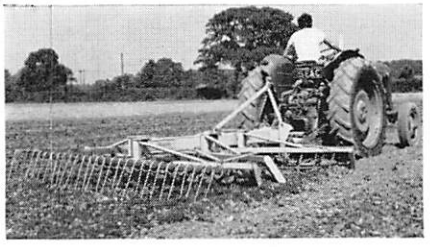

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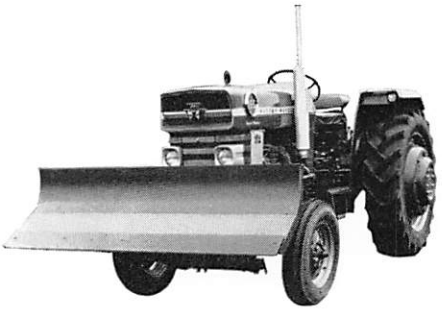

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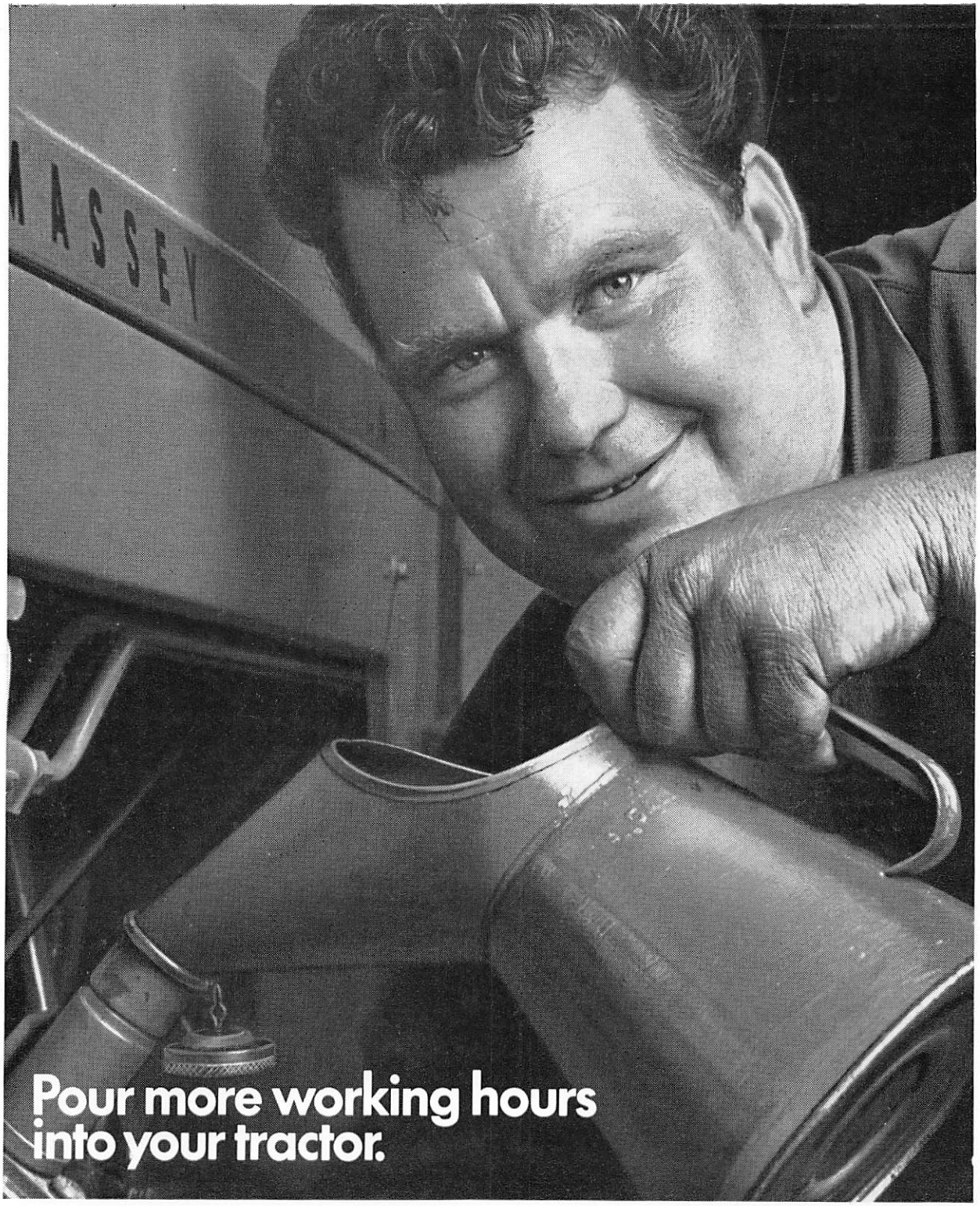

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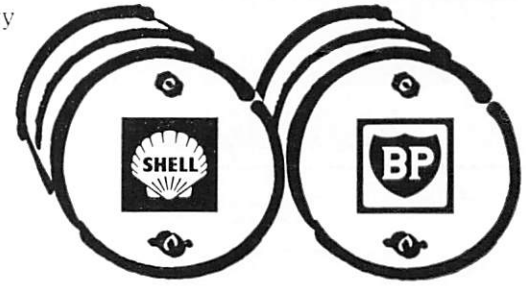

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