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MANAGEMENT OF RESEARCH AND DEVELOPMENT IN A GERMAN PAPER COMPANY

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Abstract

The necessities and possibilities of companies to do research work essentially depend on the supply of raw material, on the market facts, on product grades and production structure, and on the financial means available.

The implementation of research and development activities of Feldmuhle Aktiengesellschaft with its 8 paper and board mills in Germany, with a capacity of 1.2 million tons, is discussed.

The paper refers to various aspects of the research organisation, including personnel and the scope of the different functions and their co-ordination within the enterprise. It emphasises the long-term planning of research and development projects, and describes how the costs involved are allocated to the various divisions of the company. Finally, some examples of successful research work are given.

Conditions governing R & D activities

At the start of this review no attempt has been made to define R & D as we understand it in our company: firstly because this will be seen from what follows; and secondly because it is more important to define the conditions which determine R & D activities.

These conditions are rooted more or less in the company itself, and are in the following pages explained more specifically under `internal factors´. They comprise mainly the

structure of the company, market and distribution circumstances, the production capacity, and financial means available. These internal factors are embedded in the company's predetermined external criteria. These in turn cover: the geographical situation in relation to raw material sources; the company's position in relation to economic policy to which, among other things, must be associated the importance of the pulp and paper industry towards other industries of the country; the socio-political status which so closely and decisively affects the whole environmental complex with its imposed requirements and regulations.

Both internal and external factors determine the company's R & D activities. Within Feldmuhle we understand the following:

1. Internal factors:

In the Federal Republic our company operates 8 paper and board mills, and it fully owns a paper mill in the Netherlands. Within Europe, Feldmuhle has further interests in Belgium, France and Sweden; these have, however, no major effect on German R & D activities. In Germany and in the Netherlands the turnover in 1980 was DM 2.04 milliard, of which 84% was obtained from paper and board sales: the remainder came from technical products such as moulded rubber parts, oxide ceramics, laminated foils and grinding disks.

This review is confined to R & D work associated with the paper and board sector. At Feldmuhle the installed production capacity is 1.2 million tons per year. This consists of printing paper in reels and sheets, which accounts for 63%; office paper, 6%; folding boxboard, 21%; and hygienic paper, 10%.

The proportion of paper and board sent for converting is high, 66%.

2. External factors:

External factors include the raw material situation. In the chemical pulp sector we are practically not integrated, only a minor pulp mill with a capacity of 30,000 tons per year is integrated in a board mill. The remaining 400,000 tons of pulp

required have to be bought from abroad. Fibre integration exists only in the mechanical pulp sector. About 250,000 tons per year of mechanical pulp are produced in our own groundwood mills and are immediately processed. Germany is self-sufficient in wood, but none of the paper producers owns forests. Much of the pigments and fillers for the high output of coated paper and board has to be imported.

The factors of this group also take into consideration economic policy aspects. The pulp and paper industry ranks number 24 in German industry, classified in 35 trade groups, and graded by turnover. This fact must be seen realistically to avoid being misled into false conclusions about state subsidies, e.g. for the promotion of research work or the allocation of government funds to companies to comply with environmental regulations. Speaking of the environmental situation, Germany has very strict regulations for effluents, according to the latest Federal Water Pollution Control Act which came into effect at the beginning of 1981.

In 1977, R & D expenditure of the entire German industry was DM 16.7 milliard, 83.1% of which had to be provided from company funds. In the wood, paper and printing industry, however, 97.1% out of DM 28.1 million were company financed, thus showing a considerably lower level of state subsidy.

R & D Tasks

General

As said before, internal and external factors govern R & D activities and largely determine the executive functions. Within our company, R & D tasks are widely predetermined by our company's strategy. This strategy means to secure the company's profitability by concentrating products on larger paper machines and, at the same time, by improving the various paper and board grades. As a result of this strategy some 70% of our total graphic paper production is coated today. Furthermore, Feldmuhle

no longer produces newsprint in Germany and the market share held by us is maintained through imports from foreign subsidiaries.

Therefore, one of R & D's principal tasks is to improve paper and board grades by applying the various coating and finishing technologies. This is illustrated by the recent start-up of a 7.20 m wide off-machine coater with 4 blades at our Kabel mill. A consequent follow-up of this strategy is R & D's task to find more profitable paper products, especially for the remaining small paper machines. To this effect we decided some time ago to start the manufacture of chemically-reacting copying paper. This in turn led to co-operation with a leading German chemicals company in the development of an encapsulating process, which we use.

Due to external factors, R & D concentrates on better fibre exploitation, that means on the improvement of mechanical pulp quality and on creating further possibilities for the use of waste paper, such as our development of a de-inking process together with a French partner.

A critical question we have often considered is whether we should have our own R & D, whether we should take advantage of research work conducted under contract, or whether the tasks can be performed in co-operation with institutes or with various partners.

Research work under contract was thoroughly investigated by us. It proved that the results bear no relationship to the costs involved, since outsiders lack the experience of a company-owned R & D department and must always start at zero in solving new problems. Unlike other European countries we have no major institutes financed by the paper industry, apart from the Papiertechnische Stiftung in Munich.

The situation explained here led to our decision to have a company-owned R & D department.

Origination of R & D projects

Following these general observations, I shall now consider the definition of various R & D projects, which originate from:

1) The company's five year plan. As referred to before, this governs the business strategy.

2) Daily business. Regular meetings between R & D and the sales and production personnel responsible for the various divisions often result in defining R & D tasks to help improve products or production processes.

3) R & D's own contributions. This includes projects which result from R&D's own creativity or from pre-defined research projects.

4) External sources. Projects often result from the study of literature, from customers' suggestions, from attendance at paper and pulp conferences, from visits to scientific institutes, or through co-operation with other partners.

All projects are laid out in a 3-year R & D plan, which assigns task priorities, time schedules for performance and control, and budgeting. This 3-year plan is revised annually.

R & D organisation

1. Personnel

The organisation chart in Figure 1 shows the present organisation of R & D. The little squares show the activities of the various R & D groups. There is a total of 53 persons employed with R & D, of whom 10 are science and engineering graduates, with doctoral degrees.

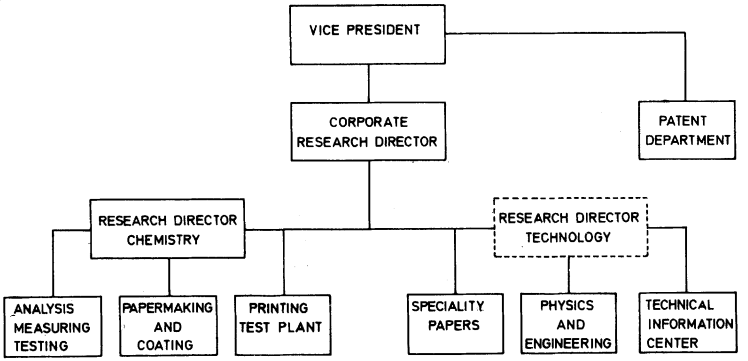

Fig 1—Organization of Feldmühle R & D.

2. Allocation of R & D work according to sectors of activity.

Figure 2 shows the activities of the above groups for the various sectors. The work of these groups is, in principle, broken down into research projects with tasks leading to new products and new results, and into developments by which we understand the improvement of already existing products and processes.

3. Allocation of R & D work within the Feldmuhle organisation.

Figure 3 shows the allocation of R & D work to the various divisions of the company, i.e. for paper, board and hygienic paper products.

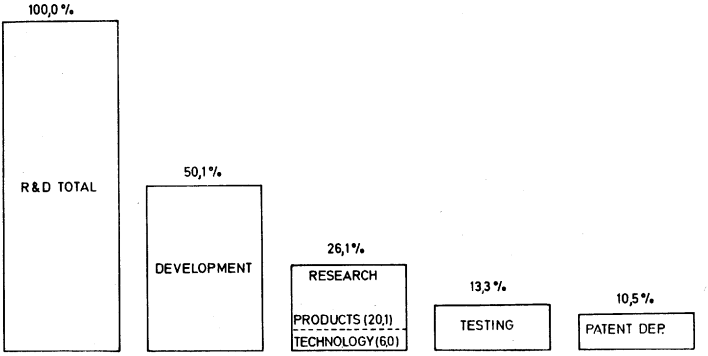

Fig 2—Actual costs of R & D in 1980 (allocated to activities).

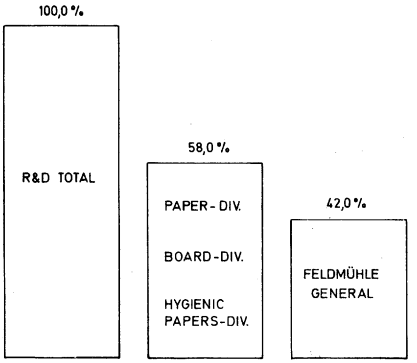

Fig 3—Actual costs of R & D in 1980 (allocated to divisions).

Co-ordination of R & D within the company

Reporting procedure

By means of a reporting system, comprising all company levels, R & D is firmly linked to the overall activities of the enterprise. Every six months, R & D activities are reported to the Board. A results and success review at the beginning of the year, is followed in July by a discussion of activities and budget planning for the forthcoming year.

A detailed written report on R & D current projects is given monthly to the Board, to the divisions, and to the mills.

Twice-yearly meetings are held between R & D and production and sales personnel responsible for their respective divisions; these meetings decide new R & D projects.

The company periodically conducts meetings of special working groups under R & D management, to discuss problems affecting furnish, coating formulations, and testing and control methods.

Each completed R & D project is followed by comprehensive reporting. For some years now we have operated a technical information centre to collect all internal progress reports on production, technology and R & D. Everyone interested in one or the other subjects provided by this information centre, which distributes a monthly list classified according to subject, author(s), and origin, can obtain a copy of such reports. We are in the process of installing a computer system which will not only facilitate storage of our own information but will give us access also to non-European data bases.

Transfer of R & D results to production

As indicated before, all our mills are informed on current R & D projects and their progress by means of reports and meetings. In joint meetings together with sales, production and R & D the mills can, in addition, influence R & D directions to utilise the technical facilities of the mills in the best way possible.

In most cases the results of R & D projects are transferred step by step to full-scale production with the aid of test and pilot plants or smaller production units. Such transfer methods can be abandoned if a project includes the start-up of a new plant. All mill units to which R & D projects are transferred remain the responsibility of mill managements.

All R & D employees engaged in a project remain in the respective mill until the R & D results have been achieved.

Total R and D costs

Corporate R and D department costs

All R & D activities for our paper and board divisions are centralised in an independent corporate R & D department. The following R & D costs cover only this division.

R & D costs are broken down into two large blocks: personnel and material costs. As in all other research institutions of the paper industry, personnel costs dominate, with about 70% of the total. The number of employees and the salary structure make up most of R & D expenditure.

The corporate department consists of 53 employees, of whom about 50% are scientists, engineers and technicians, including 10 graduates with doctorate degrees. This group accounts for a disproportionately high salary bill, some 66% of the total.

Material costs, which constitute about 30% of total R & D costs, are further considered here. They reflect production and administration costs, and overheads. This illustrates R & D's position as an independent and autonomous institution within the company.

The largest component in this category is materials, including supplies and fuels, accounting for 40%. Depreciation and repair make up a further 30%. This indicates the scope of investment and maintenance within R & D.

Personnel and material costs constitute the total costs of R & D activities. They represent 0.3% of the net turnover of Feldmuhle's paper and board sector, and are tending to increase.

These total expenses must be seen on the basis of the internal and external factors referred to before. We support this expenditure and consider it necessary in the long run. It is known that we hold a special position within the German paper industry in this respect.

Costs per workplace are DM 90,000 per year. On the average this means that some DM 63,000 are spent per year per person in terms of salaries and wages in R & D.

Costs incurred for R & D work in the mills

It was described above how work similar to that performed by R & D is also done at the mills, especially when R & D results have to be transferred to a production scale. Investigations, lab tests and full scale production tests cause considerable costs during transition periods. The costs incurred in the mills are in addition to the R & D budget, and are thus charged to the relevant mill. Expenditures, however, incurred by delegation of R & D personnel to the mills (personnel and travel expenses) are borne by R & D.

3-year planning and budgeting of R & D

It has been described how R & D planning is done for 3 successive years. This planning comprises the assessing and evaluation of the qualitative aspects (contents framework) and of the quantitative aspects (volume and value framework).

1. Contents framework

All activity planning is started with a selection of objectives either necessary or suitable for R & D, according to established criteria. Before initiating R & D activities, the

various steps of the intended work are described in detail, including the main objective, subordinate objectives, and technical as well as economic facts.

The detailed description of the intended activity shows the relationship of the activity to Feldmuhle's product market and to its respective mills. Thus the survey tells whether the activity covers a new product for a new market, or an already existing product which is to be improved and/or produced more cheaply, or whether it is meant to solve problems of operation or sales.

2. Volume and value framework

The volume and value framework is produced by quantifying the `contents framework'.

The implementation of the activity is determined by the labour force and time available. The next step, therefore, is to assess the priorities, the time required by the employees (staff hours), and the duration (start/end) of a project.

The `volume framework' becomes an `economic framework' as soon as the assessment is expressed in terms of money. Such assessment is done on the basis of standard prices (staff and machine hour rates). This procedure enables relatively exact cost planning.

3. Budgeting

The R & D budget is assessed every autumn for the succeeding business year; it has to be applied for before being approved. Planning and distribution of the approved funds is in the responsibility of R & D. Since R & D results cannot be predicted as easily as production results, this detailed planning is continuously reviewed. It is handled flexibly by feedback of activities' results and by adequate input to the planning process. With the flexible planning methods the predetermined budget must by no means be exceeded.

Allocation of R & D costs to the company's divisions

The originator principle is the basis for the allocation of R & D costs to the company's divisions. The expression is self-explanatory, and needs no further comment.

We feel that distributing costs according to this principle is a good solution, since the division causing greatest R & D activities is charged with the highest costs. It may happen that divisions with unfavourable results or divisions undergoing expansion with high capital costs are charged with relatively high R & D costs, because under these conditions comprehensive R & D activity becomes necessary. Basic research and special activities which are in the common interest of the company, are separately shown as `general cost block' (FM general). This category includes also activities which are caused solely by R & D. In this connection reference is made to fig. 3.

R & D results control

R & D results are controlled in two ways. Cost controls are done monthly in the form of cost centre-, cost type-, and cost unit accordingly; results controls are done half-yearly.

It is well known that results of R & D activities are far more difficult to assess than those of other sectors of the company. The difficulties begin when allocating levels of success to R & D activities and worsen when quantifying or valuing such success.

To create a suitable control and valuation instrument, we first have to determine all R & D contributions to the operating results of the various business sectors. Bearing in mind that R & D activities will chiefly affect the production and selling side, we differentiate between the following results which can be influenced by R & D activities:

a) on the selling side: maintaining and expanding sales;

b) on the production side: maintaining an economically endangered production sector by technological improvements, production increases and reduction of production costs.

As relevant profit evaluation parameters we use, on the selling side, the profit contribution based on prevented sales decline, and the profit contribution based on sales increase.

On the production side are entered accordingly: the profit contribution based on prevented production loss or on realised production increase, as well as the actual savings realised by means of self-sufficient production of raw materials or of advantageous raw material substitution.

In order to create R & D specific success value numbers (SVNs) we have to find the ratio between the above values and the required R & D expenditure. The system of computation applied is shown in figure 4.

We appreciate that the profit figures in sales and production used in ascertaining our SVNs were not achieved solely through R & D activities. Further elaboration on this is necessary, and we are working on it. On the other hand, the present handling of our control system shows that it is possible to evaluate R & D success and to set priorities. The importance of personal motivation in achieving high SVNs should not be underrated.

Some examples:

Example 1 measures: substitution of raw materials
results (P.C.): savings through company-own production = DM 3 million
R & D expenditure: DM 347,000
SVN 9

Example 2 measures: production increase by improved production methods
results (P.C.): production increase = DM 2.15 million
R & D expenditure: DM 87,000
SVN 25

R&D RESULTS CONTROL INSTRUMENT

(profit contribution (P. C.)= net sales less direct costs)

Sectors	Profit Groups	Profit Evaluation Parameters	SVN
sales	maintaining sales	PC of prevented sales decline	PC sales decline in DM / R&D expenditure in DM
sales	expanding sales	PC of sales growth	PC sales growth in DM / R&D expenditure in DM
production	maintaining production	PC of prevented production loss	PC production loss / R&D expenditure in DM
production	increasing production	PC of production increase	PC production increase in DM / R&D expenditure
production	low cost production	savings through company-own manufacture of raw materials	savings through company-own manufacture of raw materials / R&D expenditure
production	low cost production	savings through substitution of raw materials	savings through substitution of raw materials / R&D expenditure in DM

Fig 4—Direct results control instrument (profit contribution (P.C.) = net sales less direct costs)

Example 3 measures: reduction of excessive breaks in the paper machine
results (P.C.): value of prevented production loss
= DM 1.75 million
R&D expenditure: DM 63,000
SVN 28

Example 4 measures: expanded sales through improved quality
results (P.C.): expanded sales
= DM 9 million
R&D expenditure: DM 59,000
SVN 153

Example 5 measures: elimination of production breakdowns
results (P.C.): prevented production loss
= DM 100,000
R&D expenditure: DM 125,000
SVN 0.8

These examples indicate that the SVNs reflect the success of R & D activities. Even if we cannot at present give comprehensive analyses of the parameters which influence SVNs, they still represent valuable data for the success of an R & D project, and for setting priorities of R & D activities.

Discussion

Discussion following prepared discussion contribution from Dr. J. Mardon.

Mr. D. Attwood, PIRA, UK

Dr. Asaoka, in your preprint you discuss Japanese government subsidies to your institute. Can you tell us please a little more about this, in particular, what ratio of funding you expect from industry and from government?

Dr. H. Asaoka, JPRI, Japan

The Japanese government gives no subsidy to any industry. If the government wants work done in a particular field, it discusses this with the appropriate companies, who put up the necessary money. Thus, in general, the government doesn't subsidise any industry.

Mr. A. Ibrahim, AccuRay Corporation, USA.

Mr. Justus, references to the concept of the extended nip press can be found as long ago as 1967-68, where Wahlström and others showed that the applied pressure and its duration could be varied to achieve optimum pressing of a specific grade. This work was supported in publications of Beloit's own research. I see Beloit's development of the extended nip press as the first stage in the practical application of these results. Does your Corporation have any plans to go to a second stage, in which the applied pressure and the drainage flow are under operator control, and variable to suit the product?

Mr. E. Justus, Beloit Corporation, USA.

The extended nip press is a project on which Beloit have been working for over ten years. On a three dimensional plot, showing sheet moisture as a function of both nip residence time and nip pressure, the area of practical interest can be enlarged with the extended nip press to include nip residence times of up to 30 ms, at pressures up to about 600 psi, leading to increases in sheet dryness of some 25% over conventional presses.

Physically, the heart of the extended nip press is a curved shoe fitting beneath the press roll. It is about ten inches long in the machine direction, and loaded hydraulically to about 600 psi, equivalent to about 6000 pli in a conventional nip. There is a belt adjacent to the shoe, and the two felts and the paper sheet run between the belt and the Venta-nip press roll.

Lubrication is by oil applied between the belt and the shoe, whose mechanics are the same as those of a crown-controlled roll. The first commercial unit was assembled and run in the shop, and has been running on a paper machine some nine months. A full report will be given on it at the Tappi meeting shortly.

It is imagined that an extended nip press could be used in a liner-board machine as second after a double felted first press. This combination should give drynesses into the dryer section of above 45% dry. The advantages of the extended nip press seem to include a reduction of about 25% in the amount of water to be evaporated, and an approximately 15% increase in sheet density.

Mr. S.F. Brailsford, Reed International Consultants Ltd., UK

Mr. Justus, you implied that it was best for machinery development to be left to the manufacturers. However, surely the interests of the paper and board machinery suppliers are diametrically opposed to those of the paper manufacturers? We, the paper producers, prefer to use the least quantities of chemicals and the cheapest machines possible, which must surely be against the interests of the chemical suppliers and machinery builders. Thus I put it to the panel that the paper manufacturers find it hard to believe that it is in their own best interests to leave all R & D to the suppliers.

Mr. E. Justus

I don't want to travel with an airline that designs its own aircraft and I don't believe that in the long run it would be economical for airlines to do so. Machine building is a specialised trade, and the builders are to be commended for eliminating expensive and difficult to maintain, but very profitable, items from machinery (e.g. suction rolls).

Machine speeds have doubled on almost every grade of paper over the past twenty five years, and the cost of machinery per unit of production has increased less in the paper industry than in almost any other.

Dr. A. Mawson, Wiggins Teape, UK

Many people in paper-making argue as Mr. Brailsford, but I believe that competition forces suppliers to continue improving the performance and productivity of machinery. While I believe that discontinuous innovation is most likely to arise outside the industry, I am sure that incremental technical improvements will always come from within.

Mr. B.W. Burgess, PAPRICAN, Canada

The position isn't at all clearly defined. No organisation has a monopoly of expertise, so I don't agree with Mr. Justus that all machinery development should be left to the manufacturer.

Dr. D.A.I. Goring, PAPRICAN, Canada

Mr. Justus, is your Corporation working on air-forming for high speed machines?

Mr. E. Justus

No, and there is a reason. It seems to us that what gives paper its particular characteristics, is the hydrogen bond. Dry-forming is for speciality products, while my Corporation is in the business of supplying machinery for making commodity grades. We intend leaving dry-forming to the speciality machine builders.

Dr. A.H. Nissan, Chairman

This issue doesn't need to be polarised, and while I would hate to suppress inventiveness amongst users, I think that I am in favour of most of this development being done by machinery builders. The cost of research by suppliers can, except for royalties, be distributed over a large number of units if it is successful, whereas this is not the case of research by users.

Mr. B.W. Attwood, Consultant, UK

Mr. Justus must realise from his own experience that machinery innovation can be a two way process. His corporation has made use of ideas developed by paper-makers and developed them to levels unattainable by their originators.

On the subject of air-forming, it is important to bear in mind that it is a speciality process, not for general application. I am concerned that, unless it is being done in secret, none of the major machinery manufacturers is investigating either this or any other of several new ideas, which may be the precursors of technology discontinuities. It looks very much to me as though the main research effort at this time is into evolutionary modification.

Dr. N.K. Bridge, PIRA, UK

A report on innovation and the factors influencing it has been prepared by the Science Policy Research Unit at the University of Sussex. One of the conclusions presented there was that innovation is often initiated by users, then further developed by the suppliers. This seems very natural, and I am sure that Mr. Justus recognises the approach.

Mr. F. El-Hosseiny, Weyerhaeuser, USA

I think that the development of machinery should be left to anyone who wants to do it, though I agree that the manufacturers are likely to make a better and cheaper job of it. But paper-makers have to be careful not be inveigled into buying extremely expensive equipment that they neither understand nor need.

Dr. J. Colley, APPM Ltd., Australia

Development and innovation doesn't stop as soon as equipment is delivered to the paper mill machinery house. Most installations have an element of speciality about them, and no manufacturer can expect his machines to suit every application straight away. The last stage of development, in the paper mill, is usually conducted by the paper-maker, though with the manufacturer usually present too.

Dr. J. Mardon, Omni-Continental, USA

Dr. Justus has a valid point, from one particular viewpoint. The key to managing R & D lies not in knowing what to do, but in knowing what not to do. By tying up a lot of limited resources of expertise and equipment in machinery research you are not equipped for, your research operation will be very ineffective and you would have done better leaving it to the manufacturers. I am sure that is what Mr. Justus was referring to, as both he and I have seen many examples of it. If a paper-maker has an innovative idea, then his most effective way to exploiting it, is to develop it himself as far as he reasonably can, before taking it to the machine builder for further improvement. But to try to produce large scale pilot plant is a mistake.

Dr. A.H. Nissan

Without wishing to take sides, I will just mention that Tsai Lun, M. Robert, and the Fourdrinier brothers were all users. The twin-wire was a user development, and I think George Tomlinson was a user. But machinery builders have produced revolutionary changes also. Dr. Mardon's point about when to take a developing idea to a machine builder is important, because, whatever else, the builder does have experience of how to design and make pieces of machinery that work, and the outcome of the idea will be much influenced by whether or not it works. There isn't however a god-given law about this.

Mr. G. Place, Proctor and Gamble, USA

I believe there is a god-given law on this subject, which is that the R & D management and the general management of a company must have a very clear view of what business they are in. What I hear from Mr. Justus is a very clear view of his business, and therefore a very clear view of the research his company will undertake. If a revolutionary change does come about then Beloit either will have to have made arrangements with their research group to switch to the new technology, or go out of business. Thus the primary strategic question for a company is to resolve what business they are in, and for both R & D and general

management to see it the same way. This view of the business can be as narrow and specialised as you like, provided there isn't some discontinuous change of technology. As soon as one occurs, the view will have to be widened if the company is to remain in business.

Mr. E. Justus

A lesson I saw illustrated very well the other day during a visit to the Imperial War Museum is that the simplest way of doing a thing is the best. The example I saw was of World War II aero engines, amongst which the successful ones stood out by virtue of their simplicity and cleanliness of design. I thought this example one of the best of the artistry and rightness of design that I have ever seen.

Dr. A Mawson

The similarity between two of the engines you looked at, the Rolls and the Daimler Benz, probably illustrates a point we are overlooking, namely that we learn much from our competitors.

Dr. A.H. Nissan

Before bringing the discussion back to paper-making, I must just say that the most successful aero-engine design has been the turbine, developed by an RAF engineer, a user.

Mr. B.W. Attwood

What happens to an innovator from a paper mill who has a idea, but who can't interest anyone, either machinery builders or other paper-makers, in it? He must have something material to show them, because innovation is concerned with doing things differently.

Mr. P.E. Wrist, Mead Corporation, USA

I see a difference between invention and innovation. The innovation mentioned by the previous speaker was not in widespread, successful, commercial use and therefore was not, as I understand it, an innovation. It was only at the stage of

invention. To qualify as an innovation, as I see it, an invention has to be in commercial use.

Mr. J. Gough, Wiggins Teape, UK

Mr. Wrist, in the last diagram you showed in your presentation, demonstrating the relationship between the research resources required and the rate of growth sought, what was the scale of the x axis, the research resources? If it was percentage annual sales, then it implies that for a major breakthrough, it is necessary to spend around 6% of annual sales revenue on R & D. This is an unheard-of figure in our industry.

Mr. P.E. Wrist

Those figures were drawn from the examples firstly of a number of companies undertaking minor product development, who seemed to be spending, on average, rather less than 1% of annual sales: secondly, those who, while doing good development work, were remaining within their industries, spending 1-3%: thirdly, some examples of companies breaking into new markets. I would be the first to agree that present annual sales is a poor way of quantifying expenditure. For a conglomerate, with enormous sales, the amount required to penetrate a new market is a rather small percentage. My main point in that diagram was, to make a major breakthrough a company must spend on R & D at far higher rate than it need just to maintain market position.

Dr. A.H. Nissan

If, in a business with annual sales of $1 m, a product improvement is introduced that increases sales to $2 m, then it doesn't follow that R & D spending should double. So, this annual sales percentage issue is very misleading. I have seen only one article, many years ago, where an attempt was made to calculate, accurately, recommended levels for R & D expenditure. The calculations were involved, and required taking account of product life and profitability, amongst other things.

Mr. D.G. Croxon, Kimberly-Clark

Mr. Wrist, would you think it advisable to involve research workers in discussions of profitability, or do you believe they should be left totally in isolation, not even allowed telephones?

Mr. P.E. Wrist

I don't think taking their telephones away will much improve profits. There is an advantage in having at least the research managers know something about business and the factors that influence profit. However, that isn't their primary concern, which must be the identification of new technical opportunities to be brought to the main management's attention. They must point out the advantages, while recognising that the company is a team effort in which there are others more skilled in making financial judgements. This way lies the course to a true corporate decision on the viability of new projects. Profitability is very difficult to relate to R & D, and by loading such matters onto R & D personnel, the risk is of giving them too much to worry over, such that their performance is impaired. Still, they should be aware that making a profit is one of their company's objectives.

Dr. J.L. Brander, Wiggins Teape, UK

Expenditure on R & D is sometimes believed to be a function of what industry you are in. In other branches of machinery building 6% of annual sales is considered adequate to keep market position, without expecting any breakthroughs. I would like to ask Mr.Justus if the same is true in paper machine building?

Mr. E. Justus

6% is a lot and we would like to have a budget like that, but we don't.

Dr. M. Hussain, Abitibi-Price, Canada

From one of the charts in Dr. Asaoka's paper, I see that Japan consistently spends less as a sales percentage on R & D than we do in USA, in every industry except iron and steel.

Since we all recognise that the Japanese economy is doing better than that of the US, is there something significant in that? Also, I would like to ask Mr.Justus if he would care to comment on the suggestion I have heard, that Beloit deliberately held the extended nip press back in order to protect their foundry business?

Mr. E. Justus

The reason for the extended nip press' long development period, was arriving at a suitable mechanical arrangement that would survive in a paper mill. The belt was the most difficult part of the assembly. Our first design made use of hydrostatic rather than hydrodynamic bearings. The development has been hard work, and if you were to see our annual expenditure figures you would see that we weren't trying to hold back on it. We are in competition with the world in machinery production and if we have a development that will make more paper at lower cost, we won't hold back on it.

Dr. A.H. Nissan

The development time of the extended nip press was not unusually long.

Mr. A.G. Marriott, BPBIF, UK

There has been very little discussion about the financial justification for R & D, though it has been suggested, especially by Mr. Wrist, that it is essential for a company's survival. Would anyone of the panel like to comment on the quite widely held belief that it doesn't pay to be market leaders in an innovation, and that the second group in, the copiers, stand to do much better? The Japanese at one stage of their post-war development seemed to illustrate the truth of this.

Dr. A. Okagawa, JPRI, Japan

Japanese industry spends roughly 0.3 to 0.4% of sales on R and D, which is comparable with what is found in other countries, not less as has been suggested.

Dr. W. Adams, AccuRay, USA

We have discussed to some extent how inventions come about, before being developed into innovations. I think they usually come into being wherever a problem is well identified, and where there is stress. The greatest inventiveness is shown in time of war, or when companies are in trouble. So if people of inventive minds are subjected to stress, then inventions result. To develop further, to the innovation stage, using Mr. Wrist's definition, involves people with marketing skills. So, bearing in mind what I've said, I would like to ask anyone on the panel if they have ever tried taking their problems to their suppliers in a stressful way?

Dr. A.H. Nissan

Can anyone on the panel define "a stressful way"?

Mr. P.E. Wrist

The big thing that helps change an invention into an innovation is an identifiable market need. The chance of rapid adoption of an invention when there is a need for it are great. This shows in statistics too, such that some 80% of innovations can be shown to be in response to previously identified market needs, whereas only 20% arise without a market need. That doesn't mean that the latter group is unimportant, because when such inventions finally gain acceptance they often provoke change, revolutionary rather than evolutionary.

Lasers are a good example. For years after their development they were virtually unexploited, yet now we see that they will probably be at the heart of the next revolution in communications technology. We need both kinds of inventions, but in an industry where it is important to make a profit every year, it is probably better to look for inventions that meet market needs, rather than the other sort.

Mr. E. Justus

If a customer with an invention wants to provoke a response from us, then his best chance is to spell stressful "M-O-N-E-Y".

Dr. A.H. Nissan

On that, which defines the essence of all our involvement in the industry, I think we should call a halt.

Today we have had fourteen panelists give their views on various aspects of R & D, and I think that the fact that I have had to cut short the discussions must testify to the high standard of their various presentations. Thank you for putting such efforts into the preparations.

Concluding Remarks

Mr. M.I. MacLaurin

Firstly, I want very much to thank Dr. Nissan for so ably chairing today's proceedings. It required much preparation and hard work, but the results have well justified the effort. So, on behalf of us all, Alfred, thank you.

Thank you, also, the Engineering Dept. Staff who have been working behind the scenes, handling the audio equipment and projectors, as well as the very efficient people, Sandra and all the UMIST students, who have been doing all the microphone work, and the two girls, Katherine and Dawn, who have been manning the front desk.

I will be brief in closing this symposium because many people have a lot of travelling to do this evening, and I want to sustain our reputation for being on time. But I shall speak for a few minutes about the next, the eighth, to be held in 1985.

Firstly, a large number of delegates has in fact responded to my request for opinions yesterday, and it is quite clear that we shall be at Oxford unless some compelling difficulty arises. We shall start investigating right away, to see how things can best be arranged to overcome some of the problems we have had here. But is does seem that a majority would prefer being at Oxford.

Secondly, this particular meeting in its first morning and its last day, has departed somewhat from the tradition of these symposia, and I think that format has been timely for 1981, especially as regards todays discussions. However, I think it is not something we shall repeat too soon, and the 1985 meeting will

be essentially scientific throughout, with a return to the format of previous symposia in the series.

Thirdly, you may recall that, in my opening remarks on Monday, I suggested we didn't need a theme for 1985. Well, even before the first working session Dr. Rance had put his disagreement on record, and it has become clear during the week that most people here disagree with me on that. So I am now persuaded of my folly and publicly repent.

What really convinced me was the emergence during the week, based upon a lot of help from everyone, of an idea for a theme, endorsed by the committee. We shall have to sort out the wording of it, but, as we all know, the paper-making processes and the properties of paper products depend very much on the properties of the pulps we use and the processes by which we prepare them. In 1985 we intend to bring those relationships together as the theme for the symposium. If anyone has ideas about this, even if you think it is utterly wrong, I would like you to write to one or other of the committee.

Now, all that remains to be said is thank you to everyone for taking part in the week's events. Travel home safely, and let's all meet again in 1985.