

THE ROLE OF FUNDAMENTAL RESEARCH IN PAPER-MAKING

Rutger Martin-Löf

Vice Chairman

The National Swedish Board for Technical Development

Chairman

The Swedish ForestProducts Research Laboratory.

Abstract

Fundamental research is a long term activity and the results will generally not have an influence on industrial development for a long time. It is however essential for the progress of the industry, but cannot be justly evaluated by any short-term economic formula.

Fundamental research in the Swedish pulp and paper industry is today mainly carried out at the Swedish Forest Products Research Laboratory (STFI). STFI is a collective research institute and is financed jointly by the pulp and paper industry, through the Pulp and Paper Association and by the state, through the National Swedish Board for Technical Development (STU). The budget for STFI amounts to 60m SKr of which approximately 70% is financed by the basic agreement between the state and the industry, whereby the state carries a share of 42% and the industry 58%. The remaining 30% of the budget is financed by different funds and from contract research.

The pulp and paper industry together with the state also supports research at a number of other institutes, such as the Swedish Water and Air Pollution Research Institute (IVL), the Institute for Surface Chemistry, the Swedish Packaging Research Institute, and the Graphic Arts Research Laboratory (GFL). The necessary co-ordination of the different activities is in the hands of a research committee organised by the Pulp and Paper Association which has to formulate the R & D policy of the industry and to propose to the board of the Association how the

available funds should be distributed among the different institutions and research projects. The industry is represented on the board of STFI, in the advisory research council of the Institute, and in a number of special committees for different research areas.

The industry must believe in fundamental research

The definition of 'fundamental research' is not always quite clear. According to OECD it means aiming at increased knowledge but without any practical use in view.

I assume that this is not what we mean at this symposium by fundamental research, but rather what I would like to call "goal-orientated fundamental research". Fundamental research in this meaning must have a close connection to industrial problems. Thus, this research should, for example, increase our knowledge of wood as a raw material, of pulp and paper-making processes and products, or give a better basis for future improvements and innovations.

Fundamental research is long-term research as the results will generally not have an influence on industrial development for a long time. It is also very difficult to make a precise economic assessment of the value of fundamental research. In times of high inflation and high interest rates a conventional economic calculation would indicate that the result of a fundamental research project had to give a very high dividend to be justifiable. Such a view would kill almost any fundamental research. But on the other hand, it is for this reason understandable, if regrettable, that in a recession, a cut in industrial research costs very often hits fundamental research.

Justification for industrial fundamental research rests on belief in its importance in creating the basis for progress and development of processes and products without which there would be no long-term future for the companies in question.

Consequently, fundamental research can never be justly evaluated by short-term economic formulae.

In Sweden, the Pulp and Paper Association, which is the common organisation for all the Swedish pulp and paper companies, has declared that 40% of the pulp and paper research at their collective research institute, the Swedish Forest Products Research Laboratory (STFI), ought to be fundamental research. This is an important decision with regard to the long-term continuity of the research at STFI. It also shows that the Swedish pulp and paper industry believes in the role of fundamental research. A similar research policy has also been adopted by the National Board for Technical Development (STU), the organisation through which the Swedish Government supports technical research and development. The Board decided some years ago that a fair amount of financial support should be directed to fundamental research, mainly at technical universities and collective research institutes, among these STFI.

Fundamental research is one component of the R & D system

Industrial development in the pulp and paper industry is based on increased knowledge in a great number of disciplines, such as organic chemistry, hydrodynamics, optics etc., and the use of advanced tools eg. computer technology.

A rather general conception of the R & D structure is that fundamental research comes first to create the knowledge on which applied research is later based. The applied research in its turn leads to industrial technical developments. They may be defensive improvements of processes or products, or offensive, leading to new processes or products. Although this R & D sequence may occur, it gives a very simplified picture of the real course of industrial development.

One example of when the development did follow this pattern, was the construction of high-consistency forming and screening equipment. This development started with fundamental studies of the sedimentation of different types of fibres in dilute suspensions, followed later on by hydrodynamic studies of the flow of fibre suspensions.

It is, however, probably more often the case that the fundamental research afterwards provides an explanation for phenomena known to the industry. The enhanced rate of delignification by addition of anthraquinone in soda cooking or the increased yield obtained by two-stage sulphite pulping was known to the industry from experience, before fundamental wood chemistry research explained the reason. But even when this "reversed order" occurs, the knowledge gained by fundamental research is of great value as it gives a firm ground for further research, both fundamental and applied.

Fundamental research - collective or not?

The question whether fundamental research should be preferentially carried out in industrial R and D departments, or at technical universities, or at collective research institutes has no simple answer. The situation is quite different in various countries, as well as in different types of industries. But if the question is limited to pulp and paper research in Scandinavia, the answer is simpler.

The pulp and paper industry plays an important role in the national economies of Finland, Norway and Sweden. It is therefore of great importance that the development work in the industry is well promoted and supported. The Nordic countries are small nations and the pulp and paper companies are small, at least in comparison with those in North America. This implies that we have to rationalise and use our resources, of both manpower and money, in the most efficient way. The industrial problems are to a great extent the same for different pulp and paper companies, or groups of companies. For example, there is a need throughout the industry to reduce water and air pollution, lower energy consumption, make better use of wood supplies, etc. Consequently, there is every reason to carry out this research, fundamental or applied, in co-operation at a collective research institute. Only problems closely associated with product development, where competitive conditions between companies play

a great role, are less suited for a collective research institute.

Research is by its nature manpower intensive. The increasing cost of manpower relative to product price, also speaks in favour of collective research. Also, research instruments become gradually more sophisticated and expensive, though admittedly more effective. The price is, however, often prohibitive for a small laboratory. The new paper forming machine at STFI may be mentioned in this connection, its price being around \$12 million.

All these facts taken together have been the background for the Swedish pulp and paper industry's decision to build up and support our collective research institute. This has also been possible to achieve because the state, through its board for Technical Development (STU), shares the view that co-operative research would effectively promote the development of the industry, and is consequently prepared to give financial support.

I shall revert to the question of finance later on.

A collective research institute must not be too small in order to be able to work effectively. Many of the problems of the pulp and paper industry are complicated and require competent scientists in many different disciplines. STFI has around 275 employees working in the pulp and paper field of which number a third to a half are graduates from technical and other universities. This size of the institute is clearly above the necessary minimum. According to the recruiting policy of STFI only well-qualified graduates are employed in order to maintain a high standard. This makes the institute attractive for young, bright scientists.

Contract research carried out at university institutions may in some cases be an alternative or a complement to research at a collective institute. It should be observed, however, that it is more difficult to organise collaboration in a big project between several university institutions than within an institute. Also, collective institutes have generally much more effective 2-way communications with the industry, through advisory industrial committees and organised information systems.

Management of fundamental research

The management of research has developed during the last few decades along the same lines as management of industrial companies, namely with more influence from broader groups of people.

But what differences are there between managing fundamental research and applied research? A study of the research organisation at STFI gives some idea.

The research areas at STFI can essentially be grouped into three categories:

1. Task force projects, such as "reduction of bleach plant water pollution". These projects, which are clearly of an applied nature, are efficiently controlled with regard both to research direction and to time schedule by a steering committee with industry representatives.
2. Technical product and process areas, for example "improved packaging paper" and "process control systems". These projects are essentially of an applied nature, but may sometimes need the inclusion of a lot of fundamental research. For this type of project STFI has advisory industrial committees.
3. Fundamental research areas. One such deals with projects regarding pulping, such as lignin chemistry and process kinetics for various bleach stages. Another group of fundamental research projects is related to paper-making, such as hydrodynamic studies of pulp suspensions and basic paper chemistry. Although STFI generally has industrial reference groups also for these projects, the responsibility for selecting new fundamental projects lies with the scientists at STFI, not only with the head of research but also with the leaders of scientific groups and projects.

The ability to recognise industrial problems, coupled with scientific imagination, is a necessary pre-requisite for

good results. It is thus important that fundamental research is directed within the institute.

STFI has to present yearly an annual budget covering all research projects. However, it is important that new research ideas, fundamental or applied, can also be taken up. Therefore, each research department may devote up to 10% of the research volume to such new ideas or projects which are not anticipated in the budget.

If an institute is supposed to carry out a substantial amount of fundamental research, the base cost for the necessary research resources must be borne collectively by the industry, by the state or by both. Otherwise there is a risk that continuity will suffer, especially if there is strong dependence on project grants from research funds.

Swedish pulp and paper research

Pulp and paper research in Sweden is divided between three categories:

Industrial R & D within companies

Collective research at STFI and other institutes

Academic research at universities.

The annual expenditures are at present approximately \$34, \$10 and \$0.6 million respectively.

The pulp and paper research at the Institutes of Technology and other Universities is very limited. At the Royal Institute of Technology in Stockholm there are two chairs for Pulp Technology and Paper Technology respectively.

But besides these there is no other academic department at any Institute of Technology which is directly concerned with pulp and paper research. Some lignin research is carried out at the organic chemistry department at the Royal Institute of Technology, and some carbohydrate research and some chemical

process research at Chalmers Institute of Technology. Most of this research must be classified as fundamental and is financed as project grants from funds.

Industrial R & D constitutes the bulk of pulp and paper research. After the Second World War several new industrial R & D laboratories were built. This research included, to begin with, a rather large proportion of fundamental research. Most of this has gradually been transferred to STFI for reasons previously explained for establishing collective research efforts. The main task for the industrial research laboratories is now to solve acute and specific problems within the company and to support development plans.

The main collective research institute is STFI, but the pulp and paper industry together with the state also supports research at IVL (Swedish Water and Air Pollution Research Institute), at the Institute for Surface Chemistry, at the Corrosion Institute, and at the Swedish Packaging Research Institute. The Swedish newsprint manufacturers also support the Swedish Newsprint Research Centre (TFL). Both STFI and TFL have also close contact with the Graphic Arts Research Laboratory (GFL).

In order to give a picture of how the collective research is financed I shall give you a description of STFI's budget for 1979/80.

The total volume amounts to 60 million kronor. Of this sum 43 million kronor, approximately 70%, is financed by the basic agreement between the State, through the National Swedish Board for Technical Development (STU), and the Pulp and Paper Industries Association. The sum of 43 million kronor is divided between the State and the Industry, such that the State provides 18 million kronor, 42%, and the industry 25 million kronor, 58%.

A number of different research projects, not included in the basic agreement, is financed from different funds and to some extent from the state to an amount of 10 million kronor. Contract research from industry amounts to 7 million kronor.

To sum up, the activities of STFI are financed 70% by the basic agreement between the state and the industry, 20% by other funds partly from the state, and 10% by contract research.

This distribution among the different sources is regarded as satisfactory by the institute.

A comprehensive picture of the distribution of expenditure in 1977 on different types of R & D in the pulp and paper fields is shown in Figure 1.

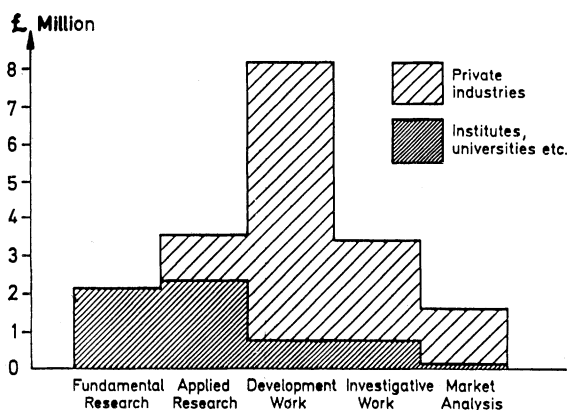


Fig 1—R & D costs for the pulp and paper industry in 1977 divided into different categories.

From my description it is obvious that the research in the pulp and paper industry is carried out in rather many institutions and laboratories and it is of course very important to the industry to achieve good co-ordination of the different activities. This is undoubtedly a problem which needs continuous attention.

At present we have mainly the following pattern of measures to obtain the necessary co-ordination. The pulp and paper association has organised a research committee which has to formulate the R & D policy of the industry and to propose to the board of the association how the available funds should be

distributed among the different institutions and research projects.

The R & D policy laid down by the research committee and the association represents the basis for the long-term planning of STFI.

The industry is represented on the board of STFI. The institute has also an advisory council of industrial representatives and a number of industrial committees for different research areas.

The long-term research plan drawn up by the institute is discussed with the research committee of the association to make sure that it is in line with the general research policy of the industry. The plan is also discussed with the National Swedish Board for Technical Development (STU) to get their views.

Also the association has representatives on the board and/or in special committees of those other institutes and laboratories which do research for the pulp and paper industry.

This system ensures that reasonably good co-ordination is achieved.

Finally I wish to inform you that the system of collective research as a form of co-operation between the state and industry is practised in a great number of industrial branches and many research areas.

The State is of the opinion that this kind of support and stimulus to technical R & D has proved to be successful and it is now an important part of Swedish official R & D policy. At present about 20% of the budget of the National Swedish Board for Technical Development (STU) is allocated to different institutes and programmes for collective research.

Finally, the close contact between fundamental research at STFI and post graduate education ought to be mentioned. It has become attractive for young graduates from, primarily, the Royal Institute of Technology, but also from other universities, to spend a few years after graduation at STFI before they move to positions in pulp and paper industries. Several of these young scientists use their research work at STFI, often fundamental research, as thesis work for a doctoral degree. This has proved

to be a very fruitful combination of STFI-research and personal education and also become an important part of the contact between the research of the institute and the industry.

Transcription of Discussion

Discussion

Prof. H. W. Giertz, University of Trondheim, Norway

Having discussed the importance of fundamental research and having heard at this symposium of how many practical achievements and industrial applications have been engendered by fundamental research, I would like to know if anyone has gone over his files to see what proportion of fundamental research projects has actually given rise to useful results? In the research organisation at Trondheim we did analyse the useful returns on fundamental research and concluded that only 15% of projects that began as fundamental research had any ultimate practical use.

Mr. H.A. Posner

We have tried to check back, as you suggest, on several occasions. However, it has always turned out very difficult, for two reasons. Firstly, the records often aren't very good. It is very often the case that to unravel the course of a particular development is impossible without the assistance of the personnel involved. Secondly, we find that much of the research we do has to be considered as building blocks, not of direct relevance to an identifiable end, but nevertheless very important to it. Combinations of apparently unrelated building blocks can, sometimes and in the right hands, be the correct combination for a technical breakthrough. For these reasons we think it very difficult indeed to try to perform the sort of analysis Prof. Giertz mentions.

Dr. J. Mardon, Omni-Continental, USA

Please forgive me if I phrase this question a little tactlessly, but I want to ask about what happened at IPC when it went through its difficult period some ten years ago. At that time, as many people in the industry know, its reputation diminished, so that it made a substantial effort to reverse this change. Could you identify what aspects of IPC's work or organisation you found inadequate, and how you changed your planning in order to remedy the deficiencies?

session 8 discussion

Mr. H.A. Posner

It is a very long story. Most people are aware that the sticky patch IPC went through in the later sixties-early seventies was partly a reflection of the mood of the times. There were however, some particular factors which contributed more than most to the problems at that time. They were quite easily identified, and all were important.

The institute at that time was trying to support its non-educational faculty on a contract research basis. This is a tough way of supporting yourself under the best circumstances. It seems to me that efficient and successful contract research organisations work very differently from most governmental research institutes. They, like everyone, have good people, and then leave them to make their own contacts and build their own organisations, subject only to the condition that they continue to turn in a profit. As soon as that condition is not met, then they are out.

At the IPC it is difficult to do that, partly because of our educational role. Thus, the use of contract research as a way for university staff to support themselves outside their academic life was one of the factors which led to the institute's difficulties.

A not-unrelated factor was our losing touch with the outside world. As is always the case, researchers would rather talk to one another than to anyone else, being quite capable of concocting enough interesting problems for one another to work on, with absolutely no reference to anyone else. So why go out to find problems? Thus I think the institute had become very much too introspective.

We also had staffing personality problems, of delayed decisions and insufficient flexibility.

Mr. G. Place, Proctor and Gamble, USA

You mentioned that the IPC targets about 50% of its resources in basic research. I believe that the paper industry is going to change its technology radically within the next two decades. What percentage of your institute's research effort is devoted to

session 8 discussion

major technological changes, discontinuous with existing methods, as opposed to evolutionary upgrades of what we are doing now?

Mr. H.A. Posner

A relatively small percentage, at a guess about 15%, but not more than that.

Mr. G. Place

Is that because you are interacting with an industry that already exists?

Mr. H.A. Posner

Yes, and it is very understandable. The IPC is not looking at things beyond the realms of current paper-making technology, because its emphasis must be on the realistically practicable. We can and do bring up questions of discontinuous change sometimes, but they must be couched in terms of existing practicability. I don't believe it is the role of IPC to undertake that type of research except when an identifiable need for it arises. We must always be aware of what industry sees as the priorities.

Mr. L. Rodes, São Paulo, Brazil

Some years ago you ran a strategic planning exercise in your institute. Would you say it was successful, and, if you were to repeat it, how would you change the way you conducted it?

Mr H.A. Posner

As a matter of fact we are conducting a similar exercise now. There is a wide variety of possible methodologies for such investigations. The one we at IPC selected is that which seems most appropriate to the collection of people involved, not only within but also outside the institute. Even the selection of the methodology has involved not only members of the institute, but also a number of people from industry.

session 8 discussion

Dr. A.H. Nissan

People have been asking how much of the fundamental research effort in the various institutes has a useful outcome. One study mentioned suggests 15%, which I consider surprisingly high. To understand how this figure comes about, I think perhaps we must appreciate that the term "fundamental research" has two connotations. Thus Sir G.I. Taylor's work on the instability of rotational flow, published in the Royal Society transactions, was pure fundamental research. Studying what happens on a table roll, even when it is the same problem as Sir G.I. Taylor's, should properly be called "Paper Science fundamental research". This is therefore an application of a deeper level of fundamental research, and I presume that this is why such a relatively high proportion of what is understood in the research institute as fundamental research has a successful outcome. Now may I ask Professor Giertz to repeat his earlier question to Mr. Posner, so that others may have a chance of answering it.

Prof. H.W. Giertz

My question to Mr. Posner was, has anyone in your institute looked back through the last fifteen or twenty years' files to try to follow up lines of research, to establish whether or not they led, eventually, to useful results? This is to some degree the matter to be covered by Dr. Scheuring in his paper later today. He will show the technical leader always goes over a project after its completion to try to show what it has led to.

Mr. B.W. Burgess

We find that applications of our work can surprisingly often be traced back to fundamental research. Though we have never conducted an exhaustive examination, it is surprising how often the comment that some piece of work is clearly traceable to such and such past fundamental research is heard. Consider these examples, which all began as fundamental and basic studies: our study of pitch fouling, now being applied in the majority of Canadian mills: similarly our corrosion research, resulting in the Papritection system which greatly extends the life of bleach

session 8 discussion

plant washers. Dr. Tabor earlier this week mentioned the work of Dr. Atack, whose study of sliding friction gave us a very useful insight into the mechanism of fibre removal in all forms of mechanical pulping. There are other examples too, where fundamental studies at our or other institutes have resulted in significant improvements to industrial processes.

Mr. G. Place

I am concerned that the paper industry must soon face serious changes, and I am trying to discover what role the various institutes are playing in identifying and forcing our attention on these changes. The structure of the funding and managerial control of these institutes suggests, in my experience, that they will be the last places to discover the discontinuities that must occur.

Mr. D. Attwood, PIRA, UK

PIRA is at present involved in pursuing such a discontinuity as those of which you speak, though it is of no help to paper-making. I am speaking of the new electronic information laboratory. This is a discontinuity that will affect us all, though it can only harm the paper industry, which will have to struggle on, trying to compete and think up different uses for paper.

Mr. B.W. Burgess

Mr. Place's question is very important. Part of the brief of our institutes must be to lead the industry, to try to determine what is going to happen in twenty year's time, so as to prepare the industry for it. We spend a lot of time on this. We have a future awareness committee engaged in technological forecasting and we make use of every device we can think of to try to anticipate future technical needs. This committee works alongside our Research Programme Committee, where the summary organisation of our research effort is done. We believe that one mechanism for initiating action on these technical step jumps is to encourage research by our staff on which they do not have to

session 8 discussion

report. We are concerned that the level of this exploratory research in our institute has declined recently and moves are in hand to reverse this. We believe it to be of the utmost importance that a scientist can retire into a corner to try out his screwy idea before it is exposed to the harsh light of reality.

Dr. R. Martin-Löf

I agree very much with what Mr. Burgess said, with the addition that I believe the government support for our institute adds to the freedom of the scientists to explore less immediately useful directions. Thus a project doesn't have to convince industry of its viability too early.

Dr. A.J. Michell

Perhaps the best example of a discontinuity, though not a very great one, in CSIRO, was the move into composite materials. It required a completely new start by us, with initially no enthusiasm from industry. This has now changed, since we have come up with several interesting inventions and patents.

In CSIRO, being a government body, the advisory committees are purely advisory. All the decision making power lies in the hands of the senior executive, who can see a project started if he feels sufficiently strongly about it.

Mr. E.J. Justus, Beloit Corporation, USA

Discontinuities, doing things differently, always need one or two dedicated people, backed by a courageous organisation, to come to fulfilment. The onus of responsibility for adopting a new idea lies with the paper industry itself. The problem of the transfer of good ideas from laboratory to mill makes demands as great on individual courage as on technology.

Prof. N. Hartler, RIT, Sweden

I think that the industrial committees play a very useful role in directing the institutes' research programmes, but that it is unreasonable to expect them to take much part in

session 8 discussion

identifying the long range changes, the discontinuities. The responsibility for this must be with the individual institute staff, who must be sufficiently strong to resist following completely what the industry committee says. They must be forceful enough to be able to see their own ideas through, and good enough that these ideas will be of value. But the responsibility for step changes must be with individuals in the institutes.

Mr. S.O. Dillen, Stora Kopparberg, Sweden

I think there are two aspects of the discontinuity subject, and the answers so far given don't match the question put. The answers tend to have been concerned with the difficulties of adaptation, of the individual effort needed to force changes through, which is indeed one aspect of the matter. But I think that the questions have been asking to what extent research in institutes can hope to recognise the discontinuities: quite another matter. It is by no means self-evident that it is in the institutes' interests to make discontinuous discoveries, because of the drastic effects they would have on the industry.

Dr. A.H. Nissan

That is why they are called discontinuities: some companies discontinue. I have not found a single instance in history of an important or novel idea being born in the mind of the majority. The ideas from which discontinuities stem invariably occur to a minority of one, and they are almost never welcome. We shouldn't be concerned about that, as one of their strengths is their ability to withstand criticism. They will not be valuable if they can't. Anyone with suggestions of how to foster such ideas should please speak up.

Prof. D. Wahren, IPC, USA

On what criteria do the members of the panel believe that a research director should work when trying to judge whether or not to support a new idea, such as might give rise to a discontinuity?

session 8 discussion

Mr. B.W. Burgess

With difficulty. There are no rules, and such decisions can only be made with support, advice, and, ultimately, courage. Our institute recently moved into bio-technology. We don't know what will result, though we hope it will be useful. We do expect, however, to have to support that work for a good number of years with no returns. The initiative to move into this field came entirely from within the institute, and has had nothing to do with the industry.

Mr. J. Adams, BPBIF, UK

Nothing has been said here about the role of universities in fundamental research. I suggest that they have a much greater likelihood of provoking the development of discontinuities than do the research institutes, because of their greater potential for cross-fertilisation from different disciplines.

And now I would like to ask Professor Göttching whether he, in view of recent EEC bureaucratic intervention in the matter of the amounts of waste paper to be included in pulp, believes that the European research institutes should work more closely with the industry federations, the better to resist bureaucratic pressures?

Prof. L. Göttching

You are asking for better co-operation between the research institutes and the industry federations in the various countries of the EEC. This you think would be the way to improve communication between the research institutes and the EEC bureaucracy. But I think that they work very closely together already, at least in West Germany. And then there is the question of who should try to improve this communication, the federations or the institutes. I think it would be a matter for the federations, as they have the necessary power.

session 8 discussion

Dr. A.H. Nissan

I draw a different conclusion from the recent EEC experience mentioned. I believe there are problems faced by all industries, particularly paper, which are not purely political or commercial, but have also a technological content, such as this one regarding the inclusion of a greater proportion of waste paper in new pulp than hitherto. These problems must be studied within the industry, even at the risk of a disquieting result. It will be impossible to stop that study; so surely it is better that it shouldn't be conducted by outside amateurs, who may well fail to take important technical aspects into consideration. I am certain that it is better in the long term for the industry's research institutes to investigate responsibly and fully the fringe problems such as conservation, pollution and safety.

Dr. R. Martin-Löf

The Swedish experience in the environmental debate was that by taking the lead and the initiative, industry could so improve its relations with the government that its point of view is much more fairly heard. I think the outcome has been greatly more satisfactory to us than it would if the initial study had been left to the National Environmental Board. I think industry must vigorously study its own problems because that is the only way of ensuring that proposed solutions fall within practical technology, and that end products meet the customers' requirements without being hazardous.

Dr. J.E. Luce, International Paper, USA

Returning for a moment to the question of discontinuities, I am sure no-one here believes they are spontaneous. Discontinuities result from the combination of two processes. Firstly, there must be the recognition of a need, that is to say, an overall need, which might be defined by asking "What business are we in?". Thus in the paper industry we are in the business of substrates, communication, wrapping or cleaning up mess. Secondly, one has to ask oneself what alternative ways are available for satisfying those needs, other than those in current

session 8 discussion

use. Generally, scientists aren't very good at asking these overall questions, but one thing fundamental researchers are good at is recognising opportunities for satisfying these needs. I suggest that even the largest companies are not able to support truly fundamental research, but they are aware of the needs. Thus the combination necessary for a discontinuity to result can occur if the links between the large company, with its knowledge of the needs, and the fundamental research institute can be strengthened. This I see as the weakest link and one that must be reinforced even if it involves considerable retraining of the people involved.

Mr. G. Place

Dr. Goring said that the greatest ideas can only arise from mountains of solid background work, and I agree with him. But my experience suggests that they usually occur only at interfaces between disciplines, not within the core of a single discipline. Thus, for them to arise there must be interaction between several sciences besides the one of need. Having created a climate in which there is this required interaction, then the exploratory team investigating it should, I think, be fairly small: one or two of the right people is probably the correct size: with any more it is likely the team would come apart. Thus I think it is worth keeping the number of people involved in the early stages small, at least until they begin to produce some results: then it becomes sensible to increase the effort. One of the roles I believe could be usefully fulfilled by the research institutes is the bringing together of the various disciplines from the universities, with whom they often have closer ties than industry does. The resulting interactions I believe, as I have said, would provide the groundwork for Dr. Goring's flags of achievement.

Mr. P. Waern-Bugge, Stora Kopparberg, Sweden

According to the figures given in the preprints, Europe manufactures some forty million tonnes of paper annually. The larger part of this goes forward to converting in one way or

session 8 discussion

another, and yet almost all the research funds are spent in the paper industry, and very little on converting. In fact there is an appalling lack of basic research on the downstream side of our industry, which I think reflects a lack of innovative thinking on the part of the end users. If any of the panel would care to elaborate on that I would be the most interested.

Dr. R. Martin-Löf

To a large extent I think rectifying this deficiency should be the responsibility of the paper industry. Converters are the paper industry's customers and as such should be encouraged to develop their uses for paper. Any rapprochement must also include the converting machinery manufacturers, and will take courage and determination. There is every reason for the paper industry to take the initiative in this, and to try to get as much as possible out of the contact. There should be two-way communication, so that, for example, paper can be matched to ink rather than, as is usually the case, the reverse.

Mr. D. Attwood

The paper industry has sometimes been very bad at recognising discontinuities when they occur in the downstream industries. For example, when web offset printing for newsprint was introduced, the paper industry failed to take notice, and all the research had to be done afterwards, at great expense. There are now new developments taking place in packaging, which the paper is not good enough to handle. We seem again to have been caught unawares by these developments, and I suggest that we should spend more time talking to downstream equipment manufacturers in future, to try to be aware of what changes are in the offing.

Mr. E.J. Justus

I want to say a few words in support of Mr. Posner. The strength of the Institute of Paper Chemistry, and the other institutes, lies primarily in their education role. The outstanding young people from these institutes who enter the

session 8 discussion

industry give it its great strength. Our company does not look to these institutes to do our research work for us. We are interested in the Ph.D. and other research work that is done, but the primary function of these institutes is as centres of educational excellence.

Mr. P. Wrist, Mead Corporation, USA

Mr. Posner described some of the changes that were made in the re-organisation of the IPC. In particular he mentioned that changes were made to the mixture of personalities, which, it was felt, had become too homogeneous. Probably one of the essential ingredients in furthering a discontinuity is a mixture of personalities and disciplines.

The Advisory Committee felt that further re-organisation was still needed, so they tried to advise the institute management of the direction in long-term research where they felt there was need for knowledge. I believe it is in supplying essential understanding that an institute's main purpose lies, rather than the development of this understanding to useful applications.

After considerable discussion, five areas in need of long term investigation were identified. The emphasis on the long term was felt to be important because of the institute's one step removal from the market place; it was felt that the institute should not chase after every short term development of the market, which it couldn't possibly hope to follow because of this position of remove. The five areas have continued important over the past eight or nine years.

The first was the supply of raw materials, the concern being to maintain adequate supplies to ensure the healthy future of the industry. Within this overall title investigations ranged from genetics to pulping yield improvements. The continuing recommendation from this branch of the work has been that the productivity of our eventually finite land resource must be continuously improved.

The second area investigated was energy consumption. It was recognised that the paper industry is highly energy intensive, second only to aluminium smelting. Thus here too, there must be

session 8 discussion

continual pressure to improve the energy efficiency of the process.

The third area was that the popular view of the environment had seen a discontinuous change, so that many actions acceptable before 1970 were no longer so after 1970. This has created the opportunity for a considerable re-evaluation of the economic factors in decision making in our industry. The initial reaction from the industry was to patch up, and reduce the impact of the waste produced. This approach has been replaced over the years by one in which the total amounts of waste are reduced, which of course has benefitted the first two fields of study.

The fourth area concerned the capital intensiveness of the industry. It is becoming increasingly more costly to introduce a new unit of production in paper-making, and, even without revolutionary change, it is important continuously to improve the process of productivity. This of course involves further investment, and so the process was thoroughly examined to try to reduce some of the capital intensity.

The last area chosen for investigation concerned the fact that very little account of intended end use is ever taken in the design or testing of our products. Q.C. tests tend to be limited to what is easy, without any real evidence that these have much relevance to properties important in the market place. So effort has been spent trying to discover what properties are of importance to end users, to try to optimise the product without excessively increasing raw material demand.

Dr. A.H. Nissan

I appreciate your having made this contribution at this juncture, where I am sure it is appropriate, and thank you for having made it at such short notice.

Dr. A. Mawson, Wiggins Teape, UK

I wish to return to the question of revolutionary change, discontinuities, that we began discussing. It has been proposed that the universities might be the ideal germinating ground for the seeds of such changes, and also that collective

session 8 discussion

government funding actually acts against the stimulation of revolutionary change. It is indeed true that large government finance (e.g. the EEC) tends to go into the collective interests of the industry, where collaboration presents no threat, and that this tends to promote the status quo. But in the U.K. money for R & D is being put increasingly into specific companies within an industry, which by helping to avoid the problems of confidentiality, opens the possibility of more revolutionary changes. This approach can, of course, give rise to products like Concorde, for which the primary need was never properly identified, and whose spin-off products weren't sufficiently immediately useful to be widely adopted.

The question of whereabouts to find the most fertile ground for revolutionary change has concerned several speakers here, and surely the need for cross-fertilisation must be apparent. But if this cross-fertilisation is to occur within a committee, it must be a committee of one only, and of course modern specialisation renders such committees very unlikely to have the necessary range of experience. The main problem, therefore, I see as being one of tapping existing sources of knowledge, mainly in universities, which is a slow, laborious job. I myself am trying to undertake it and I seek suggestions as to how I can improve my technique

Dr. J. Colley, APPM Ltd., Australia

Yesterday Professor Judt called upon the Research Institutes of the developed countries to do more work for the benefit of the developing countries. Could you briefly outline the extent to which the CSIRO Division of Chemical Technology answers this call.

Dr. Michell

The CSIRO Division of Chemical Technology has been engaged for some years in the assessment of the pulping qualities of woods from Papua New Guinea and Malaysia and in advising these countries in their negotiations of chip export contracts with pulpwood buyers from the developed countries. The work has also included assessments of the potential of possible re-

session 8 discussion

afforestation species. The work is being done in collaboration with the forest departments of the countries concerned and has included training programmes for their personnel.

The work was funded initially by the Australian government through the Australian Development Assistance Bureau but more recently funding has been provided by the governments of the participating countries.