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PAPRICAN: A CASE HISTORY OF CO-OPERATIVE RESEARCH AND EDUCATION

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As a result of the foresight, imagination and initiative of a few technical people and executives in the Canadian pulp and paper industry in the early 20's, the Pulp and Paper Research Institute of Canada was created 56 years ago to serve the industry. Its establishment recognised the fact that, even in those early days, the industry needed research and development, and that it would need to train scientists. Thus, right from the outset, PAPRICAN has had two broad missions:

1. To do research of importance to the industry:

2. To train scientists and technical personnel for the industry.

However, an appreciation of the nature of the Canadian pulp and paper industry is essential to an understanding of the development of PAPRICAN and of its programme.

The Canadian Context

The Canadian pulp and paper industry is the second largest pulp and paper manufacturer in the world, and is by far the largest exporter of both. It is of critical importance to the nation. It is Canada's leading industry in terms of value-added manufacture, employment, and salaries and wages. Furthermore, it is the country's largest net exporter of manufactured products.

The industry is thus export-orientated while at the same time serving a smaller domestic market. Canadian production includes virtually the entire range of pulp and paper products, but newsprint and market pulp together account for nearly 80 % of the shipments of the industry.

If the health and vigour of this key industry are to be maintained and strengthened, and if it is to retain its important place in export markets, it must endeavour to keep itself at the leading edge of pulp and paper technology.

The industry is made up of some 75 companies. Some of these are capable of supporting their own research laboratories, whereas others are very small, with limited technical resources. Many technical problems are common to a large number of companies and it often makes sense to share some of the research and development costs. This the industry does, not just at PAPRICAN, but also at the Forest Engineering Research Insitute of Canada (FERIC), which is concerned with problems of harvesting and transportation of wood, and at Forintek Canada Corporation, which studies problems related to solid wood products other than pulp and paper, i.e. lumber, plywood, various building boards etc. FERIC and Forintek draw their support, not just from companies in the pulp and paper industry, but also from some manufacturing other forest products and from governments.

PAPRICAN

PAPRICAN represents a unique, long-standing partnership between the Canadian pulp and paper industry, the Federal Government, and McGill University. For the first 25 years of its history, each partner maintained its own staff within the Institute, and PAPRICAN was guided by a joint administrative committee. In 1950, however, the Institute was re-organised and established as a non-profit, research and educational corporation without share capital. In place of share-holders, there are eighteen individuals who serve as members and who elect themselves Directors. Two of these members are appointed by the

Federal Government, three by McGill University and thirteen by the Executive Board of the Canadian Pulp and Paper Association (CPPA). As with any other corporation, this Board of Directors is responsible for the overall policy and financing of the organisation. The industry appointees, except for the President of CPPA and the President of the Institute, are all chief or senior executives of the Institute's Member Companies in the industry, and they normally serve for a three-year period.

The Role of the Federal Government

Each partner has its own unique role in the activities of PAPRICAN. In 1956, in lieu of an annual grant, the Federal Government constructed the main laboratory in Pointe Claire and then doubled the size of it in the mid-60's. Although the Institute is reponsible for light, heat, taxes, insurance and maintenance, the rent it pays for the use of this facility is $1 for 25 years. The Federal Government now provides no other financial support for the work of the Institute, except for work done specifically for the government under contract.

The role of McGill University

McGill University and PAPRICAN co-operate in the education of graduate students. These are students of the University who must meet McGill's entrance and degree requirements. However, they do their thesis research under the supervision of those members of the Institute's staff who hold honorary, concurrent positions on the faculty. The students become associated with the Institute because they elect to devote their thesis research to problems of fundamental importance to the industry and because they chose to have some of the Institute's scientists as their thesis supervisors. The work is done in a building erected in 1928 by the industry, but now owned and maintained by the University. Across the years, about 500 have studied under this programme,

mostly to the doctoral level. The majority have worked on topics related to the physical and organic chemistry of wood, pulp and their components. Others have taken post-graduate training in chemical engineering and in mechanical engineering. The Institute's relationship with McGill is being extended into other disciplines of science, including, for example, psychology. The emphasis is on training scientists, as opposed to technical managers. It has been a very worthwhile co-operative endeavour in that not only has the industry and Canada gained a core of well-trained scientists, but also the industry has benefitted from the imaginative and extensive thesis research the students have undertaken under the programme.

Two years ago, PAPRICAN entered into an agreement with the University of British Columbia in Vancouver which is similar to its long-standing agreement at McGill. At the moment, the emphasis at UBC is in chemical engineering and three members of the Institute's staff are located there.

The Institute is developing co-operative arrangements with other universities, although on a less formal basis. For example, three graduate students in microbiology from the Université de Montreal are working under the supervision of one of the Institute's scientists in Pointe Claire. In addition, some members of the staff are involved in the thesis supervision of a student in metallurgy at Ecole Polytechnique and of a student in management at Ecole des Hautes Etudes Commerciales, both in Montreal.

The Institute has had 56 years of successful experience in improving the interaction across the industry/university interface. It is regrettable that better use is not made by industry of the vast human resources represented by the university community. Industry and universities tend to be `two solitudes'. By extending its collaboration with universities, the Institute believes it can do much to develop more effective working relationships between the pulp and paper industry and universities.

The Role of the Pulp and Paper Industry

The dominant role in the affairs of the Institute is, of course, played by the Canadian pulp and paper industry. Companies which support the Institute, referred to as `Maintaining Members', represent over 98% of the production of the industry. To be a member of PAPRICAN, the company must also be a member of the Canadian Pulp and Paper Association (CPPA) and vice versa. Thus, in matters pertaining to the Institute, the Executive Board of the Association can speak for the entire membership. As stated before, the overall policy of the Institute is determined by its Board of Directors, but there are occasions when it is desirable to deal with the membership as a whole through the Executive Board.

Maintaining Members pay their proportionate share of the budget that is approved each year by the Institute's Board, a share which is based on the tonnes of product shipped for sale. Thus, the assessment rate varies from year to year, depending on the budget and the aggregate of shipments made by Members. As you might expect, Members have full and ready access to the results of the Institute's work in advance of publication and, in addition, they receive royalty-free rights in Canada under Institute patents. A simple membership contract between the Institute and each Maintaining Member assures the Member of these rights and includes an undertaking that the Member will pay its share of the budget of the Institute and will give 18-months' notice should it decide to resign.

It should be noted that membership in FERIC and Forintek extends beyond the Canadian pulp and paper industry and is not tied into membership of CPPA. Also, with each of these institutes, a substantial portion of the budget comes from federal and/or provincial governments.

Information regarding the current budget of the Institute and the members of people involved in its programme are given in Table 1.

Budget

1981 budget	$12,640,000 (Cdn)
Provided by Maintaining Members	11,090,000
Balance - from contact research, grants and miscellaneous revenue	1,550,000

Staff and Students

Scientific staff	119
Technical support staff	133
Other support staff	57
TOTAL	309
Plus:	
Students	32
Total number of persons associated with PAPRICAN	341

Table 1

Under current tax legislation in Canada, companies may deduct from income, for purposes of tax calculation, 100% of the costs of scientific research and development, plus 50% of any increase in that cost over the average expenditure in the preceding three years. In addition, there is a federal investment tax credit which in most parts of the country, is 10% of the R&D expense, but in some regions of the country is somewhat higher. Because of the way in which these investment tax credits are calculated, the net taxable benefit is, in fact, about one half, i.e. generally 5 % in place of the 10 %. These tax incentives, aimed at encouraging research and development, have not changed materially since 1962, and are regarded by industry in general as quite inadequate.

Nature of PAPRICAN's Research and Development Programme

The Institute's programme is addressed to problems related to the conversion of wood into pulp and paper products. Generally, it is not concerned with forest management, nor wood harvesting, but it does include work on the effect of wood quality on pulp properties. In addition, the Institute has one joint project with FERIC which has led to the successful development of a process[1,2] for removing bark, foliage, grit and rot from chipped whole trees, a process which will enable companies to make fuller utilisation of the forest resource and minimise wood costs. The Institute's programme, therefore, encompasses work on problems associated with mechanical pulping, chemical pulping and bleaching, chemical recovery, paper-making, product quality and coating, as well as those in such related subject fields as corrosion, environmental protection, energy conservation and recovery, systems and control, development of testing methods and biotechnology. In addition to this programme, it provides such services as literature searches, tests and analyses, calibration of testing instruments and contract research.

The Institute's programme includes strategic basic research, applied studies, and development work. Research is of little value if not put to use. This doesn't mean to imply that the emphasis of PAPRICAN's work is on the applied side of the innovation spectrum. It isn't. But even with its fundamental research, one should foresee an ultimate use for the findings. This is why, at the Institute, it is generally referred to as strategic basic research, i.e. it is fundamental or basic research undertaken with the objective of obtaining a better understanding of the fundamentals of the industry's raw materials, processes, and/or products. One way of characterising the Institute's programme is illustrated in Figure 1, which shows the estimated time to completion of the research underway at the Institute. The graph is based on a value judgement, but it does indicate the relative emphasis on programmes having long-term, medium-term and short-term implications.

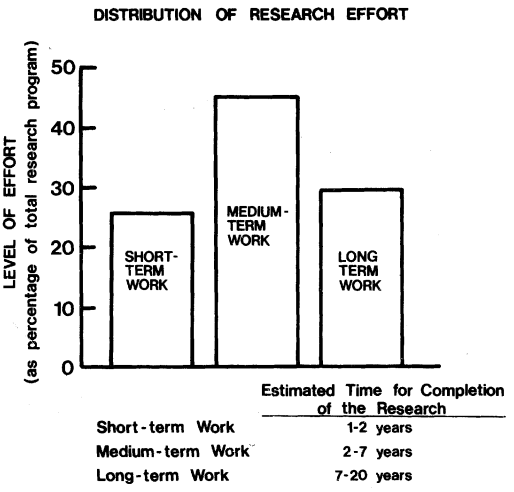

Fig 1

In most cases, the Institute's developments grow out of its research, often out of its strategic basic research. The raison d'etre of the Institute is to engage in research of importance to the industry, whether it be strategic basic research, applied studies, or development work, rather than to aim specifically at patentable developments. However, when valuable new concepts are discovered, it would be foolish not both to patent them and to ensure their further development. From experience the Institute has found that the evolution, the testing and then the translation of its innovations into commercial use can best be accomplished with some form of Institute involvement, either in a supervisory, supportive, or consultative role. There are too many pitfalls from the laboratory bench or pilot plant to the point of commercial use not to bring into play all of the resources available, including those who have the most intimate knowledge of the development. Although this is particularly true with major developments, it applies as well in many cases to the transfer into use in the mills of Institute technology arising from any of its work.

Programme Development

The entire programme of the Institute is directed to the problems of the industry and those which it is likely to face five, ten or twenty years hence. Only with a clear understanding of these problems and of the opportunities available to the

industry is it possible to develop the long-term goals and objectives of the Institute. It is essential, therefore, that the Institute should not operate in a vacuum, but as an integral part of the industry it is attempting to serve. Two groups have been organised for the express purpose of assisting the Institute in programme development and implementation, namely:

The Research Programme Committee: this is a Committee appointed by the Board of Directors and comprises senior executives as well as operating, technical and research personnel from the industry, plus representatives of the federal government, of McGill University, and of CPPA, as well as the President and Vice President (Scientific), of the Institute. Its primary responsibilities are to help the Institute identify the research needs and priorities of the industry, to recommend long-term goals for Institute research, to undertake each year a review of the work underway, and to advise on the transfer of results to the membership. It is one of the key factors in the development of the Institute's programme and is essential to its success. It has played no small part in shaping the direction of effort in the Institute and developing industry confidence in its programme.

Member Liaison Representatives: each Member Company appoints a Liaison Representative who helps keep the Institute aware of the research needs from the point of view of his company and who helps to ensure that his company takes advantage of the results of the work of the Institute. The appointment of these representatives is of recent origin and is an attempt to improve still further the two-way communication that has always been an essential feature of the relationship between the Institute and its Member Companies. Thus far, it has proven to be quite effective and of considerable help.

In the identification of the research needs of the industry, the Research Programme Committee speaks from the viewpoint of the industry as a whole, whereas the Member Liaison Representative speaks on behalf of his individual company.

The Institute does not rely solely on the Research Programme Committee and Liaison Representatives in the development of its programme. Care is taken to ensure that the Institute is in touch over a wide technical, scientific and industrial front. For example, at least one member of the Institute is on virtually every committee of the CPPA Technical Section, and on many TAPPI committees as well. Other interactions with industry include those with key trade sections of CPPA, with suppliers of chemicals and equipment to the pulp and paper companies and, on occasions, with customer groups. One of the most significant forms of dialogue is that which takes place with company personnel, not just in organised seminars and consultations, but particularly in the course of fundamental and applied research work often carried on by PAPRICAN in Members' mills. Information useful to the development of the Institute's programme also comes from dealings with governments and international government agencies, through participation in various scientific societies and from background economic studies and technological forecasting carried out by the Institute.

From the above it must be clear that the Institute scientist is thrust into the industrial as well as the scientific milieu. The breadth of view thus gained is invaluable in the process of identifying the most urgent research needs of the industry and the long-term objectives of the Institute, an on-going process in which both the Institute and the Research Programme Committee are heavily involved.

As the long-term objectives are identified it is up to the staff to develop the necessary research programme. The key, of course, is the quality of the staff. Without imaginative, well-motivated, able people, all the committees and all the interactions with industry would profit little.

The development of the process[1,2] referred to earlier for removing bark, foliage and other extraneous material from chips, serves to illustrate how a programme is developed in response to perceived research needs. Ten years ago, it was recognised that wood costs could be reduced and better utilisation made of the forest resource if a larger portion of the tree that is normally harvested, as well as presently unmerchantable trees, could be used to produce chips for pulp manufacture. This would involve chipping the entire tree (except stump and roots) in the woods, and then separating out the sound chips from the extraneous material, probably at the pulp mill. However, it was appreciated that it would be necessary to break the bark away from the chips and then segregate bark, foliage and other impurities from the mixture. The difficulty lay in finding a property of bark that is sufficiently different from that of wood to allow it to be used in the separation process.

From a study of the literature and from some brain-storming, it was decided that possibly advantage could be taken of the weaker structure of the bark relative to that of the whole wood.

Some exploratory work was done, sufficient to indicate that the approach held some promise of success. A project proposal was then prepared which, after review, was approved for incorporation in the programme. Both fundamental and applied research were undertaken; the former to study the bark-to-wood bond and the effect of micro-organisms on the strength of the bark; the latter to test the hypothesis that the structure of bark could be preferentially broken down whilst the whole wood was preserved virtually intact. From these tests and the supporting fundamental work, an approach for achieving the objective was conceived and evaluated in the laboratory.

From the results of that work the chances of technical success appeared good and a preliminary economic assessment was undertaken using the data then available. From this, it appeared that the process would be economically feasible and the next step, that of pilot-plant trials, was embarked upon.

After completion of these trials, the economic assessments were defined. The Institute is now working with individual companies to evaluate the process using their full-tree chips and is in negotiation with suppliers pertaining to the commercialisation of the process.

It is a simple process, utilising standard equipment found in many mills. It involves the steps of conditioning the bark, either by storage or by atmospheric steaming, followed by agitation to break it down, and finally separating the good wood from the impurities. The bark and foliage are then available for use as a fuel or for other uses.

Throughout the history of the project, the work has been subjected to regular reviews by the Research Programme Committee and by the management of the Institute. This project differs from other Institute projects in that, since 1975, it has been carried forward under the management of the Institute, while jointly supported by PAPRICAN and FERIC. This is particularly appropriate since the process could well affect harvesting methods and transportation, as well as wood preparation at the mill.

Communication of Results

The value of research lies only in the use that is made of it. Thus, as in any research organisation, at PAPRICAN a great deal of effort is devoted to the communication of results. Unfortunately, even with well-written reports, effective communication cannot be assured and indeed seldom occurs. Thus, the Institute relies heavily on formal and informal interpersonal communciations, such as occur with the many visitors to the Institute and during seminars given at company locations and also to larger groups at Pointe Claire or other convenient locations.

During project work in the mills, there is of course an intimate and effective dialogue developed between Institute and company personnel. Indeed the involvement of company personnel

in the work of the Institute has proved to be one of the best ways of transferring our findings into use in the mills. Participation in the activities of industry associations, and especially in the committees of the Technical Section, CPPA, provide another valuable route for communication with industry personnel.

The Institute's written reports are generally tailored for specific audiences. For example, the annual report is prepared primarily for industry executives, governments, and the general public. 'TREND', which is issued twice yearly and contains articles in semi-technical language, is intended for non-technical personnel in the pulp and paper industry but goes as well to many technical and operating people in the companies.

Semi-annually, progress reports on all active projects are sent as confidential documents to representatives of Maintaining Member Companies, based on a mailing list provided by the Members. These are technical reports and provide a valuable insight into the nature of the research and the results which are being obtained. They are intended for anyone in a Member Company who is interested in following in detail the work of the Institute.

Upon completion of a project, or a phase of a project, a PAPRICAN Report is prepared. This is a one- or at most two-page document which first of all places the subject in its industrial context, and then highlights the methods used and the results obtained. By returning a reply card which accompanies it, the recipient of the PAPRICAN Report can automatically receive the fuller, detailed technical report.

In commercial terms, the communication of the Institute's findings is in essence the marketing of its product. As a result a great deal of care is given to the content and form of any written report, and every technical report must pass an internal review before being issued. As is natural, the Institute is proud of its product and is anxious that it be well-received and appreciated. Although communication must necessarily be a two-way street, the Institute assumes the major responsbility for endeavouring to ensure effective communication.

The philosophy which prevails is that the research is not completed until it has been properly communicated.

In an industrial context, a research organisation is very vulnerable to the short-term imperatives of `the bottom line'. Its main purpose is to breed good ideas, to nourish them well, and, when they have grown strong, to apply them to the solution of technical problems. It is not like a machine that can be stopped and started again at will without difficulty.

One can direct a manufacturing unit to produce, but no one can dictate or control the generation of ideas that are the very foundation of research. Not only is the innovation process a fragile one, but research must be regarded as an investment, a long-term investment. It requires a commitment to the future and a willingness to fund it over the long haul. Fortunately for PAPRICAN, the Canadian pulp and paper industry has provided the essential climate and support for research ever since the creation of the Institute in 1925. What is equally important is that the staff of the Institute perceives the industry as having confidence in the Institute and as being prepared to make the necessary long-term investment in its activities.

An institute like PAPRICAN is essentially a collection of extremely creative people. Nevertheless, in many respects its operation is no different than that of other forms of organised human endeavour. The first job is to determine what must be done, then to bring to bear the best brains available, to stimulate their thinking, to select the appropriate lines of endeavour, and to provide the resources necessary for the task. Basically, it comes down to a question of attitude: pride in good science and a deep-rooted desire to address the most urgent research needs of the industry.

REFERENCES

1. Berlyn, R.W. and Hutchinson, J.D. "Chip Debarking. A Method for Removing Bark and Foliage from Wood Chips". Canadian Patent No. 1000656, Nov. 30, 1976. Assigned to the Pulp & Paper Research Institute of Canada.

2. Berlyn, R.W., Hutchinson, J.D., and Gooding, R.W., "A Method for Upgrading Chips from Full Trees", 1979, Pulp and Paper Canada, **80**(8), p. 56

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?

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

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.

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 exhuastive 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

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

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

identifying the long range changes, the discontinuities. The reponsibility 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?

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 Göttsching 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. Göttsching

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.

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 busines 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

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 displines, 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

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

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

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

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 committtee 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-

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.