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RESEARCH AND DEVELOPMENT ACTIVITIES FOR THE PULP AND PAPER INDUSTRY IN THE EEC COUNTRIES

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Abstract

Most EEC countries have institutes concerned with research and development for the pulp and paper industry. These institutes are either independent establishments, such as PIRA in Great Britain or the Centre Technique in France, or they are part of larger institutions, such as the paper department of TNO in Holland or the Institute of Paper Technology of the Technical University of Darmstadt in the Federal Republic of Germany.

Budgets and personnel and hence the capacity of the research institutes vary considerably, characterised by a total staff of 12 persons minimum to 185 persons maximum. Accordingly, the budget varies between US$ 0.8 - 7 M per institute. The funding of the EEC research institutes is done in various ways, either by the government, or mixed, in the form of government and industrial contributions.

A few years ago the EEC commission in Brussels initiated a new funding incentive for certain projects.

Since the various research institutes already existed before the EEC was founded, it is not surprising that research strategies continue to have a strong national bias. The multinational character of research is still under-developed. The reason for this is, among other things, that the paper industries in some EEC countries regard international research with a certain suspicion. In addition, active communication and cooperation in research and development are impeded by the fact

that much energy must be expended for raising funds. This is bound to lead to pronounced formalisation and to tactical biases in those bodies which are concerned with research and its contents.

Introduction

The nine EEC countries are paper producers with a long tradition, which have to supply one of the most exacting markets in the world with graphic papers, packaging papers, board, hygienic papers, and technical speciality papers. Because of the long national history of the EEC paper industry, it is very heterogeneous, predominantly composed of privately owned and medium-sized companies, with only very few large ones, totalling a turnover in excess of US$ 500 M. As many as 1150 paper mills produce 23 M tonnes of paper and board, which is still only 75 % of the consumption of the 260 M EEC population.

Compared with the production of paper, the pulp and groundwood production of 6 M tonnes is small, whereas the use of waste paper at a level of 10 M tonnes is of the same order as in the American paper industry. These facts determine the main areas of research and development in the central research and university institutes. The emphasis is on paper technology including waste-paper recyling and environmental protection, and on printing and packaging. By comparison, wood chemistry and pulp/groundwood technology play only a minor part in research compared with Northern Europe and North America.

Parameter	EEC	Northern Europe N, S, SF	USA
Countries	9	3	1
Population (m)	260	17	220
Paper Consumption (kg/c)	120	165	275
Pulp Mills (Chem and Mech)	130	165	280
Paper Mills	1150	140	690
Production			
Chemical pulp (10^6 t)	3	11	42
Mechanical pulp (10^6 t)	3	5	4
Paper and Board (10^6 t)	23	12	58
Consumption			
Chemical pulp (10^6 t)	9	6	43
Mechanical pulp (10^6 t)	3	4	4
Waste paper (10^6 t)	10	1	13
Paper and board (10^6 t)	31	3	64

Sources: 1. Papier, 1979. Leistungsbericht der Zellstoff-, Holzstoff-, Papier-, und Pappenindustrie. Ed. Verband Deutscher Papierfabriken, Bonn, 1980
2. Pulp Paper Int., 1979, Annual Review (July).

Table 1
Pulp and Paper in EEC, Northern Europe, and USA in 1978

Central Research and University Institutes

There is hardly another region in the world with a multi-layer infra-structure of research institutes similar to that in the larger EEC countries, West Germany, France, UK and Italy. Some of these institutes were founded at the beginning of this century but the larger part in the 1950's. Although we will, in the following, deal mainly with the most widely known central research and university institutes in Europe, we must not forget the comprehensive R and D activities of the chemical, engineering and other supply industries, of the pulp and paper industry itself, and of the printing and packaging industries. The total research expenditure of the various branches of the industry as regards personnel, instrumentation and machine equipment is considerably larger than the expenditure of the central research and university institutes in the EEC.

Country	Production (1979)			R&D Costs (1980)	
	Pulp 10^6 t	Paper 10^6 t	Total 10^6 t	Total 10^6 US$	Specific US$/t
FRG	2.0	7.5	9.5	7.2[1]	0.75
France	1.9	5.3	7.2	6.8	0.95
UK	0.3	4.2	4.5	4.5	1.0
Italy	1.1	5.1	6.2	3.2	0.5
NL	0.2	1.7	1.9	0.75	0.4
Belgium					
Denmark	0.5	1.2	1.7	1.25[2]	0.15
Ireland					
Total	6.0	25.0	31.0	22.7	0.73

[1] Including 4 University and seven Central Research Institutes.

[2] Estimated: Gembloux (B) and Copenhagen (DK)

Table 2 R&D Costs of Research Institutes in the EEC related to Pulp and Paper Production

Table 2 shows the production of pulp (chemical and mechanical) as well as paper and board in the EEC countries. It also shows the costs of the central research and university institutes. Since there is no large central research institute in the Federal Republic of Germany compared with those in France, UK, and Italy, the table shows the total costs of 11 small or medium-sized German institutes. The costs for the other countries, however, are those of one central research institute each, namely:

- for France, Centre Technique de l'Industrie des Papiers, Cartons et Celluloses (CTP), in Grenoble,
- for the UK, PIRA in Leatherhead,
- for Italy, SIVA in Rome, Milan and Fabriano.
- The Netherlands are represented by the paper department of the government research institute "TNO" in Delft.
- For Belgium and Denmark, estimated costs are given, since the universities at Gembloux and Copenhagen are engaged in certain R and D activities in the pulp and paper fields.

Of particular interest are the relative R and D costs per tonne of pulp and paper. The largest relative expenditures in central research and university institutes are those in the UK and France, about US$ 1 per tonne, whereas in Italy and the Netherlands the relative expenditure is only half as much, while it is very modest in Belgium and Denmark. (No research activities are known from Eire). Although the figure for the Federal Republic of Germany includes all the costs in the following research and development sectors:

- cellulose and polymer chemistry,
- pulp/groundwood technology,
- environmental protection,
- paper technology,
- paper converting,
- printing and packaging,

which is not the case for the figures for France, the UK, Italy and the Netherlands to the same extent, the relative R and D costs in West Germany are, at US$ 0.75 per tonne, below the

French and British levels*. But then, the research and development activity of the supply industries in Germany has a variety not found in the other EEC countries as far as the chemical, engineering and the wire/felt industries are concerned.

Selected Research Institutes in the EEC

The comparison between research institutes which follows, refers to:

- CTP/Grenoble (F),
- PIRA/Leatherhead (UK),
- SIVA/Rome (I),
- IfP/Darmstadt, (FRG),
- TNO/Delft (NL),

whose staffing, budget and floor space are shown in Table 3.

Institute	Year	Founded by	Budget 10^6 US$	Staff	Space m^2
CTP	1957	Pulp & Paper Industry	6.80	185	4,800
PIRA	1930	Printing Industry	4.50	171	5,700
SIVA	1956	Ente Nazionale Cellulose e Carta	3.20	124	19,000
IfP	1905	Paper Industry and Government	1.20	40	2,500
TNO	1939	Government	0.75	12	800

Table 3 General Information about Research Institutes in the EEC (1980)

* the costs of the following institutions are excluded:-

- France: Ecole Francais de Papeterie, Grenoble (EFP)
- UK: University of Manchester, Paper Science Dept. (UMIST)
- Italy: Stazione Sperimentale pere la Cellulosa, Carta e Fibre Tessili Vegetali ed Artificiali, Milan.

Table 4 shows how difficult an objective comparison of research costs is. It shows the various departments of the institutes with their main research areas.

Inst.	Dept. 1	Dept. 2	Dept. 3	Dept. 4	Dept. 5
CTP	Cellulose Pulp Environment	Paper/Board Converting	Automation and Tech. Assistance	Equipment Development	Economy
PIRA	-	Paper/Board	Printing	Packaging	-
SIVA	Pulp	Paper/Board	Printing	Packaging	-
IfP	Pulp (Mech) Environment	Paper/Board Converting	-	-	-
TNO	-	Paper/Board	-	-	-

Table 4
R and D areas of Research Institutes in the EEC (1980)

CTP works in the areas of cellulose and polymer chemistry, pulp technology, environmental protection, paper and board manufacture, and converting.

In addition, CTP has a small economics section. In view of these activities, CTP is more than any of the other EEC institutes comparable to the North European central institutes.

The situation is different in the other EEC institutes as far as the breadth of research activities is concerned. PIRA as well as SIVA concentrate on the paper, board, converting, and packaging sectors. Since hardly any pulp or groundwood is produced in the UK it is understandable that no research is done in this field, in contrast to Italy with its own, albeit, small, pulp industry.

IfP in Darmstadt concentrates on the paper technology sector, and, in converting, on corrugated board, and has a relatively large environmental protection department. For the sectors of cellulose chemistry, pulp technology, printing, and

packaging, there are other university/central institutes in Germany in Darmstadt (3), Munich (4), Karlsruhe (1), Hamburg (1), and Braunschweig (1). This decentralisation of research reflects the federal structure of the country.

Finally, the research activity of the paper department of TNO is solely in the paper sector, with some activity on converting and environmental protection.

1. Staffing

Institute	Total Staff	Staff Distribution in percent.					
		Dept.1	Dept.2	Dept.3	Dept.4	Dept.5	Admin. Library Workshop
CTP	185	22	24	17	11	2	24
PIRA	171	-	30	33	17	-	20
SIVA	124	16	30	11	23	-	20
IfP	40	23	50	-	-	-	27
TNO	12	-	100	-	-	-	-

Table 5
Staff of Research Institutes in the EEC (1980)
(Distribution according to Departments)

Table 5 shows the total staff of the institutes and the split between departments, the latter being those of Table 4, apart form the service departments (administration, library, workshop).

In all institutes, the "paper and board" and sometimes also "converting" departments (particularly corrugated board) are the strongest. The activities of IfP and TNO are concentrated in these areas.

Since Great Britain and Holland produce hardly any pulp and little groundwood, it is understandable that no "pulp" departments exist there. PIRA's primary research area is traditionally printing. "Environment" is part of the "pulp" department at CTP, SIVA and IfP, while at PIRA and TNO it is part of the "Paper/Board" department.

A particularly interesting feature of the personnel structure is the proportion of graduates, laboratory technicians, craftsmen and other members of the staff, working in laboratories, pilot plants, administration and documentation. For the benefit of those from other parts of the world interested in research, Table 6 also shows the averages although the arithmetic averaging procedure is somewhat problematical.

		Staff Distribution (in Percent)			
Institute	Total Staff	Graduates[+)]	Technicians	Craftsmen	Others
CTP	185	35	44	7	14
PIRA	171	46	23	5	26
SIVA	124	23	24	40	13
IfP	40	33	33	22	12
TNO	12	42	33	25	-
Average		35	32	20	13

[+)] University or Technical University degree

Table 6
Staff of Research Institutes in the EEC (1980)
(Distribution according to Qualification)

Graduates are the strongest group, averaging about one third of the total. This is indeed the ratio at CTP and IfP, whereas at PIRA about half the staff are graduates. Since degree qualifications vary in the individual EEC countries, comparing the proportion of graduates has to be done carefully.

Institute	Graduate Staff Total	Distribution of Graduate Staff (in Percent) Chemists	Physicists Mathematicians	Paper Eng.	Mech. & El. Eng.	Other[+)]	Administrators
CTP	62	35	15	20	15	12	3
PIRA	79	20	28	15	5	25	7
SIVA	28	50	4	-	18	24	4
IfP	13	15	10	45	15	15	-[++)]
TNO	5	40	10	-	40	-	-[++)]
Average		32	13	16	19	15	(5)

[+)] Other. Biologists, Chemical Eng., Printers, Interpreters etc.
[++)] General Administration not included

Table 7
Graduate Staff of Research Institutes in the EEC (1980)

Table 7 gives the breakdown of graduates by discipline: scientists (chemists, physicists, mathematicians) and engineers (paper, mechanical, electrical and electronics), that is, the disciplines most important for the institutes. On EEC average, chemists dominate, providing about one third of all graduates, followed by the various kinds of engineers, who together make up another third. The large difference in the numbers of paper engineers is explained by the fact that there are no technical universities in Italy and Holland with paper technology departments.

The large number of paper engineers at IfP is explained by the fact that IfP, apart from carrying out research, is responsible for the training of paper engineers. On the whole, however, the scientists of the three disciplines mentioned dominate in the EEC, while mathematicians are but a small group.

The absence of graduate administrators at IfP and TNO results from the fact that the administrations are in the hands of the Technical University of Darmstadt and the government Institute TNO, respectively.

Research does not live on sufficient funds and good management alone but on the motivation of the staff, particularly the graduates, and on the experience of all its members.

Institute	Total Staff	Average Age years	Age Distribution (in Percent) 18 -30 years	31-40 years	41-50 years	51-65 years
CTP	185	39	18	40	20	20
PIRA	171	43	23	18	23	36
SIVA	124	37	36	25	23	17
IfP	40	35	40	23	23	14
TNO	12	47	8	33	17	42
Average		40	25	28	21	26

Table 8
Age of the Staff of Research Institutes in the EEC (1980)

Against this background, an analysis of the age structure of the staff in the research institutes is of particular interest (Table 8). The average age in all institutes is 40, with a relatively large range of 12 years. The age distributions show that there is a balanced ratio between the age groups in some of the institutes, whereas in others the over-fifties dominate at the expense of the important group of 30-50 years. The Italian and German institutes have the youngest staff, for which there may be special reasons.

For social reasons, an existing age structure can hardly be changed in the medium and long terms. This will remain true in the future because of both the general level of unemployment, and the stagnation of the paper industry in some EEC countries.

2. Funding

The management of each institute has to make increasing efforts to secure revenue. The sources of financial support reflect the different origins of the institutes. CTP and PIRA originated from industrial initiative, whereas SIVA, IfP and TNO are government institutions. Thus it is natural that 70 and 80% of the funding of PIRA and CTP, respectively, are provided by industry, even if these proportions are differently split between member subscriptions, services, and contract research.

		Distribution of sources (%)				
Institute	Budget 10^6 US$	Industrial support		Government support		Grants and loans
		Member subs.	Contract research	General support	Contract research	
CTP	6.80	65	15	-	18	3
PIRA	4.50	23	47	-	27	3
SIVA	3.20	-	7	93	-	-
IfP	1.20	-	12	45	43	-
TNO	0.75	10	30	40	3	16
Average		20	22	36	18	4
		42		54		4

Table 9
Funding of Research Institutes in the EEC (1980)

Member subscriptions are normally a fairly safe source of income but depend on the business situation if the subscriptions are linked to the production or turn-over of the industry. It is possible that research activity is increased if a larger part of the budget borne by the industry is financed through contract research.

As for the institutes in Italy, Germany and Holland, government support predominates, either as direct subsidy or in the form of contract research which is subject to professional control.

For some years now, subsidies by the national governments have been supplemented by funds from the supra-national EEC Commission. The various institutes are trying to obtain increasing sums of money from this large pot to augment national subsidies which are becoming more difficult to obtain: a strongly motivating factor from the point of view of financing.

Whether supra-national funding really stimulates research is something which may find a critical assessment at the symposium.

In Table 10 the budgets are split into
- salaries,
- investments (capital),
- running costs (revenue),
- travel.

		Distribution of Expenses (in percent)			
Institute	Budget 10^6 US$	Staff	Investment	Running Costs	Travelling Expenses
CTP	6.80	70	10	18	3
PIRA	4.50	55	10	27	7
SIVA	3.20	70	28[+)]	3	1
	(2.54)[++)]	(86)	(10)	(3)	(1)
IfP	1.20	70	15	12	3
TNO	0.75	75	10	10	6
Average		71	11	14	4

[+)] TMP-Pilot Plant (1980): 663,000 US$
[++)] Excluding: Investment TMP-Pilot Plant at SIVA

Table 10
Expenses of Research Institutes in the EEC (1980)

On average, salaries account for about 70% of the budget, with a modest 10% for investments. Ignoring the expensive SIVA investment (in a TMP plant), the investment costs vary only little, which is not the case for the running costs.

It should be noted that the running costs of IfP are not fully included in the budget since they are borne by the Technical University.

Institute	Budget	Total costs per person	Staff costs per person	Investment & running costs per person	Travelling expenses per graduate
	10^6	US$/P	US$/P	US$/P	US$/G
CTP	6,80	37,000	26,000	10,000	3,200
PIRA	4,50	26,000	14,000	10,000	3,800
SIVA	3,20	26,000	18,000	8,000	1,100
IfP	1,20	30,000	21,000	8,000	2,800
TNO	0,75	62,000	47,000	12,000	9,000
Average+)		30,000	20,000	9,000	2,750

+) Excluding TNO

Table 11
Relative Costs of Research Institutes in the EEC (1980)

Table 11 lists relative expenses per person employed (travelling expenses per graduate employed). The stated and calculated figures for TNO are very different from the rest and are therefore not included in the average.

For the other four institutes, the relative expenses in 1980 were about US$ 30,000 per head. The figures in the third column reflect indirectly the different income levels in the various countries, but also the different numbers of graduates and the different average ages of the employees. It would appear that the researchers in France are better paid than in the other EEC countries (with the exception of Holland). This impression is confirmed by the figures for the relative staff costs, which in addition show a significant difference in Great Britain from the

EEC average. The relative investment and running costs show, surprisingly, little variation about the average of US$ 9,000. The relative travelling expenses reflect partly the frequency of conference trips at home and abroad, partly the amount of trouble-shooting in the factories of the industry.

Institute	Budget	Pulp/ Environment		Paper/Board Converting		Printing		Packaging	
	10^6 US$	10^6 US$	%	10^6 US$	%	10^6 US$	%	10^6 US$	%
CTP	6.80	2.70	40	4.00	60	-	-	-	-
PIRA	4.50	-	-	1.6	35	1.8	40	1.1	25
SIVA	3.20	0.5	16	0.8	25	1.0	30	1.0	30
IfP	1.20	0.4	35	0.8	65	-	-	-	-
TNO	0.75	-	-	0.75	100	-	-	-	-
Total	16.45	3.6	22	7.95	48	2.8	17	2.1	13

Table 12
Costs of different R & D Areas at Research Institutes in the EEC (1980)

In Table 12, an attempt is made to split the costs by research area. This can be done only very approximately since the demarcation between research areas is different in different institutes. Environmental protection, for example, is considered in some institutes part of the "pulp" sector, whereas at PIRA and TNO it is integrated with the "paper and board" sector. A similar discrepancy exists for the area "converting" which in some institutes is a department of its own for which the costs are quoted, whereas in others it is part of the "paper and board" sector.

On EEC average, most money is spent on research on "paper and board" and less on "pulp and environmental protection". As far as environmental protection is concerned, one can expect

increased funding from government and industry and hence an expansion of this research activity.

Table 13 deals with the split of expenditure between:
- trouble-shooting,
- product development,
- applied research,
- fundamental research.

Institute	Budget	Fundamental research		Applied research		Product/Process development		Trouble shooting	
	10^6 US$	%	10^6 US$	%	10^6 US$	%	10^6 US$	%	10^6 US$
CTP	6.80	6	0.40	65	4.40	1	1.20	12	0.80
PIRA	4.50	10	0.45	40	1.80	5	0.20	45	2.00
SIVA	3.20	-	-	45	1.45	20	0.65	35	1.10
IfP	1.20	35	0.40	50	0.60	10	0.10	5	0.05
TNO	0.75	15	0.10	75	0.55	5	0.05	5	0.05
Total	16.45	8	1.35	54	8.80	13	2.20	24	4.00

Table 13
Structure of R & D activity in research institutes in the EEC (1980)

Taking into account the research activity of the pulp, paper and supply industries, one would have expected that all the institutes introduced here are to a considerable extent engaged in fundamental research and only marginally in trouble-shooting and product development.

This is not confirmed, as the table shows, since the proportion of trouble-shooting is relatively high, thanks particularly to PIRA and SIVA. This is certainly understandable for PIRA since it was founded and is to this day predominantly supported by the industry. This also explains why the two

government institutes, IfP and TNO, do little trouble-shooting, though they do not ignore it completely in order to keep in contact with industrial problems.

Fundamental Research in the EEC leads, regrettably, a lowly existence. If the expenditure for fundamental research at CTP, PIRA and IfP is translated into numbers of employed engaged in it the result is about 10 persons, independent of the size of the institute. This assumes that the people doing fundamental research have higher qualifications and are therefore more highly paid than the average at these institutes.

The big field of action at the institutes is applied research. When looking at the figures one has to remember, however, that the border line between applied and fundamental research on the one hand, and product development on the other can be diffuse and that it is drawn with different degrees of self-criticism or liberalism at the various institutes.

3. Research Programmes

As far as strategic and programme aspects of research in the EEC can be condensed into tables and statistics, the following tables serve this purpose.

Table 14a shows

- who initiates R and D projects,
- which criteria determine the selection of R and D projects,
- which persons or bodies monitor the R and D projects.

The mechanisms vary considerably between institutes, particularly the initiation of projects. There is more pronounced formalisation at the French CTP where the council determines the guide-lines which are then worked out in detail by the programme committee and by working groups, in collaboration with the researchers. In the other institutes, the researchers themselves have a greater influence on initiating projects, particularly at PIRA and SIVA but also at IfP. Suggestions from industry are taken into consideration, however. In Holland it is

Table 14a

R and D Strategy of Research Institutes in the EEC

Institute	Who initiates projects?	Criteria for selection of projects	Monitoring of projects	
			Internal	External
CTP	.Council .Programme Committee	.Needs of Industry .Evolution of Technology	.Project Leaders	.Working Groups
PIRA	.Researchers, with help from Industry	.Needs of Industry	.Project Leaders	.Advisory Groups
SIVA	.Senior Researchers	.National and Industrial requirements .Widening of Competence	.Project Leaders and Senior Researchers	
IfP	.Senior Researchers with help from Technical Committees	.Needs of Industry and Government .Qualification of Engineers	.Head of Institute	.Supporting Assoc. and Ministries .Faculty
TNO	.Research Assoc. of Paper Industry .Paper Mills .Researchers	.Needs of Industry	.Head of Dept.	.Advisory Committee .Working Groups of Research Assoc.

the Research Association of the Paper Industry which is responsible for initiating projects, apart from individual paper mills and researchers at the institutes.

It is obvious that the selection of projects is determined by the wish to assist the national pulp and paper, and printing and packaging industries, particularly in the form of applied research. The main aim is to provide impulses for saving raw materials and energy and for further optimising the processes. For SIVA, a further intention is the broadening of the competence of its staff. This is also true for IfP where most of the research is done by younger engineering graduates who want to obtain a doctorate within about five years.

The internal control of projects is in most cases the responsibility of project leaders and of senior researchers. Since IfP is a university institute the internal control rests with the Head of the institute, who has the added responsibility of ensuring that the research projects satisfy the scientific requirements of the faculty of mechanical engineering. External control is exercised by working groups and consultative bodies in which the industry is represented, thus ensuring transparency and motivation. At the predominantly industry-funded institutes (CTP and PIRA), industry has a say in the control of projects. At the predominantly government-funded institutes (SIVA and IfP), industry has no direct control function but has an indirect influence on the quality of the projects through publications and presentations.

Table 14b deals with the time scale of projects, the assessment of the value of projects, and the presentation of results. The value of a project is assessed either in a formal manner, as at SIVA, by calculating invested man-hours and costs, or on a supply and demand basis, as at PIRA, which depends for a large part of its budget on contributions from its members. The topicality of projects is important in attracting new members, besides retaining existing ones. At CTP, the programme committee and the working groups share the control function, pooling the knowledge of representatives from the industry and the institute.

Table 14b

R and D Strategy of Research Institutes in the EEC

Institute	Duration of Projects years			Assessment of worth of Projects	Presentation of Results of Projects
	Min	Max	Average		
CTP	1	5	2.3	.Programme Committee .Working Groups	.Annual Reports .Reports to Industry .Publications and Lectures
PIRA	0.5	5	2	.Member Retention Value .Royalty Income .Attractiveness to Sponsors	.Conferences and Lectures .Meetings of Advisory Groups .Training and Licences
SIVA	0.5	2	1	.Research Hours and Expenses	.Reports .Publications
IfP	1	5	2	.PhD Degree .Patents	.Publications, Reports .Conferences, Lectures .Meetings of Tech. Committees
TNO	1	3	2	.Advisory Committee .Working Groups	.Reports .Meetings of Working Groups

The presentation of research results takes the form of publications, papers given at conferences, and reports which are either confidential and made to the industry, or published. Apart from these normal modes of communication, CTP, IfP, and PIRA have the additional platform of seminars for training and education. Of particular value is the communication of research results at meetings of technical committees of the paper industry since this promotes critical discussion and stimulates follow-on projects.

		Publications and reports		Papers		Participations at meetings etc.	
Institute	Projects	Home	Abroad	Home	Abroad	Home	Abroad
CTP	30	5	3	24	10	30	16
PIRA	10	38	-	30	10	50	5
SIVA[+)]	?	6	-	2	-	12	4
IfP	8	16	4	12	4	55	12
TNO	5	11	1	3	1	10	2

[+)] Re-organisation of institute and start-up of a new building in Rome (Pulp and paper, and printing departments).

Table 15

Projects, publications, papers, and participation at meetings and conferences of research institutes of the EEC (1980)

Finally, table 15 presents figures for the communication of research results in the form of reports, publications, and conference papers at home and abroad. Naturally, communication at home predominates over communication abroad, a result in part of the language barrier for those institutes whose language is not English: this should not be under-estimated. The same priority ranking is seen in the figures of participation in conferences, seminars, and meetings. There is room for improvement generally in communication abroad, an area in which this Fundamental Research Symposium at Cambridge should certainly help.

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.