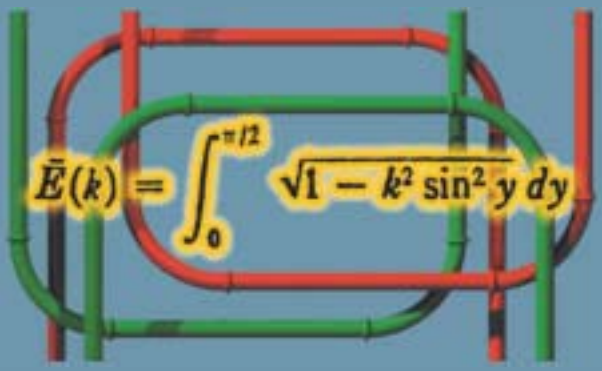
PUBLICATIONS OF THE ACADEMY OF FINLAND 12/02

Research Programme for Process Technology 1999-2002

EVALUATION REPORT



ACADEMY OF FINLAND

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Research Programme for Process Technology 1999-2002

EVALUATION REPORT

Members of the Evaluation Panel:

Professor Bengt Andersson,
Professor Anna Soffia Hauksdóttir,
Professor Cor J. Peters (Chair),

Coordinator:

Ritva Taurio Lic. Tech.

Academy of Finland in brief

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Preface

The Research Programme for Process Technology (PROTEK) of the Academy of Finland was designed from the need of a better understanding and closer control of the basic phenomena involved in industrial processes. It was found necessary by the scientific community to invest more resources into basic research on process technology, to raise the standards of basic research and to integrate the information generated by different disciplines.

The three-year programme comprised ten projects representing the following organisations: the Universities of Helsinki and Oulu, Helsinki University of Technology, Lappeenranta University of Technology, Åbo Akademi University and the Technical Research Centre VTT. Most of the groups started their research in August 1999 apart from one project that began in January 2000. The total budget was EUR 2.5 million, of which coordination accounted for EUR 33,600. The research projects involved are listed in Appendix 1.

The international scientific evaluation of the programme was conducted by Professor Bengt Andersson from Chalmers University of Technology, Professor Anna Soffía Hauksdóttir from the University of Iceland and Professor Cor J. Peters from Delft University of Technology, who acted as the chair of the panel. The experts were asked to focus their evaluation on e.g. the following issues: the objectives and composition of the programme, the effect of the level of the funding, the scientific quality and recommendations for future research programmes. The complete assignment of the evaluators is in Appendix 2. Sincere thanks are due to the experts for their most valuable work.

The evaluation of the relevance and effectiveness of the programme was conducted by the Programme Committee, consisting of Senior Technical Adviser Mika Aalto from the National Technology Agency (Tekes), Professor Riitta Keiski (chair) from the University of Oulu, Professor Risto Raiko from Tampere University of Technology, Professor Peter J. Slotte from Åbo Akademi University and Docent Antti Vuori from Kemira Corporation. This part of the evaluation was based on the self-evaluations of the research groups and on the expertise the Programme Committee has on the research area.

Riitta Keiski
Professor
Chair of the Programme Committee

Introduction

The first proposal for a process technology-related research programme was drafted by the Research Council for Natural Sciences and Engineering in 1997. Preparations and planning were continued in early 1998, and on 9 June 1998 the Board of the Academy of Finland decided to launch the PROTEK Research Programme in 1999. The programme was carried out in co-operation with the Research Council for Environment and Natural Resources (later Research Council for Biosciences and Environment).

The main objective of PROTEK was to improve the quality of industrial processes and in the long term to promote the competitiveness of process industry products, with a special view to environmental, economic and safety considerations. The three main themes of the programme included basic process phenomena, process simulation, modelling and optimisation, and development of research methodology.

More specifically, the objectives of the programme were to

- undertake and support high-quality basic research in process technology
- develop universally applicable research methods and tools for studying basic phenomena
- facilitate the application and utilisation of research results in different process industries
- develop industrial processes with a view to improved operational efficiency
- integrate and make better use of the expertise of different disciplines in process technology
- promote researcher training in process technology

The programme had a two-phased call for applications. A total of 46 preliminary plans arrived at the Academy in November 1998, amounting to nearly EUR 15 million. Of these, 21 groups or consortia were asked to send in their complete application. At this time the Programme Committee also asked some groups to unite, to co-operate more closely or to look for further expertise in certain fields.

The international evaluation group rated the applications in April 1999. The members of the group reviewing applications were Professor Bengt Andersson (chair) from Chalmers University of Technology, Sweden, Associate Professor Emilia Björnbom from the Royal Institute of Technology, Sweden, Professor Jürgen Gmehling from the University of Oldenburg, Germany, Associate Professor Cor J. Peters from Delft University of Technology, the Netherlands, and Professor John Villadsen from the Technical University of Denmark. Decisions on the acceptance of the projects into the programme were made in May 1999.

Evaluation procedure

The final evaluation of PROTEK is divided into two parts: The first part consists of the international evaluation of the scientific quality and the reaching of the original objectives of the programme and the projects, and the second part is the self-evaluation of the relevance and effectiveness performed by the groups.

The following material was sent to the international panel in June and September 2002:

- Programme memorandum
- List of PROTEK projects
- Original research plans
- Annual reports 1, 2 and 3
- Publications produced during the programme
- Summary of the number of produced publications and theses

The panel visited the Academy of Finland on September 17, 2002 in order to discuss and prepare a draft for the scientific evaluation. The formal assignment of the panel is in Appendix 2.

The Programme Committee received the self-evaluation forms completed by the research teams and the coordination reports from the years 1999-2002 for the evaluation of relevance and effectiveness. The questionnaire forms of the self-evaluation are presented in Appendix 3.

Contents

1 Part One: The scientific evaluation

1.1 The objectives and composition of the programme

In most cases the objectives of the programme were realistic and challenging, although in some cases the problem setting of certain projects was much too ambitious. Some groups lacked the tradition of doing process-related research. Because of the short time frame along with insufficient financial resources there was also less innovative research and more continuation of previous or ongoing tasks.

The balance of the three main themes of the programme was relatively good but among the various groups only one consortium met all the three fields.

The range of the projects was very wide. However, some individual projects were narrow and concentrated much more on problem-solving than on basic research. These facts made co-operation between the different groups (except inside the consortia) quite limited.

1.2 Success of choosing the projects

The project themes ranged over from bioprocesses to catalysis. The main reason for this was the good success of the original applications in the evaluation process. Consequently, this led to lack of communication between the various groups and the consortia. The range was perhaps too broad.

It was difficult to analyse whether the co-operation among various groups inside the consortia was realistic. One 'forced' consortium failed just because of lack of co-operation. It was also observed that most single projects could have managed without the PROTEK connection. Probably the formation of consortia against the background of the limited duration PROTEK was not necessary. The selection of the projects was based on their scientific merits. If co-operation is an important goal this must be stressed more in the programme, and only projects in which co-operation is necessary for their progress should be selected.

1.3 Assessment of funding

The level of funding ranged from EUR 104,600 to EUR 437,270. The groups that applied for moderate amount of funding, in principle received the funding they had originally applied for. Discrepancies between the applied and granted amount of money were much bigger in the larger consortia. On the other hand, however, there was hardly any correlation in the scientific results or in the diminishing of grants, although this was not always a consequence of reduction in the original budget. Too ambitious specific objectives set for the project also affected the extent of scientific results. A few groups were able to receive extra financial support from other sources during the course of the programme.

In general, a better financial support and a longer period of time of the programme would have led to a positive shift in the scientific results from more problem-solving towards basic and fundamental knowledge.

1.4 Scientific quality

The output of PROTEK in figures was the following:

Articles in refereed scientific journals	51
Refereed conference papers	63
Other publications	48
PhDs	4
Lics	6
MScs	14

The number of doctoral theses and refereed articles was lower than expected. This may reflect the fact that the area is not that new, i.e. more traditional. The most productive groups mostly continued their earlier work, which made it much easier for them to produce relevant output. For more innovative projects it is more difficult to come up with high-quality output at the very beginning of the project.

As pointed out earlier, as the duration of the programme was relatively short due to limited financial resources, the type of research chosen by the various groups was not too risky. It was also noted that some groups did not even try to meet their own objectives. There was no clear correlation between refereed articles (or produced degrees) and the budgets of the groups, no matter if these were cut or not.

With a few exceptions, the scientific quality of the research was high. However, the excellent individual results did not always contribute much to the added value of the consortia.

1.5 Impact

PROTEK met most of the objectives set for the programme. The size of the budget and the funding time of the programme, however, reduced the impact of the programme. The main positive outcome was the transfer of postdoctoral researchers to industry, although this aspect remained under-developed. Some projects were certainly promising for future impact. In general, the programme was a success and many new and interesting results were obtained.

1.6 Recommendations

It is highly recommended that a steering committee or some equivalent body be appointed for future programmes to guide and guarantee that the groups perform their tasks according to their original proposals. It turned out to be very difficult to relate the annual reports to the original research proposals. The intermediate results achieved and the original plans should also be compared regularly. It is also recommended that the steering committee and the various groups be in close

interaction together in order to decide how the research has to be carried out.

If the budgets of the primary proposals are cut, the groups should have the opportunity to re-adjust their scientific plans according to the assigned budget. This will avoid unrealistic expectations. At this stage the groups could also sharpen their objectives.

When a project is progressing well and very promising results are to be expected, e.g. completed doctorates soon after ending the project or even a breakthrough in the research, it should be rewarded with an extension in funding and duration of the project. For that purpose, a budget should be reserved beforehand.

Generally, the duration of programmes should be longer in order to provide time for the groups to plan co-operation within the consortium and for PhD students to finish their doctoral degrees. This would give the groups a chance to start new research with new partners as well as make it possible to carry out a proper evaluation of the programme, since nearly all results are published during the last two years of a PhD project.

Future programmes should consist entirely of consortia that can take advantage of each other's expertise and findings. A consortium should be based on a common theme and coherence in the objectives to be achieved between the partners. It is recommendable to stimulate / force PhD students to move from group to group inside the consortia, and more opportunities should also be created within the consortia for researchers to meet each other and to exchange and coordinate their intermediate results. Preferably, a representative of the steering committee should attend the meetings, and it is also a prerequisite to have minutes available of these meetings.

Major forms of output include PhD theses, refereed articles in journals and refereed conference proceedings. The ultimate effect of a consortium should be reflected in papers produced by all partners of the consortium.

In selecting themes for programmes the decision-makers should choose only a few and build the consortia around this limited number of themes. Along with the main themes, there could also be an 'open area' for excellent and innovative projects that do not fit in the definition of the main themes. The role of industry is important in defining the main themes and certain special projects in the 'open area'.

In selecting projects the reputation of the principal researcher of a group should have more attention.

1.7 Future scenes

For fruitful future co-operation between universities and industry in the field of process technology, universities should be open-minded for the applied needs of industry; on the other hand, however, it is a prerequisite that industry is aware of that research at universities may never have a problem-solving character of actual industrial problems.

2 Part two: Relevance and effectiveness

2.1 Projects

2.1.1 Goals and objectives

The three main themes of the programme included basic process phenomena, process simulation, modelling and optimisation, and development of research methodology. New inventions and innovations were made in all these main fields.

Studies of basic phenomena were involved in more projects than expected, while attempts to model sometimes led to an increased need to understand the underlying effects. Characterisation of reactions, surface forces, new materials and mass flow were examples of achievements. Modelling practices produced calculation methods, models and submodels many times for defined objectives within industry. Of all the three main themes, the modelling groups approached the applied research most. Process methodology developed in the fields of configuration of new processes, testing, applying for CFD (computational fluid dynamics) models and model validation.

The groups achieved most of their main goals. Some groups are still carrying on their work with tasks that could not be done within the time frame set for the project. One group will finish its project by the end of 2002 because of the delayed starting time.

There were various factors that hampered the progress of the research, e.g. researchers left for other positions or key persons were replaced, which affected the planned collaboration. Distance was also mentioned as a factor that hampered close co-operation. In one case the original project was planned as a joint project, but only one partner received funding. Other factors hampering research included problems with analyses, equipment-related problems and failures in planning the schedule.

The proportion of basic research was in general high (70-100%); however, groups concentrating on pure modelling could give a value below 40 per cent. The Academy's share of funding to the groups varied from 50 to 100 per cent.

2.1.2 Contribution to the society

Because of the technological character of PROTEK, the interaction between research groups and the surrounding society took place in most cases in relation with industry.

Collaboration with companies was carried out in various ways, either by supporting the original study or by commercial utilisation of the results. Process industry had the role of deliverer when the research groups received samples, materials or even equipment. Immaterial support was also given in the form of encouragement, verification of case studies, testing on pilot scale and supply of industrial experimental data for modelling. These actions generated a couple of patents, either

realised or planned, and a commercialised method. Research collaboration concerning the applicability of the developed technology within the programme is currently being negotiated.

Popularisation of fundamental science was seen to be of minor interest to the public. Many groups considered that the phase of their studies is still immature for publishing, but admitted that future applications might receive public attention. One group pointed out that its results could benefit teaching and education. Using of CFD in visual simulation would help practical process planning.

2.1.3 Promotion of research careers

The funding of the three-year programme was equivalent to 74 person-years, which means that every year there should have been almost 25 researchers on duty. However, in reality the projects involved altogether 50 researchers, of which 31 were men and 19 women. Four group leaders out of 18 were women. Foreign researchers were hired in more than half of the projects, which made PROTEK a relatively multinational programme.

Postgraduate training was an essential part of the projects, providing a profound theoretical background for young researchers. The teams listed the following positive effects: knowledge base was created; opportunities for independent and team work improved; young postgraduates were accepted to attend international 'by invitation only' meetings; independence grew among young doctors. Altogether four doctors graduated and possibly a few dissertations might be completed in 2003. Perhaps the skills that young researchers need in industry could have been better promoted.

The future prospects of research career of those involved were, however, considered to be quite positive, as there are job opportunities in industry, research laboratories and public institutions. A couple of postgraduates were employed by companies during the course of the programme. Yet the continuation or spin-offs of the project was hoped for, because of the relatively short duration of the programme.

2.2 Consortium

2.2.1 Added value of the consortium

Working as a consortium was seen beneficial as close co-operation was developed between groups in several universities and research centres. Consortium meetings were fruitful occasions to generate and discuss new ideas. In some cases the consortium would have needed a longer funding period in order to use the full synergy potential of the collaboration. There was some researcher mobility between laboratories but this possibility was not much used. Some said that collaboration would have benefited even more by the involvement of a company.

Half of the projects were individual projects and the other half were consortia. After the first year one project left its consortium and continued its work independently.

The working of the consortia varied, as did also the views of the leaders about the added value of a consortium.

2.3 PROTEK programme

2.3.1 Added value of the programme

Very different and distant research fields were represented within the programme, which was due to the selection procedure – the quality of a research proposal was the main criterion and the compatibility with other projects only secondary. This was criticised in several reports with comments that the synergy remained relatively weak and contact points did not actually exist. PROTEK was a rather scattered programme in relation to its economic resources.

The annual seminars were organised at the Academy, each having a certain scientific theme (modelling, bioprocesses, thermodynamics). According to the researchers involved, the seminars provided an opportunity to meet other researchers in a constructive atmosphere and to learn from other's experiences. Some contacts were created during these occasions, which contributed to a multidisciplinary approach and were considered a strength.

PROTEK also promoted relations with other funding organisations, for instance it helped collaboration with Tekes' programmes. The existence of PROTEK also helped the entrance into an EU programme and made one university to allocate extra funding to equipment for the groups. For future Tekes' programmes there will be plenty of novel raw material for research.

The importance of basic research within process technology is evident in the promotion of more applied research and further innovations. Deep concentration on theory and methods helped raise the level of knowledge within the groups and new consortia promoted research collaboration and opened up new thoughts.

The groups criticised the short duration of the programme. The results can be only partly included in the evaluation because of the slow process of publishing them. The continuity of this kind of programme would be essential to promote basic research. Continuation of projects producing the most promising results should be planned beforehand. However, the Academy was seen as a flexible partner.

2.4 Coordination

The PROTEK programme was coordinated by Lic.Tech. Ritva Taurio, Scientific Secretary at the Academy of Finland. The coordination plan was designed by the coordinator and accepted by the programme committee. In the very beginning, the timetable of the programme, the programme memorandum, web pages, the application announcement and other practical matters were prepared by the coordinator and the programme committee. During the programme the coordinator took care of the annual researcher meetings, annual reports and of all the practical matters of the annual meetings. The final evaluation and the visibility of the

programme, e.g. by means of web pages, were also managed by the coordinator. She also visited many of the research groups and had keen cooperation with Tekes in the field of process technology research.

The programme coordinator has completed her tasks well. The organisation of information exchange and dissemination, the strengthening of the role of theme areas, the preparation of seminars, the visits to the research groups and the support to the project team, the collection of information for and preparation of the annual and final reports as well as all the information in collection with the evaluation procedure have been done in a very efficient way. The seminars have been well organised with excellent keynote lectures and research topics. Cooperation with Tekes' programmes and information distribution via poster presentations on the PROTEK programme has increased understanding among researchers on basic and applied process technology research and research funding. The overall management of the PROTEK programme was done very efficiently.

Appendix 1.

The participants and projects of the programme

Tapani Alatossava, University of Oulu: **Rapid and specific DNA-based methods for determinations of bacteria as tools to control and monitor industrial food processes**

Juhani Aittamaa, Helsinki University of Technology: **Modelling and developing of efficient process configurations combining reaction and distillation**

Kari Heiskanen, Helsinki University of Technology and Jaakko Leppinen, Technical Research Centre: **Modelling phase interactions in process engineering**

Mikko Hupa, Åbo Akademi University, Jorma Jokiniemi, Technical Research Centre and Risto Laitinen, University of Oulu: **Fundamental studies for improving submodels in combustion modelling**

Outi Krause and Jouko Lahtinen, Helsinki University of Technology and Markku Räsänen, University of Helsinki: **Kinetic modelling of dehydrogenation of C_3 - C_5 – alkanes**

Matti Leisola, Helsinki University of Technology and Marja-Liisa Riekkola, University of Helsinki: **Separation technology, cross-linked enzyme crystal, chiral separation**

Bruno Lönnberg, Åbo Akademi University: **Alkaline delignification of lignocellulosics**

Marja Oja and Sirkka-Liisa Jämsä-Jounela, Helsinki University of Technology and Juha Kallas, Lappeenranta University of Technology: **Expert system for crystallisation and filtration processes**

Tapio Salmi, Åbo Akademi University: **Kinetics, mechanism and transport phenomena in heterogeneous catalysis**

Ilkka Turunen, Lappeenranta University of Technology: **Models in process development: selection, validation and integration**

Appendix 2.

Academy of Finland
Research Programme for Process Technology June 27, 2002

Assignment

Evaluation of the Research Programme for Process Technology

1. Introduction

The Research Programme for Process Technology (PROTEK) was designed driven from the need of a better understanding and closer control of the basic phenomena involved in industrial processes. It was found necessary to invest more resources into basic research on process technology and to raise the standards of basic research and to integrate the information generated by different disciplines. The main objective of PROTEK was to improve the quality of industrial processes and in the long term to promote the competitiveness of process industry products, with a special view to environmental, economic and safety considerations.

The three-year programme comprised 10 projects which represented the following organisations: the universities of Helsinki and Oulu, Helsinki University of Technology, Lappeenranta University of Technology, Åbo Akademi University and the Technical Research Centre VTT. Most of the groups started in August 1999 apart from one that began in January 2000. Total budget was FIM 15 million, of which coordination took FIM 0.2 million.

2. Objectives and contents of the evaluation

The final evaluation of PROTEK is divided into two parts: The international evaluation of the scientific quality and the reaching of the original objectives of the programme, and the self-evaluation of the relevance and effectiveness performed by the groups. The international evaluation is conducted by Professor Bengt Andersson from Chalmers University of Technology, Professor Anna Soffía Hauksdottir from the University of Iceland and Professor Cor J. Peters from Delft University of Technology.

The evaluation panel is expected to find answers to following questions:

- Are the objectives of the programme at different levels realistic?
- Are the common scenarios and main points of emphases of the programme appropriate?
- How successful was the balance of the programme between the three main research themes?
- Did the selected projects meet the objectives of the research programme in terms of their plans?
- Was the funding made available to the projects appropriate in view of their research plans?
- How did the achieved results respond to the original research plans?
- How have individual researchers and researcher teams participated in the joint

programme action? How has programme membership been reflected in the work of the research groups?
- What is the scientific quality of the research results obtained (innovativeness and significance to the development of the field of research)? Have there been any scientific breakthroughs, are any such breakthroughs on the horizon? How have the other scientific objectives of the programme been reached?
- What kind of success has the programme as a whole had with regard to integrating and synthesising the results?
- Are there scientific, social, economic or technological impacts in sight that are in line with the objectives set for the research programme? If so, what kinds of impacts?
- Any other comments?

The material that will be produced by the self-evaluation reports of the groups will be processed by the Finnish Programme Committee. The Programme Committee performs also the evaluation of the coordination.

3. Evaluation procedure and time-table

The main material will be provided to the international panel in June 2002. The last annual reports are asked to be delivered to the Academy by the end of August 2002. These will be sent to the panel immediately. The material is listed at the end of this letter.

The panel meets in Helsinki on September 17, 2002 to prepare the first draft of the evaluation report. Technical assistance will be provided by the Academy of Finland before and during the visit. The report is expected to be written by the end of October, 2002 while the Programme Committee contributes to the evaluation with its analysis on the self-evaluations. These two reports will be published in the same entity.

Remuneration for the Chair is supposed to be EUR 1,700 and for the panel members EUR 1,500. The Academy of Finland pays for travel and accommodation, but wishes that Business Class would be used only in urgent need.

Riitta Keiski	Jan Bäckman
Chair	Scientific Secretary

Encl. Programme memorandum
List of PROTEK projects
Original research plans
Annual reports 1 and 2 (3rd will be sent in September)
Publications produced during the programme (will be sent with the 3rd Annual report)

Appendix 3.

The questionnaire for self-evaluations of the participants

ACADEMY OF FINLAND 13.5.2002

Research Programme for Process Technology (PROTEK)

Self-evaluation of the research project and the programme

Name of project

Name of researcher

PROJECT

Goals and objectives
• Explain the main scientific outcome of the research carried out and name the best three findings. What have been the significance and innovativeness of the theories, methodology, main approaches and results? • To what extent did you achieve the goals and objectives? What remained undone because of restricted resources? What was the Academy's share of the funding of the group? • What was the proportion of basic research of all the research done in your group? • What factors have hampered the progress?

Contribution to the society
• What was the contribution to new inventions and innovations? • Was there collaboration with enterprises? How was the economic utilisation of the results?
• Have the results been used for popularisation? Is there any potential for it?
Promotion of research careers
• Was there contribution to the postgraduate training? Explain promotion of women and young researchers in their research careers within the project. • What kind of potential does the project give for the further employment of the researchers?

CONSORTIUM

Added value of the consortium
• How has the working as a consortium advanced the research of your project?§ How would the consortium have been more beneficial to your project? • To what extent has the research been carried out as a team-work between the groups of your consortium?

PROTEK PROGRAMME

Added value of the PROTEK programme
• How has the PROTEK programme furthered your project regarding – scientific work? – the development of your research unit? – researcher training? – economic or social utilisation? • What were the strengths and weaknesses of the PROTEK programme? • Can you see benefits for your own project of collaboration between the Academy of Finland and Tekes in this programme? • Do you wish to comment any other aspects regarding the programme?

The evaluation of the Research Programme for Process Technology (1999-2002) is divided into two parts; the first part concerns the international evaluation of the scientific quality of the programme and the second part describes the self-evaluation of the programme's relevance and effectiveness.

The scientific quality of the research was predominantly of a high level, but the number of doctoral theses and refereed articles was lower than expected. The international panel recommends among others that future research programmes should consist entirely of consortia that could benefit from the participating research groups' expertise and findings.

New inventions and innovations were made in all three main fields of the programme: process phenomena, process simulation, modelling and optimisation, and development of research methodology.

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