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Research evaluation in Finland

Practices and experiences, past and present

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Foreword

This report is one of the background studies commissioned by the expert group, appointed by the Ministry of Trade and Industry and the Ministry of Education, to assess the impact of the Government Additional Appropriation to Research Work, effective in 1997-1999. The study was conducted by Juha Oksanen from VTT Group for Technology Studies.

The author would like to thank the assessment expert group for their comments during the project. I am grateful to the interviewees who kindly used their valuable time to clarify to me how evaluations are utilised in decision-making. I have also had the good fortune to receive assistance and advice from many individuals throughout the work. I would like especially to thank Eija Ahola and Pekka Pesonen of Tekes, and my colleagues at the Group for Technology Studies for their thought provoking comments. Finally, I am deeply indebted to Tytti Suojanen and Phoebe A. Isard for checking the language of the report.

Naturally, all responsibility for the text lies solely with the author.

Espoo, June 2000

Juha Oksanen

Executive summary

This report provides an up-to-date review on the evaluation of public research and development activities in Finland during the last two decades. The purpose of the work is to shed light on the development and use of evaluation in the field of Finnish science and technology policy. More thoroughly analysed issues cover the extent of evaluation activities, main conclusions and recommendations, and the significance of evaluation information in decision-making processes. The report draws on a broad selection of published evaluation reports and number of interviews conducted among decision-makers with a vantage point over the Finnish R&D system.

The main findings of the report are as follows:

1. The evolution and diffusion of the evaluation culture has taken place gradually. After 17 years of development, evaluation is visibly anchored in the Finnish research and development system. In the 1980's and at the beginning of the 90's, evaluations focused more on the quality of research, on the position of basic research, and on the conditions of research. Since then, more attention has been paid to the relevance and impact of R&D activities, and to organisational and strategic questions.

2. The R&D evaluations are characterised by a fairly established toolkit of peer review and impact analyses procedures. Evaluations are carried out by people who have a good track record either in the research community, in the administration of research institutions, or in industry. Finnish commissioners tend to look for evaluators from countries that are close "culturally".

3. On numerous occasions the decision to launch the evaluation had a "pulling-the-trigger" effect, i.e. the evaluation process was the start-up for major organisational restructuring.

4. The need for strategic rethinking among Finnish R&D organisations was widely identified in the evaluations. Organisations were recommended to target activities at a limited number of selected subject areas or core tasks, and to increase co-operation with other relevant actors nationally and internationally.

5. The length of post-graduate studies leading to a doctorate has been one of the most visible structural weaknesses in the Finnish research system. The situation improved noticeably after the new graduate school system was created in 1995.

6. The development of co-operation in its various forms is one of the enduring concerns in evaluation. Finnish institutions are encouraged to exploit opportunities to participate in the definition and development of new international R&D programmes. Also, with rapidly increasing involvement in international co-operation it has become even more important than before that participation in international activities is based on strategic considerations and balanced against strategic priorities and available resources.

7. Evaluation is seen as an important external "second opinion", in relation to which decision-makers can reflect their own ideas. In addition, evaluation is also valuable for justifying and convincing other actors about the necessity of proposed decisions. Decision-makers find that evaluations are worth carrying out because they highlight and emphasise issues and aspects which are easily forgotten or lost in everyday business.

8. Some weaknesses in current evaluation practices may diminish the usability or trustworthiness of the conclusions and recommendations. Weaknesses most often mentioned by the interviewees relate to following questions: (1) lack of time for evaluations which may lead to inaccuracies; (2) evaluators' competence, and in particular, their insufficient knowledge of local circumstances.

9. The continuation of research evaluation activities was seen as integral part of managing the national R&D system at its different levels. However, excessive evaluation should be avoided, because of the large amount of human resources and time that the whole process tends to take.

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1 Introduction

In Finland, the evaluation of publicly funded research and development activities grew significantly during the last two decades of the 20th century. Simultaneously, the diversity of evaluations increased so that nowadays it covers all major types of evaluation: the evaluative eye falls not only on fields of science and technology or various research and development programmes, but also on R&D institutes, universities and R&D funding agencies.

There is a large amount of useful and interesting information available - both on evaluated subjects and on specific evaluation practices. Conclusions and recommendations by evaluators highlight different facets of the national R&D system, and may this way contribute to future-oriented decision-making on science and technology policy by helping us to identify the strengths and weaknesses of current arrangements. Gradually accumulated experience in evaluation processes can also make it easier for us to discern the potential and the restrictions related to the evaluation activity itself. However, the major part of this information has remained scattered, and no systematic attempts to map the extent and different dimensions of the phenomenon have been taken. In short, summarising and synthesising reviews have so far been lacking.

The unsatisfactory situation described above served as the starting point for this study. The Public Research Funding Evaluation Committee commissioned the VTT Group for Technology Studies to prepare a review concerning the evaluations carried out in Finland during the past twenty years and the results achieved. It was expected that the review of research evaluations would elicit information which could be useful from the Committee's point of view. The purpose of the study is to produce a concise review of the use and development of evaluation measures in the field of Finnish science and technology policy.

1.1 Research questions

This study has three main goals: to define the extent of evaluation activities, to produce a synthesis of selected evaluation results, and to provide information about the role of evaluation in decision-making processes within Finnish science and

technology policy. This task is approached by examining the following questions in more detail:

- What is, and has been, the extent and focus of R&D evaluation activities?
- Have changes occurred in evaluation practices, terms of reference, and recommendations/results during the time examined?
- What are the strengths and weaknesses of Finnish R&D in light of evaluation reports?
- What is the role of evaluation information in decision-making processes? To put it another way, how have these activities and their results been used?

1.2 Information sources

Answers to the above-mentioned research questions were sought by using two primary sources of information. The first primary source includes a selection of published evaluation reports, which comprise circa 170 separate evaluation efforts made between 1983 and 1999. The evaluation activities in four distinct fields have been put under closer scrutiny.

The first area covers evaluations of government research institutes initiated by Ministries. The second deals with evaluation activities of research funding agencies, i.e. the Academy of Finland and the National Technology Agency of Finland, Tekes. The third area concerns the Technical Research Centre of Finland (VTT), and the fourth area encompasses institutional evaluations of higher education institutions. Appendix 1 includes the listing of evaluations commissioned by these organisations since 1983.

There are several reasons why attention is focused on the areas mentioned above. Firstly, the decision to include evaluations initiated by the Ministries is based on developments in science and technology policy in the 1990's. All government research institutes were evaluated by the end of 1999, in accordance with a recommendation of the Science and Technology Policy Council of Finland. Secondly, the research funding agencies, the Academy of Finland and Tekes, have had a salient position in the Finnish research evaluation scene since the 1980's. The Academy has commissioned over 20 and TEKES over 50 evaluations on research and development activities over the years.

VTT, along with the Academy, was the first to adopt evaluation practices in the organisation's internal procedures in order to secure the quality and relevance of its

research programmes. Since then, evaluation has gained an established position at VTT: the whole institute was evaluated by outside evaluators in 1992. Moreover, the institute held an extensive evaluation round of its research and service units during the latter part of the 1990's, and a new round is already being considered.

The inclusion of the evaluation of higher education institutes into this study may at first seem misplaced, especially if compared with the former examples - university assessments have concentrated on teaching and learning, not on research activities. However, it is a thin line between research and teaching. Universities in Finland, as in other countries in Western Europe, offer an environment not only for teaching and learning but also for research; in many cases, researchers are also teachers and vice versa. The dual task of universities is reflected in several evaluation reports; issues related to research are touched upon at least accidentally, even when evaluations are clearly geared towards institutional concerns in teaching and management.

The second primary source is composed of 38 semi-structured interviews, which were conducted among decision-makers of Finnish science and technology policy representing three different levels in the public R&D system (see the complete list of the interviewees, Appendix 2):

i. Policy-level - current/former members of the Science and Technology Policy Council of Finland, and officials involved in the R&D related decision-making processes in five ministries.
ii. Intermediary-level - higher management of research funding agencies, i.e. the Academy of Finland and the National Technology Agency, Tekes.
iii. Operational level - management of selected government research institutes, and rectors of some major universities.

In addition to the above sources, information about evaluation was gathered through discussions with people actively involved in the Finnish R&D evaluation scene, and through various documents published on science and technology policy. From a theoretical point of view, this study is anchored in the literature on information use and decision-making in organisations and political communities, as well as on materials which deal more explicitly with issues of science and technology policy. Both dimensions are equally important if we want to grasp the significance of evaluation activities in the R&D field: we need to have an understanding of how the decision-making process works and how the use of evaluation fits into this process.

1.3 Organisation of report

The first chapter of this report will discuss the emergence of an evaluation culture in public administration, its causes, and its links to national science and technology policy-making. In chapter 2 the short history of R&D evaluation activities in Finland will be examined. The chapter will cover the development of the Finnish R&D evaluation scene from the beginning of the 1980's to the end of the 1990's. Forerunners and main players in the field will be identified; changes in the number of evaluations will be addressed; and the focus and general terms of reference in different evaluations will be dealt with.

In chapter 3 attention will be paid to the recommendations of different evaluation reports and their subsequent impacts. Issues will be studied in connection with evaluations carried out for Tekes and the Academy of Finland, and on government research institutes. The focus will be on recommendations with generic features, i.e. issues that are connected to the functioning of the Finnish R&D system as a whole. The use of evaluations in decision-making will be examined in more detail in chapter 4. The previous chapter approaches the use of evaluations from a more technical and static perspective, whereas in chapter 4 the emphasis will be on the strategic dimension of the activity: how do decision-makers assess the usability of evaluation efforts? The final chapter will summarise issues raised in the preceding chapters.

2 Emergence of an evaluative culture

What do we mean by the concept of evaluation? Before proceeding any further, it is essential to have a tentative understanding of the concept, its linkage with science and technology policy-making, and with the wider administrative environment in which evaluation practice has lately gained ground. It is useful to start this brief examination by first reviewing the meaning of the word "evaluation".

According to a working definition, evaluation can be defined as a systematic inquiry intended to generate information for the purposes of decision-making, judgements and learning. "Systematic" implies that evaluation is a thoughtful process of asking critical questions, collecting appropriate information, and then analysing and interpreting the information for a specific use and purpose. There are two discernible integral features that characterise evaluations in this definition. One is the normative dimension: examining and making judgements about the subject under consideration, without which the whole concept of evaluation would lose its meaning. The other significant aspect of the evaluation procedure is focused activity: before the evaluation process can begin, the target has to be clearly specified, so that effort is not wasted.

Evaluation practice has been embraced by public administrators, and nowadays it is used frequently in various policy domains. Policy evaluation can be seen as a part of the historical process in the development of tools and information systems for public management. In the field of science and technology policy, evaluation has various functions, which in a recent report (Kuhlmann et al. 1999) were arranged into three separate categories.

Firstly, evaluations provide legitimation for the distribution of public resources and for the demonstration of adequate and effective use of funding by measuring the scientific/technological quality or (potential) socio-economic impacts. Secondly, evaluation can also play a role in targeting and "controlling" in terms of improved management and "fine tuning" S&T policy programmes and measures. Thirdly, evaluation can be understood as an attempt to improve transparency in the rules of the game and in the profusion of research funding and subsidies, and to enhance the information basis for shaping S&T policies in the sense of a government-led "mediation" between diverging and competing interests of various players within the S&T system.

Indeed, to evaluate research and development activities is like walking on a tight rope: by looking retrospectively at the past performance of programmes, policies, or institutions, evaluations try to identify problems as well as opportunities, at which policy measures should be targeted in the future. To sum up, the concept of evaluation in this study refers to the examination of publicly funded activities and institutions in the field of science and technology policy with special emphasis on retrospective or ongoing examinations.

If the systematic utilisation of evaluation practices is a relatively new phenomenon in the offices of the administration, the same cannot be said of the research community. On the contrary, the evaluative attitude has traditionally been an integrated into working practice within the research community. The quality of the work carried out by individual scientists and academics is continuously exposed to thorough scrutiny: research proposals go through a well-established assessment system, and research results are critically evaluated by academic peers prior to publication. Published ideas and findings are subject to critical public review. This more or less organically evolved internal quality control of the research community has been regarded as a principal instrument for the self-regulation of science. The system is deemed to be the most effective instrument of self-regulation in promoting critical selection that is crucial to the evolution of scientific understanding.

For a long time, society at large was content with the self-regulating measures taken by the research community. Since the 1970's, however, the functioning of the publicly funded research and development system has raised new vivid interest outside the research community. Various reasons for this attention have been expressed (e.g. Rip 1999, Georghiou 1999). One explanation often articulated is based on the stringency of financial means which has obliged governments to pay more attention to accountability in the use of public resources. In this situation, the demand for accountability is applied to all publicly financed activities - the more efficiently and cheaply the activities are carried out, the better.

Another reason, which is closely related to the first one, is a change in understanding the role of the research community. Currently, research institutes and universities are commonly perceived to be a main source of technological advancement and economic growth. This has created a new interest in the relevance and applicability of the research results, as well as in impacts of public science and technology policy. This is exemplified by the mounting demands of societal relevance and effectiveness of R&D activities.

The third reason behind the increased attention to the R&D system includes changes that have taken place in the public management culture. If in the past the allocation of public resources was based on centralised decision-making which defined the use of means in detail, then today the power of decision-making has been devolved further down the hierarchy. The transition has been supported by legislative changes which leave decision-makers more latitude for targeting available resources within broadly set frames. However, this development does not mean that the role of the state administration concerning the planning of activities and measures, or the monitoring of performance, was out-dated. On the contrary, vis-à-vis the growing demand for transparency of activities, the reviewing and evaluating of performance has gained unprecedented significance. Various tools for monitoring and evaluating have been developed in order to keep track of performance and to detect the weak points or new opportunities at which public actions could be targeted.

The fervent evaluation of public policies has led to a situation where we have an abundance of information about different issues. This has created a new need to synthesise, summarise and assess this material critically - the term "meta-evaluation" is often used in this context. The term refers to an endeavour which aims to aggregate results and recommendations of various evaluations, or tries to come to some conclusions about the technical quality of evaluation processes and/or reports that have been produced. This interest in the evaluation of evaluation has grown at the same pace as the expansion of evaluative activities into new fields of public administration.

The need for a closer inspection of evaluation activities and experiences is nowadays underlined on many occasions. The issue was brought up, for example, by the Ministry of Trade and Industry (Kauppa- ja teollisuusministeriö 1997) some years ago in a report which dealt with future activities in the field of technology studies. According to the report, there is a risk that as evaluation practice expands, the practice itself may become too fixed and be taken for granted. The report raised the concern that narrowly focused evaluations of programmes or organisations do not pay due attention to the wider aspects of the phenomena to be evaluated. On that basis it was concluded that more research-based debate on the premises, methodologies and aims of evaluation activities is needed in Finland.

Yet, as a recent OECD report (1999) correctly remarks, "meta-evaluations are still fairly rare and not much is really known, for example about the use of evaluation". One reason for this rarity of summarising reviews lies most probably in

methodological problems. One of the difficulties is related to the time frame: the uses and impacts of an evaluation are not immediately apparent in general. They manifest themselves many years later, if at all. Another reason is linked to difficulties involved in getting reliable information about the subject: how do we discern the impact of an evaluation retrospectively from other potential causes?

The focus in the above-mentioned OECD report is on the use of evaluation in public management, but the claim is also true in the context of research evaluation both nationally and internationally. However, it would be an exaggeration to maintain that the practices and uses of research evaluation have attracted no attention at all. In Finland, for example, the field of research evaluation is not totally unexplored.

The evaluation of various fields of research was under closer scrutiny in a Scandinavian study, which Luukkonen and Ståhle (1990) carried out at the end of the 1980's. They studied policy uses of evaluations performed by the research councils and equivalent organisations in the Nordic countries. Luukkonen (1995 and 1997) continued to study the phenomenon and analysed the impacts that the evaluation had on research practice. Another Finnish figure with long experience in R&D evaluation is Erkki Ormala of the Science and Technology Policy Council of Finland. In Germany, Kuhlmann and Holland (1995) carried out a comprehensive analysis on evaluation practices in the S&T programme field in the mid-1990's. In this 'meta-evaluation' they thoroughly examined over 50 evaluation studies, which the Federal Ministry for Research and Technology had commissioned since 1985. The aim of the investigation was to find ways to improve the Ministry's evaluation practices both in terms of instruments and management. A recent Norwegian study has also paid attention to research evaluation and especially to strategic opportunities of these efforts for the Research Council of Norway (Brofoss 1998).

3 Diffusion of the R&D Evaluation in Finland

The historical development of research evaluation activities in Finland has followed a path familiar from other industrial countries. Kuhlmann (1998) has discerned two development lines, which have left their mark on present R&D evaluation practice. The historical core of evaluation activities is composed of peer review as an internal tool of the research community, which supports decision-making concerning the allocation of resources for research areas and disciplines. This activity has traditionally focused on research proposals laid out by individual researchers and research groups. Nowadays, an increasing share of peer review activities is linked with the evaluation of research projects in a competitive funding context. Peer review is also exploited more and more in evaluations which address the quality and performance of research programmes or groups in retrospect.

The core of peer review is encircled by a second group of evaluation studies, which can be called impact analyses of research and technology programmes. This approach is manifestly external vis-à-vis the research community. The launching of impact analyses is based particularly on the concerns of actors in the politico-administrative system: they are interested in finding out if and to what extent scientific, technological, economical or wider societal goals set up in political decision-making are achieved through publicly funded measures. The "outer shell" of evaluation activities consists of the evaluation of public institutions in which R&D takes place, i.e. government research institutes and universities. There are no independent approaches or methods for institutional evaluation; they are derived from models of peer review and impact analyses.

The model sketched above applies well to the developments in Finland, where the science and technology policy field has witnessed an emergence of a vital evaluation culture during the last two decades. The first efforts inspired by international examples and internal considerations were carried out at the Academy of Finland and the Technical Research Centre of Finland, VTT, at the beginning of the 1980's - 1983 to be exact. The Academy of Finland was primarily interested in carrying out evaluations on scientific fields, whereas the evaluations at the VTT focused on the institute's research programmes. Some years later, the recently founded Tekes - which was at the time called the Technology Development Centre of Finland - adopted the evaluation model in its technology programme procedures.

The evolution and diffusion of the evaluation culture took place gradually and after 17 years of development, evaluation is visibly anchored in the Finnish research and

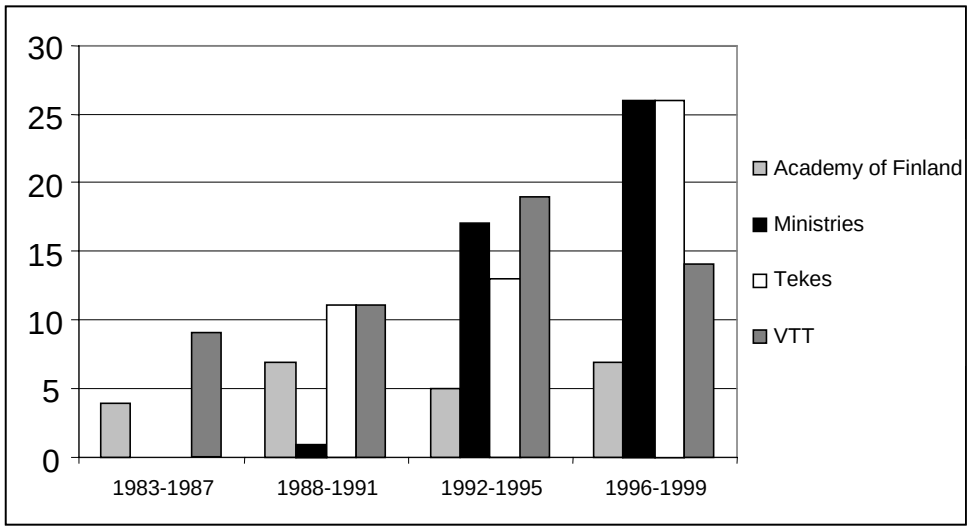
development system. Today, evaluation is included almost on a routine basis in numerous official documents dealing with the strategy and development of the national innovation system. For example, in the science policy strategy of the Academy of Finland for 1998-2000 it was noted that "evaluating research and developing methods are among the Academy's main functions". This task was perceived to include a broad palette of subjects from general evaluation work and evaluation of scientific disciplines and research programmes to developing research indicators and the evaluation of funding.

During the 1990's the Science and Technology Policy Council of Finland, a body assisting the Government and its ministries in questions relating to science and technology, also played an important role in the nurturing of evaluation practice in the Finnish R&D scene. The Council actively promoted the diffusion of evaluation activities into different areas of the country's public R&D system. As part of the development of sectoral research, the Council recommended in 1995 that all sectoral research institutes should be evaluated by the end of 1999. This was included in the official action programme for the development of sectoral research, which was approved by the Council in 1996.

Around the same time, a recommendation to evaluate all Finnish universities by the end of the decade was also made. These two proposals have together played a significant role in diffusing and establishing the institutional evaluation practice on Finnish soil. The evaluations of government research institutes are officially commissioned by the sectoral ministries, and those of universities by the Ministry of Education. In this context, a new body under the administration of the Ministry of Education was also founded, namely the Higher Education Evaluation Council, whose main task is to assist and support universities and newly founded polytechnics in evaluation arrangements.

In light of the data gathered during this project, the diffusion of the evaluation practice has been profound: since the beginning of the 1980's the number of evaluations carried out has increased almost exponentially every fifth year - a raising curve is clearly visible. At the end of 1989, 25 evaluations were carried out; ten years later the number reached 175. Organisations whose core activities are situated at the technical end of the science continuum, namely Tekes and VTT, have been especially keen to adopt the evaluation practice in their routines. These two organisations together account for a substantial share, around 50 per cent, of the all R&D evaluations carried out in Finland. The Academy of Finland, which was previously an active commissioner of research evaluations, changed their

policy in this respect in the middle of the 1990's: the evaluation of research fields and programmes was discontinued at least temporarily, and resources were instead concentrated on a broader review of the state and quality of scientific research in Finland. This assessment is scheduled to be presented once during the three year terms of the Research Councils. From the figure below, it becomes clear that institutional evaluations increased very rapidly after the mid-nineties - thanks to the recommendations to evaluate both the governmental research institutes and the universities before the turn of the century.



Number of R&D evaluations carried out between 1983-1999 in Finland.

3.1 Direction of evaluative interest

The data gathered in this study shows that the focus of evaluations has evolved as the evaluation practice has been diffused among new areas and as changes have occurred in societal interests. In the 1980's and at the beginning of the 90's, evaluations focused more on the quality of Finnish research, on the position of basic research, and on the conditions of research. Since then, more attention has been paid to the relevance and impact of public R&D activities, and to the efficiency of organisational operation and strategic questions. This is, of course, not the whole picture, because there have been, and there still are, differences in the terms of reference depending on the subject and commissioner of the evaluation. Below we will take a brief look at how evaluations differ from each other depending on the orientation of the commissioner.

Predictably, the Academy of Finland, which is the key funding agency of basic research, has been concerned with the quality of research. The main questions for the Academy have been the scientific standard of research compared with research conducted in the same field internationally, as well as the productivity and effectiveness of research in relation to objectives and resources. The other area of interest of the Academy has been related to the strategy issues of research: evaluations are expected to consider and make recommendations about the future research profile of a field or institute. Evaluations are thus expected to generate new ideas that can be used when making decisions on future-oriented strategies and the organisation of research.

The Academy's stance on evaluation changed somewhat in the latter part of the 1990's. The latest evaluation of a single research field was completed some years ago in 1996, and since then the activities have focused on evaluating the overall state and quality of research. According to an agreement between the Academy and Ministry of Education, the purpose of this activity is to provide an overall picture of Finnish research. One of the most important functions will be to prepare a study that surveys the resources and organisational structure of science, the standard of research and its social significance, among other things. The first evaluation of this kind was completed in 1997. The next overall study will be completed by the end of 2000.

The evaluative interest of Tekes has been modified by its mission to promote the competitiveness of Finnish industry and the service sector through technological means. The evaluation procedures at Tekes have from the very start centred on national technology programmes, which are one of the main tools of the agency to further its goals. Recently, there have been efforts to evaluate a number of closely related programmes together in order to get a more thorough picture about the results and impacts of the programmes. Some new initiatives that have recently been launched as well as Tekes' areas of interest have also been evaluated; these include the technology clinic initiative, and technology strategy consulting services for small and medium-size enterprises.

The evaluative interest in Tekes' evaluations can be divided into two parts. One of them covers issues related to a programme's management, implementation, results, and impacts from a national, industry-oriented viewpoint. The other is comprised of an assessment which deals with the scientific and technical quality of a programme - usually from the international point of view.

The completed institutional evaluations of government research institutes and universities have been based on somewhat divergent purposes. In the case of the research institutes, the primary aim was to evaluate the scientific quality and performance of the institutes. Besides covering research and the impacts of activities, evaluations were expected to be future-oriented and to make recommendations about changes and developments that might be necessary to ensure the institute's capacity to meet future needs and opportunities. Single objectives set for the evaluations varied from the assessment of appropriateness, relevance and effectiveness of activities to quality issues, efficiency, and networking with other actors in the operational environment. Both scientific and functional issues were covered in all the evaluations. In this sense it is difficult to see any difference between cases in which the evaluated institute was itself actively involved in the launching of the evaluation, or cases in which the Ministry played a decisive role as the initiator of the evaluation.

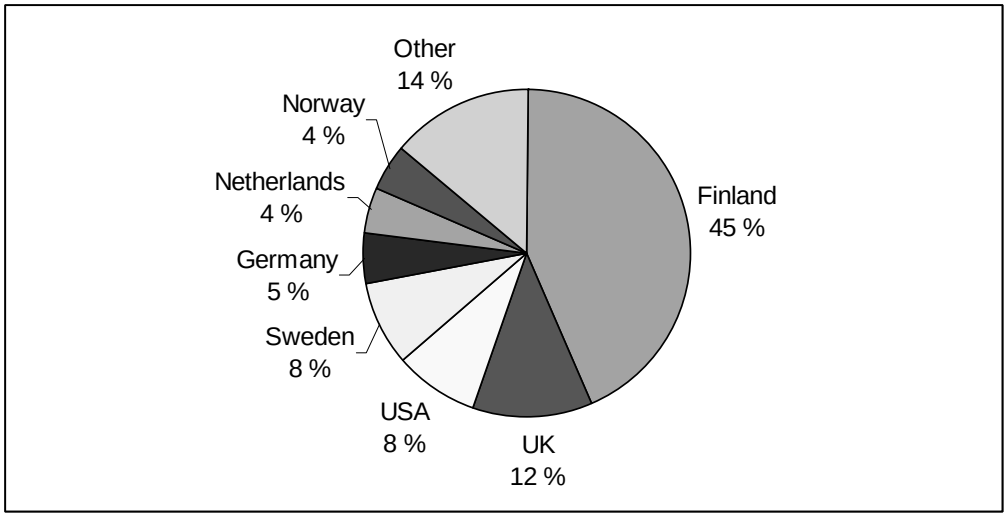
The institutional evaluations of universities have focused on the basic preconditions for teaching and research, and the capacity for change. According to the Finnish Higher Education Evaluation Council, "these preconditions include a statement of the institution's mission and goals, key processes, institutional arrangements and resources and performance, with less emphasis being given to the last two than the others". The final decision concerning the focus and timing of institutional evaluations has been left to the universities.

The policy is in line with the basic idea of the Evaluation Council that evaluation should, first and foremost, be a learning tool, which supports the internal development of the universities, and not an instrument of accountability which allows external monitoring of activities. In practice this means that the evaluations have been tailored to local needs. Therefore, it is not surprising that in implementing their institutional evaluations, universities have placed special emphasis on different issues: some on the evaluation of teaching or on strategies, and others on their regional role or administration. The evaluation carried out in 1999 at the University of Helsinki is an exception to the model adopted among other universities. The focus was not on institutional issues but on the international quality of research. International peers evaluated the quality of research activities in all the university's departments. The results of this extensive evaluation effort are used in the internal resource allocations by the university management.

3.2 Evaluators

According to the data examined in this data the majority of evaluations bear strong resemblance to the successful model of peer review in terms of procedures, methods of gathering information, and the evaluators' background. In most instances, the evaluation was undertaken by a group of outside evaluators; the group was dominated by individuals representing the national and international research community. Thus, organisational affiliation to a university or a research institute is a common characteristic among evaluators.

There are, however, some differences connected with the nature of the evaluated activity. Acknowledged expertise and reputation attained among peers in the research community is the utmost important common denominator between evaluators within the fields of science and in universities and research institutes. In the evaluation of Tekes' technology programmes and VTT's research programmes, the evaluator pool has been more diverse. The evaluations commissioned by these two organisations do not only focus on the scientific quality of the research, but also on its applicability and relevance to industry. These wider organisational goals have to be taken into account in the composition of the evaluation teams: there is a need for individuals who have the competence to assess the quality and level of research, but also for people with an industrial background.



Evaluators by country

The figure above shows the proportion of evaluators from different countries. The largest group of evaluators in the reviewed cases were native Finns - around 40 per cent of the pool of evaluators. When comparing the rest of the evaluators and their countries of origin, it becomes immediately clear that the evaluator pool is clearly biased in favour of some countries. Evaluators from the United Kingdom compose the second largest group, closely followed by colleagues from the United States and Sweden. Evaluators from Germany, the Netherlands and Norway also form an identifiable, although a noticeably smaller group. Southern Europe, including France, is scarcely visible in the figures, and the rest of the world is almost entirely invisible in this comparison.

In the evaluation carried out at the University of Helsinki last year, the distribution of evaluators according to nationality was similar: the same countries were among the top five, although in a slightly different order, with Finnish and Swedish evaluators at the top. There is a striking congruence between these figures and the information we have about the geographical orientation in international co-operation among Finnish researchers. All in all, it is possible to infer from these figures that Finnish commissioners tend to look for evaluators from countries that are close "culturally" and countries with whom Finnish researchers and administrators tend to co-operate and have contacts.

3.3 Evaluation methods

Evaluation methods have remained roughly the same as those in the peer review model. Final conclusions and recommendations are based on a mixture of information analysed by evaluators. There is a variety of written material, from project reports to self-evaluation reports of evaluated subjects. Site visits and discussions with various actors are also an inherent part of the evaluation process. In addition to these more common elements, evaluators may use survey questionnaires and in some rare cases, bibliometric studies.

Notwithstanding this fairly static state on the methodological front, new ways to organise evaluation efforts have also emerged - parallel with the diversification of evaluation objects. There are a number of examples in which an international organisation or association is requested to undertake an evaluation. Another variant is a case where the responsibility for organising an evaluation is given to an outside organisation, such as the evaluation of the National Health Institute by the Academy of Finland. Consulting firms from Finland and abroad are also commissioned to evaluate Tekes' technology programmes in particular. They may

further outsource some parts of the evaluation to third parties who have relevant expertise in some aspects of the programme.

The most noteworthy of these new arrangements is a case where an international association or organisation has been asked to undertake the evaluation. An illustrative example of this is the evaluation of molecular biology and biotechnology research in Finland, which took place in the mid-nineties. The evaluation occurred in a situation where publicly funded biotechnology development programmes had been implemented for eight years. In order to get up-to-date information about the current needs and future plans in the field, the Ministry of Education requested the Academy of Finland to organise an international evaluation of biotechnology and molecular biology research in Finland. The goal was to assess the programme outcomes. The Medical Research Council of the Academy of Finland planned and supported the execution of the evaluation, which the Council of the European Molecular Biology Organisation (EMBO) agreed to undertake as part of the scientific evaluation of its member states.

International bodies have also played a significant role in number of institutional evaluations of Finnish universities. The Association of European Universities (CRE) implemented an evaluation of three universities at the end of the 1990's, namely Helsinki University of Technology, Tampere University of Technology, and Åbo Akademi University. The CRE offers its member universities the opportunity to be reviewed by experienced university leaders around Europe. The evaluation model of the CRE is tailored to assist universities to detect their strengths and weaknesses in the area of quality management, and in this way to contribute to developing a strategic way of thinking. The evaluation phase itself was congruent with many other evaluations carried out in the university sector in Finland: the university's self-evaluation was followed by a site visit of an external review team and finally, their report.

The evaluation of the Helsinki School of Economics and Business Administration is another example of the involvement of international associations in institutional evaluations. The evaluation was part of the accreditation process of the European Quality Improvement System (EQUIS), which has been developed by the European Foundation for Management Development. As a result of the evaluation, the Helsinki School of Economics and Business Administration was granted the European Quality Label. The Helsinki Swedish School of Economics and Business

Administration has also recently been accredited European Quality Improvement System (EQUIS) status after the evaluation process.

However, using the experience and views of international organisations for organising and implementing evaluation efforts is not an entirely new phenomenon. As early as the 1980's, the Organisation for Economic Co-operation and Development (OECD) was invited to review social science policy, and some years later, the national science and technology policy. Both studies were part of the OECD series of reviews in individual member countries.

Tekes has also recently searched for slightly more modified evaluation approaches. In a recent mid-term evaluation of R&D programmes in electronics and telecommunication, there was an attempt to incorporate a broad base of international expertise in the evaluation process. The peer review of projects was co-ordinated by experts from the USA, while the Tekes Advisory Board in Tokyo commented on the programmes from an international business perspective. In this particular case, even the target of evaluation differed from earlier efforts: it consisted of an array of closely related programmes, which, however, were funded by different agencies and constellations of those agencies. Two of the programmes belonged to Tekes' technology programme portfolio, one was funded by the Academy of Finland, and a Swedish-Finnish programme was jointly funded by Tekes and NUTEK, the Swedish National Board for Industrial and Technical Development.

In light of the reviewed evaluation reports, the field of R&D evaluations is characterised by a fairly established toolkit of peer review and impact analysis procedures. Evaluations are carried out by people who have a good track record either in the research community, in the administration of research institutions, or in industry. In fairly rare cases, the implementation of an evaluation has been left to an outside professional organisation or a company specialising in consulting and evaluation issues.

4 The Finnish R&D system in perspective - What are the results of the evaluations?

This chapter focuses on the conclusions and recommendations in Finnish evaluation reports over the past two decades. The purpose is to point out areas of importance for the functioning of the Finnish research and development system - as they have been seen by evaluators. Observations made below are based on the review of evaluations carried out for Tekes, the Academy of Finland, and for the Ministries. Institutional evaluations of universities and internal evaluations that have been carried out at the Technical Research Centre of Finland, VTT, will be left out at this stage.

For practical reasons, attention is mainly paid to conclusions and recommendations which touch upon more generic features of the Finnish public R&D system, rather than to those that deal with narrowly defined areas or individual institutions. The sheer amount of material available in around 90 evaluation reports would make a more detailed analysis very difficult, if not impossible, to carry out: the common characteristics would be lost in the abundance of detail.

In order to avoid this loss, we will start by identifying some key themes that are common to different evaluation reports. Then we will proceed to a somewhat more detailed review of these key questions. Each of the themes will be presented separately. However, first we need to bring up some methodological issues, which set the framework for reviewing the evaluation reports.

4.1 Confines of meta-evaluation

At first sight, to review and summarise conclusions and recommendations of selected evaluations may seem to be a fairly uncomplicated task. Evaluation reports are publicly available and they often cover the same issues under the same headings; maybe even in the same order. Therefore, it would seem that we could get a good overall picture of the state of the Finnish R&D system by simply summarising the conclusions of diverse evaluation reports. However, there are inherent problems with this approach, which are also demonstrated by the material at hand. Firstly, we have a disparate group of evaluations which differ in many respects - however similar they may seem on the surface. Evaluations of public R&D activities are not only dissimilar in the light of subjects (fields of science, R&D programmes, institutes) but also in the terms of reference, and the precision of the analysis.

Secondly, the evaluations are carried out during a relatively long time span, and therefore, conclusions made at a certain point in time may no longer be relevant regard to an individual evaluation. Evaluations undertaken in the middle of the 1980's were carried out under markedly different historico-political conditions when compared to evaluations ten years later. A straightforward comparison and categorisation of conclusions and recommendations may easily lead the reviewer astray, and he or she may not pay due attention to circumstances and conditions that were prevailing in society at the time of the evaluation.

Thirdly, evaluations are usually based on the opinion of a few evaluators. Even if they are acknowledged and respected experts in their own fields of specialisation, it is likely that they will encounter situations during the evaluation process where they have to step into unfamiliar territory. In a number of cases, the evaluators have had to make judgements on highly divergent research activities, and it is questionable whether anyone's expertise covers such a wide area outside of their own field of professional specialisation. This restriction was explicitly pointed out by the international group which evaluated a national cardiovascular research programme for the Academy of Finland at the turn of the 1980's and 1990's. According to them, "evaluation of a national cardiovascular research programme is a daunting task - an immense amount of data must be digested; not all researchers present their work in the most favourable light and the Evaluation Committee cannot profess an 'expert' opinion in all areas of cardiovascular endeavour".

And finally, we must consider the question of the quality of research. Quality is not an unambiguous concept, and it is sometimes mixed with questions of relevance, for example. This is probably not such a large problem in established fields of research which have gradually developed a shared understanding of quality issues. However, the situation is acute in cases where the activity to be evaluated draws from different fields of expertise or aims to fulfil different objectives simultaneously. We are confronted with a fundamental question: on what basis should, or could, the quality of the activity be evaluated? This problem is familiar to evaluators of technology programmes, for example: one programme may include several sub-programmes - not to mention projects - whose goals intentionally differ from each other. When facing a situation like this, the reviewer has to ask him- or herself whether the quality of separate sub-programmes can be assessed by using a single yardstick, or whether the variety of objectives should be acknowledged and taken into account in the analysis.

4.2 Identification of key themes

For the purposes of this report, I collected the evaluation reports into a database. The categorisation of the evaluation reports into the database enabled a more thorough analysis of the reports' content. Thematic entities have been constructed by comparing the conclusions and recommendations made in different reports. At this stage of the study, it was also possible to draw on materials which were produced by the funding agencies, namely the Academy of Finland and Tekes, for their internal use. A short, four-page review of the evaluations carried out for the Academy gives a concise summary of the main findings and perceivable changes in evaluations over time. Tekes commissioned a review which focused on the usability of evaluations concerning Tekes' technology programmes. The report includes an analysis of 38 technology programme evaluation reports from the 1990's.

The key themes, which were filtered from the material available, are as follows:

- quality of R&D activities
- strategic issues
- organisation of R&D activities
- researcher training and career
- R&D co-operation
- international collaboration

The rest of this chapter will address these key themes in more detail. References to individual evaluations will be used to highlight and clarify the themes. The outcomes of different recommendations will also be commented on. I must emphasise that the text excerpts and references to individual cases should be seen as case examples of the main recommendations; the aim is not to give an in-depth presentation of all recommendations in the evaluation reports that have been analysed.

4.2.1 Quality of R&D activities

Above under the heading "Confines of meta-evaluation" we considered the individual methodological difficulties that are related to summarising conclusions about the quality of research from a disparate group of evaluation reports. In short, problems are caused by differences in the evaluations' focuses and aims, by the long time span, and by the tentative nature of individual evaluations are based on the assessment of a few experts. The heterogenous data does not give us a position stable enough to summarise results about the overall quality of research.

Thus, I shall refrain from making further interpretations about the quality of Finnish research. Instead I will offer readers the opportunity to familiarise themselves with a selection of conclusion which evaluators have reached concerning the quality of R&D activities. Some evaluation summaries on quality issues have been compiled in Appendix 3. No formal mechanisms were used in selecting them; the only guideline was to cover the central areas of R&D evaluation, i.e. evaluations of research and technology programmes and institutional evaluations, excluding university evaluations.

4.2.2 Strategic issues

Rarely do we see an evaluation report that does not include recommendations for a reassessment of strategic issues and/or core activities. The need for strategic rethinking among Finnish R&D organisations is based on two key observations made in the evaluations. The first concerns the ambiguity of missions and objectives. This ambiguity can be seen in unfocused and disparate research activities and research groups which are too small to be viable. The second one relates to the general fact that resources are always limited and scarce compared to potential targets. In recent times this relative scarcity has been highlighted by perceived limitations in the growth potential of financial and human resources.

A common recommendation made in this situation is to target activities at a limited number of selected subject areas or core tasks, and to increase co-operation with other relevant actors both nationally and internationally. This kind of strategic focusing could open the way for larger programmes and larger research teams. In other words, the critical mass of R&D activities is increased by increasing the size of programmes and simultaneously reducing their number, and this will supposedly improve the opportunities for new scientific findings and innovations.

Some recent evaluations, however, have drawn conclusions which are, if not completely the opposite, at least somewhat contradictory to the traditional 'wisdom' of science and technology policy, which emphasises the importance of critical mass for high-level R&D activity. Especially in areas where rapid scientific and technological development is taking place, large, static programmes may not always be the best measure for encouraging the R&D community to adopt changes and to find new opportunities in the changing environment. There is a need for more flexible constellations of smaller interrelated programmes which can be covered under an umbrella programme. This kind of a recommendation was made in the evaluation of Tekes' Rapid technology programme some years ago in 1998.

Whichever approach is chosen, strategic rethinking implies that there is a need for internal review: to identify key areas and promising future avenues where activities should be continued. The other side of the coin is the need for a certain amount of flexibility which will allow less fruitful avenues to be discarded. Decisions to continue or discard some activities should also take into account the needs of the customers and Finnish society at large. Naturally, who the customers are and how the needs of society are understood differ between evaluations.

There is wide agreement among evaluators about the ways in which the views of different stakeholders can be incorporated into the strategy work of organisations: this goal can be attained by ensuring a wider representation of interests in the board or advisory committee of an institute or agency. Concurrently, the tasks of these bodies should focus more clearly on strategy questions. This recommendation has provoked some disagreement. For instance, the follow-up group reviewing recommendations included in the evaluation of the Geological Survey of Finland, GTK, did not concur with the proposal. According to the follow-up group, the needs of the stakeholders have to be taken into account in other ways.

The sectoral research institutes have a unique characteristic which may in some instances make the definition of the institutes' core activities even more challenging: many of the institutes are not pure research organisations, but in addition to research and services, they also carry out official assignments, such as regulatory and executive activities. At the same time, the adoption of more customer-oriented strategies call for more transparent accounting systems at the institutes. This is especially important for those institutes which are also service producers. When services are delivered to external markets, it is essential that there is a clear distinction between government subsidised services and other commercially run service activities. Otherwise the institutes are easy targets for accusations that they are violating the competition legislation.

The evaluations demonstrate that the pressure to reform accounting systems is also linked with other changes in the public sector: the commercial-style accounting system is an integral part of the management by results model, which was adopted by Finnish public administration on a large scale in the 1990's. The importance of having more transparent systems is further urged by recent developments in the funding structure of research institutes and universities: more of the institutions' budgets are obtained from external sources and at the same time, the amount of base funding from the Government budget has remained the same or even declined.

4.2.3 Organisation

The need for organisational restructuring emerged as a theme from a number of institutional evaluations. This is not so surprising, because the terms of reference in institutional evaluations usually require the reviewers to evaluate the ability of an organisation to fulfil its duties effectively and efficiently. In some particular instances this requirement is more pronounced than in others. This was the case, for example, in the evaluation of the Academy of Finland, as well as the evaluations of the Technical Research Centre of Finland (VTT), the Geological Survey of Finland (GTK), and the Forest Research Centre of Finland (METLA). In all these cases the decision to launch the evaluation had a "pulling-the-trigger" effect: the evaluation was the start-up for organisational restructuring. In fact, in three cases the evaluation led to major changes in the organisations. In the case of METLA, the changes were more restricted - most likely because the institute had just some years previously carried out an internally induced organisational reform.

A good example of the effects that an evaluation can have on an organisation is the evaluation of the Academy of Finland. The review team made altogether over 10 recommendations relating to the organisational restructuring of the Academy. Perhaps the most visible and effective of these was the recommendation about the number of research councils: "the number of research councils must be reduced to three, maximally four. In addition, the number of council subcommittees must be reduced substantially". The evaluation panel did not, however, recommend precisely which councils should be included in the future. The panel only addressed some issues that it considered important and that the Academy should bear in mind when deciding the terms of reference of the new councils. One of them was the need to establish a balance between discipline-oriented and sector-oriented councils. Another one was the panel’s understanding that there was no justification for a special Research Council for Technology. After the dust had settled, the Academy went through a change process which has left it with four research councils, and the Research Council for Technology was not among them - just as proposed by the review team.

Recommendations for restructuring activities have not been limited solely to the intra-organisational level, but in some cases they have also included an inter-organisational dimension. For instance, in the evaluation of GTK the question of merging two research institutes, namely GTK and VTT was raised by the evaluators as an option that should be considered. However, the follow-up group, which went through all recommendations made in the evaluation report, did not

share the evaluators' opinion. In their own words, "the working-group has not found adequate reasons to merge all the activities of GTK and VTT. Instead development of co-operation between the two institutes is still necessary."

The latest evaluation of a sectoral research institute, namely the evaluation of the Agricultural Economic Research Institute of Finland (MTTL), had more dramatic impacts. After the publication of the evaluation, it was decided that MTTL should be integrated with the Agricultural Research Centre of Finland (MTT) in two years time. The decision was one of three options for the future organisation of MTTL which were laid out by the evaluation team. Even here, however, the demand for restructuring preceded the actual evaluation. Thus we must be cautious and not draw too wide-ranging conclusions about the impacts of the evaluation - it certainly had some effect on the decision reached by the Ministry of Agriculture and Forestry, but precisely how much, we do not know.

Other evaluations have raised the question of the structural relationship between the Finnish Environment Institute, the Institute of Marine Research and the Meteorological Institute. It has been addressed, for example, by the Science and Technology Council in a paper on the development of sectoral research. So far, however, no measures have been taken.

Other organisationally relevant recommendations made during the institutional evaluations concerned the position of branch offices, laboratories, and auxiliary activities - such as research forests in case of METLA - in the research institutes' organisational chart. For example, the evaluation team of the GTK concluded that "the branch offices should be maintained but will no longer have semi-autonomous programmes, although they will continue to be important local points of contact for the GTK". The significance of the regional units was also commented on in the evaluation of the National Veterinary and Food Research Institute (EELA):

"The regional units will remain an important asset to EELA. To ensure this, their activities should be clarified and divided into distinguishable service and research tasks. An important aspect is to consider the needs of society especially with respect to regional needs and expectations. (...) The Regional Units are recommended to concentrate on service and advisory tasks. This requires intensive reorganising." (International evaluation of the National Veterinary and Food Research Institute (EELA), 1998)

Finally, some evaluation reports pronounced the need to bring together widely scattered departments and smaller units of a research institute in one location, with the aim of improving the environment for collaboration within the organisation.

This kind of advice was given, for example, in the evaluation of the Finnish Institute of Occupational Health.

4.2.4 Researcher training and career development

Weaknesses in Finnish researcher education and in researchers' career prospects have been attracting evaluators' interest over the years. The length of post-graduate studies leading to a doctorate has clearly been one of the most commonly identified structural weaknesses in the Finnish research system. The topic has raised concern particularly among international evaluators since the very first evaluations in the 1980's and into the 1990's, as we can see from the following text excerpts:

"(...) the situation in Finland seems to be rather different. Although the age at which a student finishes his master's thesis (comparable to the "Diplomarbeit in Germany) is not so different, it takes definitely too long to finish with the Ph.D. degree. (...) To stop this development, we strongly recommend that the time for the dissertation be shortened, and that the number of assistantships be increased in order to decrease the burden of teaching duties. A young chemist must be encouraged by the professor and by the situation in the department to finish his Ph.D. degree (including the work for his licentiate) in not more than 4 years so that he can decide about his future before the age of 30." (Evaluation of Scientific research in Finland: Inorganic chemistry. The Academy of Finland 1983)

"(...) students in Finland take an extremely long time to complete their studies. It would appear that some of the graduate students are taking part in teaching and clinical work to an extent that it might prolong their graduate training within Finland. On average, the M.D./Ph.D. or Ph.D. will only get their degree at 30-35 years of age. (...) The teaching or clinical obligations of the graduate students should be cut to allow for an earlier Ph.D. than at the age of 30 or above. (Embo Evaluation Report on Molecular Biology and Biotechnology Research in Finland. The Academy of Finland, 1996)

(...) One of the goals of the programme is said to be the production of highly trained graduates in synthesis technology areas defined to be of interest under this programme. However, we are concerned that not enough rewarding positions are available in either industry or academia for Ph.D. recipients and that the length of time required to receive a Ph.D. degree is still very long by international standards. In our opinion, a Ph.D. should ideally be obtained in virtually all circumstances before the age of 30, and preferably before the age of 28. There must be more incentive for the best, graduating Ph.D's to finish sooner rather than later. (Synthesis Technology Programme 1992-1996. Tekes, 1996)

The continued attention paid to this unsatisfactory situation was most likely the incentive for developing Finnish researcher training during the past decade when the issue was given priority in the science policy agenda. A manifestation of this is the new graduate school system, which was created in 1995. Today there are circa

100 graduate schools, and the total number of doctoral students in these graduate schools is nearly 4,000. During the last two years of the 1990's the annual number of new Ph.D.'s reached the target level and is presently ca. 1,000, which is twice as many as at the beginning of the 1990's. After the structural changes carried out in the mid-nineties, researcher training has not drawn the evaluators' attention in more recent evaluations.

Other detected deficiencies in the structure of researcher careers included undeveloped post-doctoral training and an insufficient incentive structure, which were seen to be a potential hindrance both to individual researcher's career prospects and to the further development of the national R&D system. The former concern has been tackled by the Academy of Finland, which some years ago introduced a post-doctoral programme intended for young persons who have recently earned their doctorate.

4.2.5 R&D co-operation

The development of co-operation in its various forms - within a research field or an organisation, between research areas and disciplines or organisations, regionally or inter-regionally, and nationally or internationally - is one of the enduring concerns in evaluation. Special attention has been given not only to the enhancement of collaborative activities between industry, universities and research institutes, but also to the dissemination of skills and knowledge through different arrangements.

Weaknesses in the co-operative arrangements have been identified at different levels of the national innovation system. Recently, the importance of co-operation and networking between various stakeholders in the national innovation system has been brought up by an evaluation group, whose objective was to make recommendations on the ways in which the Finnish system could be developed so that it would promote independent inventions and their commercialisation. From the evaluators' point of view, there should be more coherence between the organisations involved in the promotion of inventiveness and innovation. In practice, this kind of coherence would "mean more networking between the organisations and more specialisation by the individual organisations".

The question of co-operation at the level of funding agencies was raised at the turn of the 1980's and the 1990's, when some evaluation teams noted that there was an apparent lack of coherence and co-operation in the funding decisions of separate funding agencies. The agencies were basing their decisions on narrow mission

objectives without paying enough attention to the whole. This became clear in the evaluation of Finnish space science in 1994: the evaluation panel found that there was a need for co-ordination between the Finnish funding agencies in the planning of the space programme if maximum benefits were to be gained from a national programme of space science and, in particular, from the membership in ESA. The panel had come across a number of situations where different funding sources had acted independently and often incoherently in responding to funding requests from groups wishing to be involved in space missions. During the past years, the Academy of Finland and Tekes have actively striven to improve co-operation in the funding of R&D activities.

The issue of co-operation is especially manifest in the context of R&D programmes, because the promotion of co-operation is usually one of the programmes' major goals. In the light of the evaluation reports, the measures taken over the years to further co-operation between the main players of the national R&D system have been successful, i.e. collaboration between universities, research institutes and industry has, in general terms, strengthened. R&D programmes have enhanced target-orientation among researchers, and generated closer co-operation between researchers and the users of research results.

"The Finnish Pharmaceutical Technology Programme has taken the important steps in initiating university-university cross-disciplinary collaborations which would almost certainly not have happened otherwise. It also enhanced communication between universities and industry. The effect on Finnish drug companies has also been substantial. It gave them access to skilled pharmacists and engineers who could help them solve formulation and production problems. It had a major impact on the ability of individuals to move between industry and universities." (Evaluation of the Finnish Pharmaceutical Technology Programme 1989-1994, 1996)

There is, however, some variation in the extent of co-operation depending on the time of the evaluation as well as on the areas and measures under evaluation. For example, in Tekes' earlier technology programme evaluations in the 1980's and still at the beginning of the 1990's, the programmes' success in promoting co-operation and interaction between participants was not on average remarkable. At the time, insufficient or lacking co-operation and knowledge transfer between research and industrial communities were one of the main weaknesses of the programme. Since then the situation has improved. Still, there are problems in the level of collaboration and knowledge flows within the technology programmes themselves. The Achilles heel seems to be the way in which the open flow of information and knowledge between sub-programmes and projects can be ensured: ideas and activities are shared between partners participating in a common project, but there

is often considerably less co-operation between different projects, not to mention sub-programmes.

At the level of sectoral research institutes, obvious bottlenecks in co-operation are more difficult to detect. A positive image of the co-operative arrangements of research organisations emerges from the evaluation reports. For instance, in many cases the evaluators comment favourably on the relationship between research institutes and universities, and they encourage the institutes to further these activities in the future.

"(...) the panel was pleased to note the increasing level of collaboration between the KTL and the universities and would wish to see these links evolve and strengthen in the future. " (Evaluation of the National Public Health Institute of Finland, 1995)

"(...) some of the departments and the Regional Institutes of the FIOH have excellent co-operation with the universities but where this is not the case it should be improved." (Evaluation of the Finnish Institute of Occupational Health, 1995)

Notwithstanding this promising picture, the general need to enhance contacts and co-operation from the current level was also immanent in the case of the sectoral research institutes. The evaluation reports list a number of familiar recommendations for the advancement of co-operation and diffusion of knowledge between the research institutes, academia and the private sector. One possible way of increasing dialogue is to broaden the membership of boards and other bodies that support the management of the organisation so that they include representatives from different sectors. Another often raised option is to support the mobility of researchers between research organisations, including the private sector, both within Finland and abroad.

4.2.6 International collaboration

Active participation in international research co-operation is considered vital to individual researchers, research organisations, and the national innovation system at large. Most evaluations pointed out the important benefits that a small country like Finland can gain from contacts with the international research community. Research co-operation is understood to offer the opportunity to raise the standard of national research environments and provide new impulses leading to interesting research findings.

This opinion in the evaluations is widely shared by the Finnish R&D community and decision-makers. National policy in the field of science and technology has favoured internationalisation of research activities during the last twenty years or so. Over the years, Finland has joined several international research organisations - including EUREKA, COST, CERN, ESF, ESA and EMBL - and in this way has opened new doors for Finnish researchers to take part in international collaborations. Many indicators prove that the Finnish R&D community is today reaping the benefits of these earlier decisions. Overall, the international collaboration of Finnish organisations increased rapidly during the 1990's and has even accelerated after Finland joined the European Union at the beginning of 1995: Finnish research groups succeeded in the competition for EU research funds in the 4th R&D Framework Programme (1994-1998). Publishing in internationally refereed journals, which caused concern in evaluations especially in the 1980's and the beginning of the 1990's, has been growing steadily. Co-publishing with international colleagues also seems to be on the increase.

All activities for advancing collaboration on the international front have been welcomed in the evaluations. At the same time, however, it has been emphasised that it is not sufficient just to follow international trends. Finnish institutions are instead encouraged to exploit opportunities to participate in the definition and development of new international R&D programmes; opportunities for participation have increased markedly since Finland's EU membership. For example, in the institutional evaluation of Tekes in 1995, the agency was encouraged to be actively engaged in the formulation of future international programmes at the EU level. At the same time, national funding agencies have been advised to take into account international programmes, for instance, at the EU level, prior to launching new national R&D programmes, in order to avoid overlapping activities.

With rapidly increasing involvement in international co-operation we are entering into a new phase when it becomes even more important than before to pay attention to the quality and relevance of international research collaboration. Participation in international activities has to be based on strategic considerations and be balanced against strategic priorities and available resources. International collaboration may otherwise put unnecessary strain on the staff and other resources of research organisations.

The burden of the EU research programmes came up in the follow-up review of the Finnish Institute of Occupational Health in 1998. The evaluators noted that there

was a certain amount of dissatisfaction with EU activities within the institute and with the burden that the activities put on the Institute's resources. Participation in EU co-operation had increased the workload of many staff members and taken an undue amount of working time. It is also noteworthy from the institute's point of view that EU activities are not always "cost-effective", i.e. they do not generate external funding. The evaluation group asserted that there needs to be a strategy for participation that maintains the interests of Finland and the Institute. At the same time, however, it was underlined that "a careful consideration of the Institute's priorities and staff time and energy needs to be included in decisions regarding participation in EU activities".

5 Strategic information for decision-making?

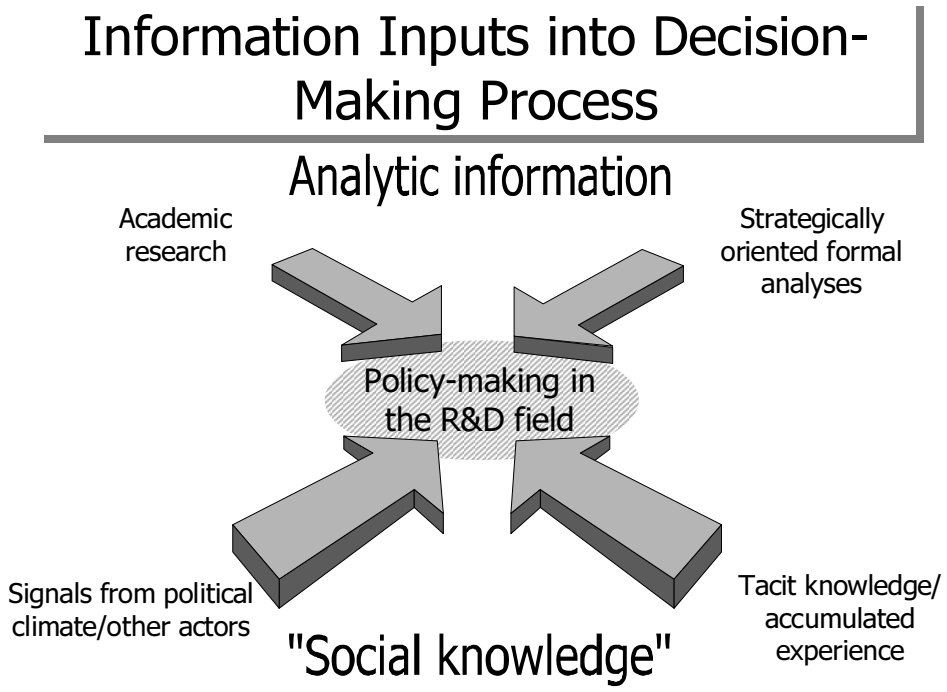
This chapter will examine the role of evaluation in decision-making process. To put it another way, we are interested in knowing how evaluation and its results have been used by decision-makers. This can be considered a crucial question for the legitimacy of evaluation even in a broader sense. The rationale for evaluation as an intentional, goal-oriented activity depends on its capability to provide insights and information which is accurate and can be utilised in the development of activities.

The issue will be approached from the decision-makers' point of view. In order to get an idea of the potential uses of evaluation results, 40 decision-makers at different levels of the national R&D system were interviewed. This approach was regarded as the most appropriate way to tackle the question, because few follow-up studies have examined the impacts of completed evaluations.

5.1 General ideas about evaluation

The general attitude towards the evaluation of R&D activities among the interviewed decision-makers was both positive and pragmatic. Evaluation was seen to include many elements which make it useful in decision-making. It was pointed out, however, that evaluation is not a magic cure for all situations; rather, the launch of an evaluation has to be well-planned and it must be based on clear goals.

The whole question of the utilisation of evaluation information turned out to be intricate for the decision-makers. They found it often difficult to discern afterwards the way in which a specific evaluation effort had contributed to decision-making in a particular situation. Evaluation was seen to be closely intertwined with other relevant information sources at the decision-makers' disposal. The figure below presents the different information sources that were deemed to be important by the interviewees. The emphasis and significance of the different sources varies not only depending on the situation, but also on individual working methods and organisational cultures. Some decision-makers prefer to read documents and reports whereas others find it more natural to gather background information through face-to-face communication.



The opinions concerning the usability of evaluation diverged somewhat depending on organisational affiliation and, of course, on the interviewees' familiarity with the issue. It seems that the most positive attitudes are found among people from ministries. The middle ground was occupied by university rectors and directors of sectoral research institutes. In the funding organisations, thoughts on evaluation were more varied: evaluation was understood to be an integral measure in the work of the R&D community, but at the same time there were some concerns about its present capability to support strategy work.

These slight differences can probably be explained by people's varied experience with different kinds of evaluations. The practical contribution of an institutional evaluation is often easier to detect compared to the potential effects that an R&D programme evaluation can have on the evaluated activity. People at ministries and research institutes have witnessed that evaluation has, for example, led to extensive organisational reforms. However, in the context of R&D programme evaluations, the potential effects are more indirect and take place within a longer time span; for example, the effects may surface after many years in the planning of new programmes, and then it will be much more difficult to discern their origin.

5.2 Evaluation as a management tool

The majority of the interviewees considered evaluation to be a management tool which can be used in many different ways. A recurring view associated evaluation with cost-awareness both at the level of an individual research organisation/programme, and at the level of the national R&D-system as a whole. In many comments it was emphasised that the public financier, and finally the taxpayer, has the right to know whether public resources are used efficiently and for relevant purposes. This emphasis on accountability might be interpreted as one dimension of the public sector reform which has been made during the past two decades across OECD countries. The evaluative attitude is an integral part of this so-called "new public management", and management by result is probably its most obvious manifestation.

However, evaluation was not only seen as a tool which would ensure the accountability and relevance of public R&D activities, but also as a procedure closely linked with internal development and learning. According to many interviewees, the evaluation process has offered the staff an opportunity to pause for a moment and to reconsider what they are doing, why they are doing it, and how they are doing it. This way their have a chance of identifying weak points in the functioning of their organisation or programme and ambiguities in their goals. This kind of internal learning process has also led to new opportunities and started reforms even before the external evaluation process has been completed. The learning aspect in the evaluation process was deemed particularly important by some university rectors and directors of government research institutes: some of them also noticed that, from the organisation's standpoint, the internal evaluation preceding external evaluation was the more productive and useful part of the evaluation process.

A somewhat more critical viewpoint concerning the internal learning aspect was brought up in some interviews, too: the interviewees referred to the possibility that the current "evaluation boom" in Finland can also be understood as "governing from afar". Administration induced use of evaluation activities and various indicators in the R&D field affect the self-understanding of research organisations and teams by directing attention to certain issues, whereas other potentially relevant questions are left aside. In this way, evaluation may trigger an externally desired self-steering process in the organisation or team.

Apart from the opportunity for internal learning, evaluation helps to clarify the mutual expectations of partners and other interested parties. Thus, an evaluation of

an individual institution can turn out to be a learning process for those in a wider institutional environment, including other agencies in the administrative domain, such as ministries and other partners. For example, evaluation of research institutes has offered the ministries an opportunity to review the institutes more thoroughly; their functioning, their position within the administrative field and their role in the development of the sector in question. In addition, some interviewees at the ministry level felt that institutional evaluations have succeeded in pointing out weaknesses which might demand internal changes even within ministries.

Recent evaluations of sectoral research institutes have increased connections between ministries and subordinate research institutes. The evaluations have given ministries a legitimate means to get attention of institutes on issues deemed important from the ministry's point of view. At the same time, however, horizontal co-operation across boundaries of administrative sectors has not developed to the same extent. The last point has raised some concern at the Science and Technology Policy Council. According to the Council it is clear that evaluations have proved to be beneficial for the research institutes, and for the inter-relationships between the evaluated institutes and the Ministries concerned. The Council is, although, concerned that evaluations do not answer - not even when reviewed together - questions with a broader scope, cutting across administrative borders, such as how well the arrangements of research activity compare to overall needs of sectoral research in Finland.

5.3 Evaluation as persuasion

Evaluation activity also involves a strong persuasive dimension - when persuasion is understood as an effort to convince other people about the soundness and necessity of certain plans and decisions. This dimension of the evaluation activity is in itself a "delicate" issue, as one of the interviewees put it.

Justifying and convincing takes place at different levels. For the organisation's management, evaluation offers general support and assurance in decision-making situations. The support that evaluation gives them is clearly valued among decision-makers. Evaluation is seen as an important external "second opinion", in relation to which decision-makers can reflect their own ideas. This "second opinion" gives management the opportunity to assure itself that planned actions and strategic choices are also reasonable from an external point of view.

In addition to the "second opinion" effect, evaluation is also valuable for justifying and convincing others about the necessity of certain decisions. Within the

organisation, evaluation provides support to the decision-makers in relation to the staff: decision-makers do not have to stand alone when they can point out that someone from outside, who has 'objectively' assessed the situation, has also come to the conclusion that certain kinds of decisions are inevitable. Evaluation is also understood to be a handy tool for showing the relevance of activities for actors with whom the organisation has close links, such as ministries, funding agencies and other stakeholders. If, however, evaluative conclusions turn out to be negative, the evaluation process itself can function as an indicator of the organisation's active willingness to improve its performance.

This aspect of justifying and convincing is particularly important in a time of difficult decisions when evaluation results may be used to legitimate decisions and activities which would otherwise be difficult to carry out; these include such topics as organisational reforms and the reallocation of resources, or the prioritisation of R&D areas. This came out clearly in most of the interviews. For instance, from the ministries' point of view, the evaluation of research institutes has had a clear pull-the-trigger effect. It was felt that it had been easier to launch larger organisational restructuring processes and notable readjustments of strategies through external evaluation. Some interviewees even thought that without evaluation, the ministry in question would not have had enough power to get the research institute to carry out reforms that were deemed necessary, or reforms would have been postponed.

Overall, conclusions and recommendations in an evaluation report can be utilised in many ways, and by different actors. The same conclusions and recommendations - especially if they are positive - can be used as arguments for additional resources and other demands, too. Evaluation results have also been used to point out the relevance of the work to a broader public. The strategic use of evaluation information seems to be a part of business, so to say. This is understandable because after publication, the evaluation report, like any other published document, is open to different interpretations. Individuals and groups who feel that they have been 'mistreated' in the evaluation and presented in the wrong light may try to downplay the relevance of the whole endeavour. On the other hand, people who think that evaluation presented them in a favourable light will try to gain from it. In some particular evaluation cases, however, overt politicization of evaluation has had harmful impacts, and has even led to open internal conflicts.

5.4 Strengths and weaknesses

It appears from the interviews, that the value of evaluation as a management tool does not lie in its special capability to identify and raise totally new issues. Rather, it is more the rule that the evaluated organisation and its environment are to some extent aware of the questions that are brought up by the evaluation group. The reason why the evaluation is still regarded as worth carrying out is based on the idea that the evaluation will succeed in highlighting and emphasising issues and aspects which are easily forgotten or lost in everyday business. One of the interviewees expressed this by noting that "external opinion is always welcome, because it is human that people tend to become blind to their daily routines; then someone who comes from outside the organisation sees things that the staff may not notice". Evaluation also constructs a more coherent picture about the situation and draws attention to certain questions; it clarifies and gives more weight to them.

The interviewees also brought up some weaknesses in current evaluation practices, which may diminish the utility or trustworthiness of the conclusions and recommendations. The most often mentioned weak points were related to the following two issues: (1) lack of time for evaluations which may lead to inaccuracies and superficiality in results; (2) the competence of evaluators' and in particular, their insufficient knowledge of local circumstances.

Lack of time does not allow evaluators to familiarise themselves thoroughly with the object of the evaluation. Reasons for the lack of time are related both to financial issues and fully-booked schedules of the evaluators. Reputable and well-known evaluators are involved in many different activities at the same time, and they only have a limited time to concentrate on an individual evaluation case. One of the interviewees noted that "we do not have any means of securing that the evaluators go through all the documents that were delivered to them in advance". On the other hand, the visible lack of time for the evaluation was not considered such a serious issue: commissioners know the limitations, and thus they can be taken into account when the conclusions and recommendations are later reviewed.

The lack of time was also commented on by the evaluators of the Finnish Institute of Occupational Health in a follow-up report: "The group was not satisfied with the amount of time that it had to do the evaluation". They identified a number of reasons why the time reserved for the evaluation was limited: the time that the evaluators could give to the review; the increased costs of a more extensive evaluation; the timetable of the commissioner, and the need for answers in a reasonable time period.

The contribution of international evaluators was highly valued by many decision-makers. At the same time, however, potential shortcomings relating to this common practice were mentioned surprisingly often when we remember that the use of international evaluators is well established in Finland today. There is a good reason for this practice: the need to ensure the neutrality of an evaluation, which would otherwise be difficult because of the limited pool of native experts without a stake in a particular evaluation. International experts are also seen to offer a valuable outside perspective on national R&D activities; evaluators from abroad may identify strengths and weaknesses which could go unnoticed by a native. Experienced and well-reputed evaluators are also in a position to compare local R&D arrangements to international standards and best practices.

The preceding comments were widely shared by the interviewees. However, they also see drawbacks in the use of international evaluators. The interviewees thought that a lack of knowledge of local conditions had several times led the evaluators to draw inaccurate conclusions and recommend measures that cannot be applied in the Finnish context. It is also noteworthy that still today, the major part of official documentation about research activities and the publication of research results are in Finnish. This natural barrier is hard to overcome - even if evaluated research groups and organisations, as well as commissioners use time and human resources to translate the principal documents into English. Evaluations usually try to resolve this by problem by ensuring that there is at least one Finnish member appointed to the evaluation team.

5.5 The future of evaluation activities

In general, the continuation of research evaluation activities was seen as indispensable part of managing the national R&D system at its different levels. At the same time, however, the interviewees widely concurred that excessive evaluation of R&D activities should be avoided. This applies especially to institute-wide evaluations, which should not be conducted too often, because of the intensive documentation needed to prepare for the evaluation and the large amount of staff time that the whole process takes: there should also be time to concentrate on core business. The majority of the interviewees estimated that a suitable period for broader institutional evaluation efforts is every 5 to 10 years. Single R&D programmes and parts of research areas can be evaluated more often.

Interviewees also brought up another aspect related to the improvement of evaluation practices so that they would be relevant in decision-making situations. This aspect concerns the development of measures and tools that combine elements

and perspectives from future-oriented strategic studies to more retrospectively-oriented evaluation activities. For instance, ex-post evaluations of programmes produce valuable information about the performance of past policies and decisions, but they are not informative enough for actors such as funding organisations, which are continuously scanning the terrain of R&D activities in order to identify signs on which to base their resource allocation decisions.

The third point regarding the improvement of evaluation practices deals with the need to assure a smooth flow of information between evaluators, decision-makers and other interested parties from the beginning of the evaluation process. From the decision-makers' standpoint, the final evaluation report is often an insufficient medium to ensure that the insights and information produced in the evaluation are put into use in decision-making. Instead, many interviewees emphasised the significance of continuous interaction during the evaluation process as a means to link evaluation more closely with decision-making. They also mentioned that there was a need to connect the design of evaluation to the planning phase of a programme or policy to be evaluated. This would enable more systematic data gathering and better co-ordination between evaluation effort and programme management.

To conclude, there is also need to ensure that evaluators have at least some basic knowledge of the local context in which the subject of the evaluation operates. This can be anticipated to become even more important in the future, if R&D evaluation continues to emphasise the wider social relevance of publicly funded research and development activities.

6 Summary

In Finland, the science and technology policy field has witnessed an emergence of a vital evaluation culture during the last two decades. The first efforts inspired by international examples and internal considerations were carried out at the beginning of the 1980's. The evolution and diffusion of the evaluation culture has taken place gradually without perceptible outside pressure: evaluation was perceived by administrators' as a management innovation and it was adopted by different organisations. After 17 years of development, evaluation is visibly anchored in the Finnish research and development system.

The focus of evaluations has evolved as evaluation practice has diffused through new areas and as changes have occurred in societal interests. In the 1980's and at the beginning of the 90's, evaluations focused more on the quality of Finnish research, on the position of basic research, and on the conditions of research. Since then, more attention has been paid to the relevance and impact of public R&D activities, and to organisational issues and strategic questions. According to the reviewed evaluation reports, the field of R&D evaluations is characterised by a fairly established toolkit of peer review and impact analysis procedures. Evaluations are carried out by people who have a good track record either in the research community, in the administration of research institutions, or in industry. Finnish commissioners tend to look for evaluators from countries that are close "culturally" and countries with whom Finnish researchers and administration tend to co-operate and have contacts.

Generic features of the Finnish public R&D system, which were touched upon in conclusions and recommendations, are as follows:

- quality of R&D activities
- strategic issues
- organisation of R&D activities
- researcher training and career
- R&D co-operation
- international collaboration

The need for strategic rethinking among Finnish R&D organisations was widely identified in the evaluations. A common recommendation made in this situation is to target activities in a limited number of selected subject areas or core tasks, and to increase co-operation with other relevant actors both nationally and internationally.

However, especially in areas where rapid scientific and technological development is taking place, large, static programmes may not always be the best measures for encouraging the R&D community to adopt changes and to find new opportunies in the changing environment.

The need for organisational restructuring emerged as a theme from a number of institutional evaluations. Recommendations for restructuring activities have not been limited solely to the intra-organisational level, but in some cases they have also included an inter-organisational dimension. In a number of cases the decision to launch the evaluation had a "pulling-the-trigger" effect: the evaluation was the start-up for major organisational restructuring.

The length of post-graduate studies leading to a doctorate has clearly been one of the most commonly identified structural weaknesses in the Finnish research system. The continued attention paid to this unsatisfactory situation was most likely the incentive to develop Finnish researcher training during the 1990's - a manifestation of this is the new graduate school system, which was created in 1995. Other detected deficiencies in the structure of researcher careers included undeveloped post-doctoral training and an insufficient incentive structure, both of which were seen to be a potential hindrance to an individual researcher's career prospects and to the further development of the national R&D system. The former concern has been tackled by the Academy of Finland, which some years ago introduced a post-doctoral programme intended for young persons who have recently earned their doctorate.

The development of co-operation in its various forms - within a research field or an organisation, between research areas and disciplines or organisations, regionally or inter-regionally, and nationally or internationally - is one of the enduring concerns in evaluation. Special attention has been given not only to the enhancement of collaborative activities between industry, universities and research institutes, but also to the dissemination of skills and knowledge through different arrangements. Weaknesses in the co-operative arrangements have been identified at different levels of the national innovation system. Formerly, insufficient or lacking co-operation and knowledge transfer between research and industrial communities were among the main weaknesses of the R&D programmes. Since then the situation has improved. Still, the general need to improve contacts and co-operation remains.

Active participation in international research co-operation is considered vital to individual researchers, research organisations, and the national innovation system

at large. National policy in the field of science and technology has favoured internationalisation of research activities during the last decades. Today, many indicators prove that the R&D community is reaping the benefits of these earlier decisions: international collaboration increased rapidly during the 1990's and has even accelerated since Finland joined the European Union in 1995. Publishing in internationally refereed journals has been growing steadily. Co-publishing with international colleagues also seems to be on the increase.

However, we must remember that it is not sufficient just to follow international trends. Finnish institutions are encouraged to exploit opportunities to participate in the definition and development of new international R&D programmes. Also, with rapidly increasing involvement in international co-operation it becomes even more important than before that participation in international activities is based on strategic considerations and balanced against strategic priorities and available resources.

The general attitude towards the evaluation of R&D activities among the interviewed decision-makers was both positive and pragmatic. Evaluation was seen to include many elements which make it useful in decision-making. It was pointed out, however, that evaluation is not a magic cure for all situations; rather, the launch of an evaluation has to be well-planned and it must be based on clear goals.

The opinions on the utility of evaluation diverged somewhat depending on organisational affiliation and, of course, on the interviewees' familiarity with the issue. It seems that the most positive attitudes are found among people from ministries. The middle ground was occupied by university rectors and directors of sectoral research institutes. In the funding organisations, thoughts on evaluation were varied: evaluation was understood to be an integral measure in the work of the R&D community, but at the same time there were some concerns about its present capability to support strategic planning.

The majority of the interviewees considered evaluation to be a management tool which can be used in many different ways. A recurring view associated evaluation with cost-awareness both at the level of an individual research organisation/programme, and at the level of the national R&D-system as a whole. Many comments emphasised that the public financier, and finally the taxpayer, has the right to know whether public resources are used efficiently and for relevant purposes.

Evaluation was seen as a procedure closely linked with internal development and learning. The evaluation process 'forces' staff to pause for a moment and to reconsider what are they doing, why are they doing it, and how are they doing it. This kind of an internal learning process has led reforms even before the external evaluation process has been completed. Apart from the opportunity for internal learning, evaluation also helps to clarify the mutual expectations of partners and other interested parties. Thus, an evaluation of an individual institution can turn out to be a learning process for a wider institutional environment.

The support that evaluation gives for them is clearly valued among decision-makers. Evaluation is seen as an important external "second opinion", in relation to which decision-makers can reflect their own ideas. This "second opinion" gives management the opportunity to assure itself that planned actions and strategic choices are also reasonable from an external point of view. In addition to the "second opinion" effect, evaluation is also valuable for justifying and convincing others about the necessity of proposed decisions. This is particularly important in a time of difficult decisions when evaluation results may be used to legitimate decisions and activities which would otherwise be difficult to carry out; these include organisational reforms and the reallocation of resources, or the priorisation of R&D areas.

Overall, the value of evaluation as a management tool does not lie in its special capability to identify and raise totally new issues. Rather, it is more the rule that the evaluated institution and its environment are to some extent aware of the questions that are brought up by the evaluation group. The reason why the evaluation is still regarded as worth carrying out is based on the idea that the evaluation will succeed in highlighting and emphasising issues and aspects which are easily forgotten or lost in everyday business. Evaluation also constructs a more coherent picture about the situation and draws attention to certain questions; it clarifies and gives more weight to them.

There are some weaknesses in current evaluation practices, which may diminish the utility or trustworthiness of the conclusions and recommendations. The most often mentioned weak points were related to following two questions: (1) lack of time for evaluations which may lead to inaccuracies and superficiality in results; (2) evaluators' competence and in particular, their insufficient knowledge of local circumstances.

In general, the continuation of reseach evaluation activities was seen as an indispensable part of managing the national R&D system at its different levels. At the same time, however, the interviewees widely concurred that especially institute-wide evaluations should not be conducted too often, because of the intensive documentation needed to prepare for the evaluation and the large amount of staff time that the whole process takes.

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Appendix 1: R&D evaluations from 1983 onwards

Commissioner Academy of Finland

Evaluation	Year
Evaluation of Scientific Research in Finland: Inorganic Chemistry.	1983
Evaluation of Scientific Research in Finland in Experimental Nuclear and High-Energy Physics. Kokeellisen ydin- ja suurenergiafysiikan arviointi	1985
Evaluation of Basic Research in Automation Technology in Finland	1986
Evaluation of Scientific Research in Hydrobiology in Finland	1986
Evaluation of Research in Forest Regeneration in Finland. Metsänuudistamistutkimuksen arviointi	1988
Evaluation of Research in Environmental Toxicology in Finland	1988
Kasvatustieteellinen tutkimus Suomessa. Evaluation of Educational Research in Finland.	1989
Finnish Cardiovascular Research. A Critical Evaluation	1989
Peace Research in Finland, A Critical Evaluation	1990
Research and Teaching in Computer Science, Computer Engineering, and Information Systems - A Critical Evaluation	1990
Oikeustieteellinen tutkimus Suomessa. Evaluation of the science of law research in Finland.	1992
Evaluation of Research in Forest Damages Caused by Air Impurities in Finland	1992
Evaluation of Finnish Membership in IIASA	1994
Evaluation of the Low Temperature Laboratory, Helsinki University of Technology	1995
Psychiatric Research in Finland in 1995. A peer review report for the Academy of Finland	1996
Evaluation of Electronics Research in Finland	1996
Fennistic Research in Finland at the Beginning of the Nineties. Report of the Evaluation Panel	1996
Evaluation of the Finnish Research Programme on Climate Change Silmu	1996
National Programme on Materials and Structure Research - Progress Report. Materiaali- ja rakennetutkimuksen ohjelman	1996

väliarviointi	
Molecular Biology and Biotechnology Research in Finland, Embo Evaluation Report	1996
The State and Quality of Scientific Research in Finland	1997

Commissioner Academy of Finland & Ministry of Trade and Industry

Evaluation	**Year**
Evaluation of Basic Research in the Energy Field in Finland	1988

Commissioner Academy of Finland & Tekes

Evaluation	**Year**
Evaluation of Finnish Space Science	1994

Commissioner Agricultural Research Centre of Finland

Evaluation	**Year**
Evaluation of Research on Field Crop Production at the Agricultural Research Centre of Finland	1991
Evaluation of Research on Animal Production at the Agricultural Research Centre of Finland	1992

Commissioner Bank of Finland

Evaluation	**Year**
An Evaluation of the Research Activities of the Bank of Finland	1999

Commissioner Ministry of Agriculture and Forestry

Evaluation	**Year**
Evaluation of the Agricultural Research Centre of Finland (MTT) - Report of the Evaluation Panel	1996
Getting Ready for the Next Century. Evaluation of the Finnish Geodetic Institute	1998
Evaluation of the Finnish forest research institute Metla. Report of the Evaluation panel	1998
Evaluation of National Veterinary and Food Research Institute EELA. Report of the Evaluation Group	1998
International Evaluation of the Finnish Game and Fisheries Research Institute - Report of the Evaluation Group	1999

Commissioner Ministry of Education

Evaluation	**Year**
Evaluation of Finnish research in sports sciences	1991
The Academy of Finland. An International Evaluation	1992
Report on the External Evaluation of Higher Education in Mathematics and Natural Science in Finland	1992
Evaluation of the University of Jyväskylä: Raport of External Visiting Group	1993
Evaluation of the University of Oulu: Report of External Visiting Group	1993
Humanistisen koulutusalan arvioinnin tulokset: Humanististen tutkintojen työryhmän loppuraportti	1993
Educational Studies and Teacher Education in Finnish Universities 1994: A Commentary by an International Review Team	1994
Kadonnutta imperiumia etsimässä: Hallintotieteiden koulutusalan arviointi	1994
Evaluation of the Sibelius-Academy: Report of External Evaluation Group	1995
Utvärdering av Lapplands universitet: Rapport från en extern sakkunniggrupp	1995
Monologista dialogiin: Tampereen yliopiston opetuksen arviointiprojektin loppuraportti	1995
Evaluation of the University of Vaasa: Report of External Visiting Group	1995
Quality Label? EQUIS Evaluation Report Helsinki School of Economics and Business Administration	1998
Vart är Hanken på väg? Rapport av en extern utvärderingsgrupp.	1998
Three Finnish Universities in the International Perspective. CRE Institutional Review of Helsinki University of Technology, Tampere University of Technology and Åbo	1998
Towards the Responsive University. The Regional Role of Eastern Finland Universities	1998
From the Cherry Orchard to the Future. Evaluation of the Theatre Academy of Finland	1999
Strategies for the Future. Evaluation of University of Art and Design Helsinki UIAH	1999
Learning by Comparing. The Benchmarking of Administration	1999

at the University of Helsinki	
Five Years of Development. The Follow-up Evaluation of the University of Oulu	1999
Teaching Through a Foreign Language. From Tool to Empowering Mediator	1999
TSEBA as a Learning Organisation. Evaluation of Turku School of Economics and Business Administration	1999
Tampereen yliopiston opetuksen arviointi.	2000
External Engagement And Institutional Adjustment. An Evaluation of the University of Turku	2000
From Academy of Fine Arts to University. Same name, wider ambitions	2000

Commissioner Ministry of Finance

Evaluation	**Year**
Evaluation of the Government Institute for Economic Research	1995

Commissioner Ministry of Justice

Evaluation	**Year**
Oikeuspoliittinen tutkimuslaitos - arviointiraportti. Evaluation of the National Research Institute of Legal Policy.	1997

Commissioner Ministry of Social Affairs and Health

Evaluation	**Year**
Evaluation of the National Public Health Institute of Finland - Kansanterveyslaitos. Report of the Evaluation Panel	1995
Työterveyslaitos - Investment in Health. The Scientific and Functional Evaluation of the Finnish Institute of Occupational Health	1995
International Evaluation of the National Research and Development Center for Welfare and Health	1999

Commissioner Ministry of the Environment

Evaluation	**Year**
Futures for FEI. International Evaluation of the Finnish Environment Institute	1998

Commissioner Ministry of Trade and Industry

Evaluation	**Year**
The Technical Research Centre of Finland (VTT) - An International Evaluation.	1993
The Technology Development Centre of Finland, TEKES - An International Evaluation.	1995
The Evaluation of the Finnish Antarctic Activities.	1995
New Challenges for Geoscience in Society. International evaluation of the Geologian tutkimuskeskus (GTK)	1996
Kuluttajatutkimuskeskuksen selvitys- ja arviointityö. Evaluation of the National Consumer Research Centre.	1997
Measuring up to the Challenges of the 21st Century. An International Evaluation of the Centre for Metrology and Accreditation	1997
Evaluation of the Technological and Industrial Benefits of Finnish space Programmes	1998
Innovation and Invention in Finland Strategies for Networking - An International Evaluation	1998
Evaluation of the RATU2 and RETU Research Programmes	1998

Commissioner Ministry of Transport and Communications

Evaluation	**Year**
New Opportunities and Challenges - International Evaluation of the Finnish Meteorological Institute	1997
New Opportunities and Challenges in Marine Research - International Evaluation of the Finnish Institute of Marine Research	1997

Commissioner Tekes

Evaluation	**Year**
An Outside Perspective on FINPRIT Programme: The Finnish Programme for Research and Development in Information Technologies	1988
Teknologiaohjelmien arviointi. Tietotekniikan kehittämisohjelman väliarviointi. Evaluation of technology programmes. Mid-term evaluation of information technology programme.	1988
Kappaletavara-automaatio 1985-1988. Evaluation of the national technology programme for automation in	1989

manufacturing.	
Evaluation of the Finnish Powder Metallurgy Technology Programme 1986-1990	1990
Arktinen teknologiaohjelma 1985-1990.	1990
Evaluation Report of Industrial Chemistry Technology Programme	1990
Evaluation of the Finnish Gene Technology Programme (1984-1987)	1990
Evaluation of the Scientific and Technological Status of Finsoft, The Finnish Software Technology Programme	1991
Finsoft-ohjelman tulosten teollisen hyödyn ja hyödynnettävyyden arviointi. Evaluation of industrial impact and benefits of the Finnish Software Technology Programme (FINSOFT)	1991
Evaluation of the Finnish Microelectronics Programme 1987-1991	1991
Muovikomposiittirakenteet 1988-1992 (sis. Ohjelma-arvioinnin)	1992
Evaluation Report of Pharmaceutical Technology Programme	1992
The Finnish Technology Programme "Industrial Building Technology". Evaluation Report	1992
Teollisen talonrakennuksen teknologiaohjelman arviointi	1992
Start up Evaluation of PMT & PLT Programmes	1992
Evaluation of the Scientific and Technological Status of FUPA: The Finnish Functional Paper Programme. Funktionaalinen paperi -teknologiaohjelman teollisen hyödyn ja hyödynnettävyyden arviointi	1992
Teknologiaohjelman välievaluointi "Valupohjaisten komponenttien valmistuksen kehittäminen"	1993
PMT & PLT Programmes - Middle Term evaluation of key technology areas	1993
The Evaluation Report of the Administration of the Materials Research Programme - A Network Perspective	1993
Elektroniikan suunnittelu- ja valmistustekniikat - ESV-teknologiaohjelman väliarviointi	1993
INVENT - Mid course evaluation	1993
Graafisen alan teknologiaohjelman arviointi	1995
Funktionaalinen paperi: Arviointiraportit - Teknologiaohjelman	1995

teollisen hyödyn ja hyödynnettävyyden arvionti; Evaluation of the scientific and technological status of the Finnish functional paper programme	
Synthesis Technology Programme 1992-1996. Evaluation Report	1996
The Electronic Design and Manufacturing Technology Programme 1991-1995, Evaluation Report	1996
Evaluation Report of the Process Technology Programme	1996
Valupohjaisten komponenttien valmistuksen kehittäminen. Arviointiraportti	1996
Pharmaceutical Technology Programme 1989-1994. Evaluation Report	1996
Biodegrable Polymers Technology Programme 1992-1996. Evaluation Report	1996
Machine Vision 1992-1996	1996
PRODEAL Technology Programme 1992-1995. Evaluation Report	1996
SIMSON: A CIM Development Programme for the Finnish Metal and Engineering Industry. Evaluation Report	1996
Energy Technology Programmes 1993-1998. Intermediate Report	1997
Oppivien ja älykkäiden järjestelmien sovellukset 1994-1998. Väliarviointi	1997
New Generation Paper Technology Programme 1992-1996. Evaluation Report	1997
Compunational Fluid Dynamics (CDF) Technology Programme 1995-1999. Mid-Term Evaluation Report	1997
Evaluation Report fo the Invent Technology Programme	1997
Suomen osallistuminen IEA:n energiatutkimukseen 1982-1996. Arviointiraportti	1997
WELD 2000 Modern Welding Technology Programme. Evaluation Report	1997
Partnership in Injection Moulding Business 1993-1997. Evaluation report	1997
The Mechanical Wood Processing and Wood-Based Panels Technology Programmes 1992-1996	1997
Technology Clinic Initiative. Evaluation Report	1998
Industrial Applications of Engineering Materials 1993-1997. Evaluation Report	1998

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Advanced Heavy Machinery Technology Programme for Mobile Work Machine Development 1993-1998. Evaluation Report.	1998
Energiateknologiaohjelmat ja Suomen energiajärjestelmä Ohjelmakokokonaisuuden arviointi. Arviointiraportti	1998
Digital Media in Finland. Evaluation Report	1998
Technology Strategy Consulting Services for SMEs. Evaluation Report.	1998
Energy technology programmes 1993-1998	1999
Improving Product Development Efficiency in Manufacturing Industries 1996-1999	2000
Pakkausalan teknologiaohjelma 1994-1999 - Packaging Technology Programme 1994-1999	2000
R&D Programmes in Electronics and Telecommunication. ETX, TLX, INWITE and Teletronics	2000

Commissioner Tekes & Federation of Finnish Metal, Engineering and Electrotechnical Industries

Evaluation	**Year**
Neljän metalliteollisuutta palvelevan teknologiaohjelman arviointi-loppuraportti. The evaluation report of four technology programmes close to metal industry.	1990

Commissioner University of Helsinki

Evaluation	**Year**
Helsingin yliopiston tutkimuksen arviointi 1999. (Evaluation of Research at the University of Helsinki 1999)	1999

Commissioner VTT

Evaluation	**Year**
VTT:n toiminnan tuloksellisuus ja laatu - Arvio neljästä yksiköstä	1983
VTT:n rakennusfysiikan tutkimuksen arvio	1985
Arvio valtion teknillisen tutkimuskeskuksen muovitutkimuksesta	1985
Digitaalisen kuvainformaation käsittelyn tutkimusohjelma	1985
Digitaalisen kuvainformaation käsittelyn tutkimusohjelma	1986

1982-1984	
Arvio VTT:n konetekniikan tutkimusohjelmasta (1983-1985)	1986
VTT:n elintarvikelaboratorion toiminnan arviointi	1986
Arvio VTT:n arktisen tekniikan tutkimusohjelmasta (1983-1986)	1987
Puualan tutkimusohjelma 1983-1985	1987
Arvio VTT:n konepajateollisuuden valmistustekniikan tutkimusohjelmasta (1984-1987)	1988
Arviointilausunto VTT:n projektikokonaisuudesta "Mitttaustekniikan tutkimusohjelma vuosina 1984-1987)	1988
Prosessien numeerinen simulointi -tutkimusohjelma 1986-1988	1989
Prosessien numeerinen simulointi VTT:n tutkimusohjelma 1986-1988 - Projektien sisäinen arviointi	1989
VTT:n materiaalitekniikan tutkimusohjelman (1985-1988) arviointi	1990
Arviointiryhmän lausunto VTT:n korjausrakentamisen tutkimusohjelma 1986-1988:sta	1990
VTT:n vedenalaistekniikan tutkimusohjelman (1987-1989) arviointiraportti	1991
Arvio VTT:n tutkimusohjelmasta "Tekoälyn sovellutukset"	1991
VTT optoelektroniikan tutkimusohjelma 1987-1989 - Loppuarviointi	1991
Digitaalisen signaalinkäsittely tekniikka -tutkimusohjelman arviointi - luonnos	1991
Arvio VTT:n avaruustekniikan tutkimusohjelmasta (1985-1988)	1991
Arvio VTT:n elintarvikkeiden prosessitekniikan tutkimusohjelmasta (1988-1991)	1992
Rakentamisen tieto- ja automaatiojärjestelmien tutkimusohjelman (1988-1990) kotimainen ja ulkomainen arviointi. Information and Automation Systems in	1992
Review of the Forest Products Laboratory, VTT	1992
VTT:n rakenneanalyysitutkimusohjelman (1989-1991) arviointi	1992
Joustava tuotantoautomaatio piensarjatuotannossa tutkimusohjelman (1989-1991) arviointi	1993
VTT:n tutkimusohjelman "komposiittimateriaalit ja -rakenteet rakennusteollisuudessa (1990-1992) arviointi	1993

VTT:n kasvibiotekniikan tutkimusohjelma 1989-1991 - Arviointiraportti	1993
Ohjausjärjestelmien suunnittelu ja automaattinen verifiointi: VTT:n tutkimusohjelma 1988-1990 - Arviointiraportti	1993
Digitaalisen signaalinkäsittelyn tekniikka -tutkimusohjelma 1990-1992	1993
Palveluverkkoteknologian tutkimusohjelma 1989-1992 - Arviointiraportti	1993
Energia ja ympäristö prosessiteollisuudessa tutkimusohjelman arviointi	1994
Puuteknologian tutkimusohjelma 1991-1993 - Evaluointiraportti	1995
VTT-STAR Evaluation. Midterm Report	1995
Tuotemallit tuotteen ja tuotannon suunnittelussa tutkimusohjelma 1992-1994 - Evaluointiraportti	1995
Integroitu ohjaustekniikka -tutkimusohjelma 1991-1994 - Evaluointiraportti	1995
VTT Energy Evaluation Report	1995
VTT Manufacturing Technology Evaluation Report	1995
Research Programme on Biodegradable Plastics - Evaluation Report	1995
Research Programme on Molecular Modelling. Evaluation Report	1995
Research Programme on Chemical Reaction Mechanisms - Evaluation Report	1996
VTT Automation Evaluation Report	1996
VTT Biotechnology and Food Research Evaluation Report	1996
Logistiikan tutkimusohjelma 1992-1994 - Evaluointiraportti	1996
Pintatekniikan tutkimusohjelma 1991-1993 - Evaluointiraportti	1996
Tietokoneavusteinen rakennussuunnittelu ja -tuotanto -tutkimusohjelma 1984-1986	1997
Mikroanturisysteemit -tutkimusohjelma. Evaluointiraportti	1997
Materiaali- ja laitetekniset kysymykset puunjalostusteollisuuden suljetuissa vesikierroissa -tutkimusohjelma 1994-1996 - Evaluointiraportti	1997
Energiaa säästävät laitteet -tutkimusohjelma 1991-1994 - Evaluointiraportti	1997
VTT Communities and Infrastructure Evaluation Report	1997
VTT Information Technology Evaluation Report	1997

VTT Building technology Evaluation Report	1998
VTT Chemical Technology Evaluation Report	1998
VTT Electronics Evaluation Report	1998

Appendix 2: List of interviewees

Reijo Vihko	Academy of Finland
Jorma Hattula	Academy of Finland
Paavo Löppönen	Academy of Finland
Esko Poutiainen	Agricultural Research Centre of Finland
Tapio Markkanen	Finnish Counsil of University Rectors
Kauko Hämäläinen	Finnish Higher Education Evaluation Council
Jorma Rantanen	Finnish Institute of Occupational Health
Erkki J. Jatila	Finnish Meteorological Institute
Mikko Alestalo	Finnish Meteorological Institute
Raimo Matikainen	Geological Survey of Finland
Paavo Uronen	Helsinki University of Technology
Elias Pohtila	Metla - Finnish Forest Research Institute
Mirja Suurnäkki	Ministry of Agriculture and Forestry
Matti Heikurainen	Ministry of Agriculture and Forestry
Marja Simonsuuri-Sorsa	Ministry of Education
Markku Linna	Ministry of Education
Matti Lähdeoja	Ministry of Education
Arto Koho	Ministry of Social Affairs and Health
Kari Vinni	Ministry of Social Affairs and Health
Timo Kekkonen	Ministry of Trade and Industry

Alpo Kuparinen	Ministry of Trade and Industry
Paula Nybergh	Ministry of Trade and Industry
Marjukka Saarijärvi	Ministry of Transport and Communications
Jussi Huttunen	National Public Health Institute of Finland
Vappu Taipale	National Research and Development Centre for Welfare and Health
Juhani Kuusi	Nokia Research Centre
Marianne Stenius	Swedish School of Economics and Business Administration
Markku Mannerkoski	Technical Research Centre of Finland
Martti Mäenpää	Tekes - National Technology Agency
Jari Romanainen	Tekes - National Technology Agency
Martti af Heurlin	Tekes - National Technology Agency
Markus Koskenlinna	Tekes - National Technology Agency
Yrjö Sotamaa	University of Art and Design Helsinki
Kari Raivio	University of Helsinki
Erik Allardt	University of Helsinki
Aino Sallinen	University of Jyväskylä
Ossi Lindqvist	University of Kuopio
Jorma Sipilä	University of Tampere

Appendix 3: Evaluators opinions on the quality of research in Finland

The Academy of Finland

Below are summarised some major findings on quality issues in a range of evaluations carried out for the Academy of Finland. One of the evaluations was, however, not commissioned by the Academy itself, but by the Ministry of Trade and Industry: Evaluation of the Technological and Industrial Benefits of Finnish Space Programmes was included here because it has, in my opinion, close links to the Evaluation of Finnish Space Science carried out for the Academy and Tekes couple of years earlier.

The Low Temperature Laboratory Helsinki University of Technology

In the evaluation of the Low Temperature Laboratory, Helsinki University of Technology in 1995, the evaluation panel judged research activities of the laboratory between 1989-1994 to be of a very high standard on an international scale. In the field of ultra-low temperature physics the laboratory has been with little question the most productive laboratory in the world over the past twenty years. The work done by professor Lounasmaa and the LTL has always been characterized by extremely high professionalism and thoroughness. The scientific standard, productivity and innovative nature of the physical research were deemed to be on a high level in all three programmes, namely in the quantum fluids and solids program, the program of nuclear magnetism, and in cryogenic engineering.

The scientific successes in the field of quantum fluids and solids have largely been due to the group's extreme technical competence coupled with the many innovations which they have developed in the course of their experiments. Much of this would not have been possible without the high level of support which has allowed them to develop the needed technology. The program of nuclear magnetism has been exceptionally successful and has provided experimental results of the highest international standard and interest. Given the complexity of the experimental facilities, i.e., the high potential of partial failures, the pace at which new results were achieved is truly remarkable, and testifies to the high reliability of the experimental equipment. The high level of know-how in cryogenic engineering has become clear in the context of CERN collaborations. Since the proposals for these collaborations routinely undergo severe review processes by CERN, there is

no doubt that the LTL's participation is highly valued and its contributions meet the required high standards.

The scientific standard, productivity and innovative nature of brain research were also assessed as being at a high level. The effort in neuromagnetism developed to the point that at the time of evaluation the lab was considered one of the most advanced in this field and probably second to none as far as instrumentation is concerned. The achievements of the neuromagnetism team are considered internationally to be among the most elegant and important contributions to this field of neuroscience. In fact, the Otaniemi group is one of the largest and most productive in the field.

Molecular biology and biotechnology research in Finland

The Council of the European Molecular Biology Organisation (EMBO) carried out an evaluation of Finnish molecular biology and biotechnology research in 1996. According to the evaluation Finnish research in molecular biology and biotechnology has great potential for the future and had at the moment of evaluation several excellent group in the areas under review. Relative to the size of the country Finnish science in molecular biology is doing very well and compares favourably with other larger countries. For example, overall, Finnish science in the areas of molecular cell biology and neurobiology has great potential and has established a world reputation in some areas. Its performance with regard to other countries in Western Europe is, in general, very productive and, by comparison to larger countries, competitive in the areas that have been successfully developed over the years by strong individuals.

In the case of biomedical science the panel came to the conclusion that the scientific base is very strong for a country with a population of only 5 million people. It is not possible to compete internationally in all areas of research and the strategy of targeting resources at successful areas is correct. The quality of plant molecular biology was reviewed as good to very good in many institutions. Most group work is on the plants most important for Finland: Scot's pine, silver birch, and barley. In many laboratories in this field both basic and applied science takes place. Provision of grants from the universities and the Academy for basic research should be matched by provision of grants from the MMM to facilitate the transfer to applications.

The panel evaluating microbiology and immunology had a positive overall impression of the work done in the field, and rated it good to very good, with at least one group meriting the highest rating of excellent. Particularly noteworthy is the good integration of public health/ clinical microbiology/ diagnostics/ epidemiology with microbiology/ immunology research, on one hand, and the discovery and consequential pursuit as priority themes of reactive arthritis, Semliki Forest Virus (SFV) etc., on the other. The Panel strongly recommends that efforts are made to retain and build on these national strengths. The standard of Finnish biochemistry is very high compared to other countries of similar population size. Of course, as the evaluation panel noted, the quality of the individual research groups varies. A particular strength lies in the frequently close interactions with clinicians. Much work is of medical importance.

Overall, part of the progress of Finnish molecular biology and biotechnology is definitely due to attempts to create interdisciplinary programmes in the form of research centres, whether they are umbrella organisations or actually have their own facilities. Deficits were found in biophysics, structural biology, biocomputing, transgenic techniques and areas of microbiology, which in the opinion of evaluation panels should be corrected. Another area which did not get high marks from the evaluation panel was agricultural research.

Electronics research in Finland

The evaluation of electronics research in Finland was carried out for the Academy of Finland in 1997. In the evaluation report the standard of basic electronics research in Finnish universities was deemed high and comparable with other countries in Europe. The quality and scale of many of the university research groups is impressively good. Only a few of them have a size that we could define as below-threshold.

The technical and scientific level of a large majority of groups is very high. This is confirmed by the good health of the electronic industrial environment in Finland. There exists a broad spectrum which ranges from research groups which are very academically oriented and perhaps more inward looking, to groups which are energetically expanding their activities and broadening their funding base to include industry, EU, ESA etc, while still maintaining a high standard of basic research. Indeed, some of the groups seem to be much closer to applied research than to academic research. This reflects the fact that nowadays it is getting rather difficult (and many cases also meaningless) to distinguish between basic, applied

and industrial research. This can be seen from the funding schemes of many groups that have funding from both the Academy of Finland and Tekes. This has also been noticed at the administrative level an increase in the co-operation between these two bodies. However, this activity should be further enhanced and long-term national strategies should be defined.

There are activities where Finnish laboratories can regarded as among the leaders in their field, telecommunications circuits being an obvious one, but also in other fields such as bioelectromagnetism and materials and manufacturing science. The representation of the work of Finnish researchers in international reputable journals and at major conferences is high and a number of researchers are involved at a high international level in organisational activities in their field. The age profile is in general a young one which is good for the future.

Overall, in the Finnish electronics sector, there is a very healthy mixture of basic and applied research with the basic research activity being well informed but not dominated by the needs of potential end-users of the results of the research. The standard of education and of postgraduates seems to be very high. In summary, there is a thriving electronics research activity in Finland which is benefiting the country both through international scientific reputation and through its strong impact on the Finnish electronics industry. The complementary activity and large equipment resources of VTT act to enhance significantly the overall capability for electronics research in Finland.

The Finnish Research Programme on Climate Change Silmu

The evaluation of the Finnish Research Programme on Climate Change (Silmu) was carried out in 1996. In the evaluation the research performed during the programme was found, in general, to be of high quality and relevance. The programme had contributed to the knowledge on climate and global change. The evaluation team came to the conclusion that generally, the performance of the groups in the "Atmosphere" subprogram has been acceptably good, and broadly consistent with the standard of research in other countries which have a significant climate research effort.

However, there were some areas where there was some doubt over the compatibility with international standards of acceptability. This impression may have been a consequence of uninformative final reports, coupled with an absence of contextual completion and publication of the results in international-standard

journals. The evaluation team took note of the publication pattern associated with each group, as one indicator of performance quality. They recognised that such an indicator is imperfect, and not directly comparable across groups. In particular, much invaluable "front-end" effort in research may find it difficult to attract the accolade of appearance in a top-class journal, but this should be the target, wherever possible.

In the subprogram "Waters" the scientific quality of the projects appeared to be quite high. The emphasis of the subprogram was entirely consistent with the goals of Silmu, and has clearly moved the understanding of the effects on Finnish freshwaters forward, especially by providing tools and overviews of the policy-makers and environmental managers. However, focusing on model application meant that the subprogram did not yield much new basic scientific knowledge. The experimental parts of the subprogram were deemed to be of very high scientific relevance and although they were by nature "high-risk" projects they were assessed potentially providing unique information on the effects of future climate change on freshwater ecosystems. During the time of evaluation there were few such projects in the world, and it was clearly a plus for Silmu that such a project was also part of the "Waters" subprogram. Unfortunately with the end of Silmu this work did not receive continued funding and thus much of the information and the full potential of the experiments has been in great danger of being lost.

The Baltic part of the program was underrepresented with respect to the potential importance for the Finnish environment (and related aspects of economic and international policy). This may reflect the lack of project proposals for the Baltic and/or the lack of success in getting these proposals funded by the Academy in the selection process. In particular, there is a need for more work on the biological aspects of the Baltic ecosystems. The evaluation group was unsure if this work was going on outside of Silmu. The work on developing a sea ice model of the Baltic to simulate seasonal ice growth is "state of the art" and of international class. The group is co-operating with key scientists in other countries and is tied into international programs. Links to other science areas (e.g. atmospheric science and terrestrial hydrology) were not realised to a great extent: integration and collaboration were small. The influence of this work on international Baltic policy seems to have been minimal - yet prediction of Baltic Sea ice is of importance to shipping and hence the economy of Finland and the region.

Research in the subprogram "Terrestrial Ecosystems" contributed to a better understanding of global biogeochememical cycles, despite the duplication of

research in this subprogram. The human dimension subprogram was very small in size, and the contribution of this subprogram into overall goal of Silmu was small. As to the quality of the economic projects it was found striking that very little seemed to have been published in the peer reviewed literature. The exception was the work on game theory. Moreover, some of the results of economic projects came out in public before the work had been peer reviewed. As is the case with most of the economics projects, the work in sociology in Silmu did not find its way into the international literature, although some of it was published in Academy reports and conference proceedings. In the opinion of the evaluation team some important issues had not been dealt with in Silmu without any apparent reason (life style changes, transportation issues, environmental negotiations, land use, and security). Co-operation with groups outside Finland could have resulted in a better coverage of these issues.

Basic Research in Automation Technology in Finland

The evaluation of Basic Research in Automation Technology in Finland was carried out in 1995. The international evaluation team concluded that research in automation is of good quality and has contributed significantly to the success of industry. By international standards it may not have reached the highest peaks of excellence, but some is very good indeed, and the quality of most is at least good.

Work on the control of chemical and of pulp processes is particularly strong, and the team recommends that every effort should be taken to maintain a strong and lively control theory group in Finland. It should have close and continuous interaction with applications. For a country of Finland’s size, the amount and the quality of work are highly creditable.

One general observation made by the team was that the traditional university organisation in Finland does not accord well with the requirements of a subject such as automation, which demands the cooperation of specialists in many different aspects of the technology. Control theory has its own areas of specialisation, and the application of control in different areas (mechanical, chemical, etc.) is a further specialisation. These specialisations lie within the automation field, but applications also demand collaboration with other fields - with specialists in digital electronics, computer systems, image analysis, etc., and with other specialists in the application areas - production engineers, machine designers, and so on. The evaluation team recommended that strong efforts should be made at all levels to

encourage the coalescence of laboratories into larger units containing a wide range of specialisation in automation.

The team was also concerned that because of the small size of the country, its geographical location, and the number of its universities there is a danger of fragmentation of research, which can lead to the isolation of individuals or small groups of research workers. The lack of stimulation that follows can result in a performance much below the real capabilities of those concerned.

At the time of evaluation the team did not see work in the areas of computer architecture and software engineering, which were seen to have a particular importance in the immediate future for automation. Therefore, the team recommended that steps should be taken to strengthen the interaction between the automation and the computer science communities.

The assessment convinced the evaluation team that the provision of equipment for automation in Finnish universities was seriously inadequate. It was much below what was available in the best university laboratories elsewhere, and below what the team had seen in VTT and expected to be the case in Finnish industry. In the opinion of the evaluation team there was a real urge to solve the question how to deal with the increasing expense of equipment needed for technological research in Finland. Otherwise, unless an improvement was made, much of the investment in laboratories and staff would be wasted. Still another observation made by the evaluation team was that much automation work at universities was on too short a time scale.

Finnish space science

In 1994 the Academy of Finland and Tekes commissioned an evaluation of Finnish space science which concluded that Finland had at the time of evaluation a healthy level of involvement in international collaboration on scientific space activities. Besides that there is, according to the evaluation team, a good international appreciation and respect for the Finnish contribution.

A significant level of activity in space science was built up rapidly, and this led to the development of skills very much focused on scientific instrument design and manufacture rather than on spacecraft or ground system elements. The evaluation team remarked that in the near future several Finnish space hardware groups are facing new challenges as international programs in which they are involved move

from a period of instrument development to the operational phase where the scientific exploitation of the data becomes the most important objective. In order that Finland may obtain the maximum benefit from its past investment in space hardware, adequate funding must be provided for data exploitation.

Technological and Industrial Benefits of Finnish Space Programmes

Technology oriented space activities in Finland were evaluated in 1998 by an international evaluation team. The Ministry of Trade and Industry commissioned the evaluation. In the evaluation the focus was on the technological and industrial benefits of Finnish space programmes. Overall, the assessment of the benefits of Finnish space activities provided a positive view of the effectiveness of Finnish public space funding.

Benefits that institutes and industries were most aware of were primarily in the space area itself: enhancement of technological and commercial capabilities as the basis for future space business. Indirect effects outside space were less emphasised. The evaluation team understood this because the entry into European space arena requires a large effort and some priority for direct space interests. In the evaluation these direct space interests were seen to retain their priority for some time to come. It was noted, however, that more attention would soon need to be paid to the indirect effects arising from space science successes, so that these could be properly exploited. The most important benefits will be in the field of technology enhancement and in better space engineering capabilities.

Finnish industry and institutes have shown to possess the required competence to successfully participate in space programmes. In view of the relatively late Finnish entry into space, it is no surprise that until now most effort has been directed at the space sector itself and spin-off has not actively pursued. Industry and institutes alike are, however, aware of the prospect of indirect benefits and of the need to actively pursue these benefits.

The evaluation team was concerned that Finnish space activities have not received the support and commitment outside of the Ministry of Trade and Industry and the Ministry of Education that might be expected in view of the present and future benefits of space activities in other sectors. In the situation where the technological benefits of Finnish space activities are already evident, the time has come to actively promote the pursuit of commercial benefits. A more active approach towards the promotion of spin-offs would be appropriate. The possibilities for

Finnish industries to participate in commercial space ventures deserve to be exploited to the full. The capabilities of Finnish companies and institutes are adequate for a higher level of activities than can fit within the present funding levels. The evaluation team considered it highly likely that an increase in the level of activities would lead to a more than proportional increase in direct and indirect benefits.

The Agricultural Economics Research institute of Finland MTTL

In the evaluation of the Agricultural Economics Research institute of Finland (MTTL) in 1999 the international evaluation group stated that the research done is applied research of adequate (but not high) quality, of its type. The research paradigm followed is rather narrow; micro-theory, production functions and standard tools of statistical analysis are very typical of the institute's research. This is also typical for most of the research in agricultural economics done in Finland. The results are published almost entirely in the series of MTTL or other Finnish series, whereas international publications are very rare. The research done is also narrow in terms of content if we look at the changing needs of agriculture and the needs to develop new rural occupations.

MTTL's functions include undertaking 'scientifically high quality research in the field, focusing on applied research in the sector, but also including basic research. It appears from the evidence that MTTL is focusing almost exclusively on applied research for MMM, with virtually no basic research. At the same time the applied research is not reaching other research users such as the advisory and extension services in readily usable form. Neither is there a clear division of roles between MTTL and the University of Helsinki in relation to basic and applied research, although this appears to be a wider issue generally in Finnish research (see the evaluation of MTT).

Upon consideration, it seems to the evaluation group that the institute has not been sufficiently clear in defining its strategy in relation to basic and applied research. While its applied research for MMM is set out in the results agreements, there is less attention given to a strategy either for producing high quality basic research or for meeting practitioners' research needs. Even in the few cases where top quality international research is being undertaken, there is no obvious rationale for the choice of topic. For example, a project on investment decision, exploring the possibilities of real option theory in energy savings, is of a very high standard, but it is not clear why this is applied to Dutch horticultural holdings using their FADN

data rather than to Finland. Another interesting Ph.D. project is applied to ASEAN markets rather than to the St Petersburg market, which would be far more relevant to Finland's needs. This is not meant as criticism of these interesting projects, but rather as evidence of the lack of any clear strategic vision of the MTTL management regarding either international collaboration, the needs of research users beyond MMM, or the balance between basic and applied research.

A potential strategy might prioritise co-operation with the Baltic States and Russia, with the agreement of MMM, to transfer knowledge from Finland and to conduct market analysis on emerging markets such as St Petersburg. Another priority in such a strategy might be co-operation with other Nordic countries on graduate training and joint projects on Nordic topics. The main issue is the need to develop a clear strategic vision.

The Agricultural Research Centre of Finland

The evaluation of the Agricultural Research Centre of Finland was carried out in 1996. The evaluation team came to the conclusion that research done at the centre was in general soundly designed and scientifically and practically relevant. However, the evaluation team found certain weaknesses in the research activities: many of the programmes (as distinct from individual projects) lacked a sharp focus and clear scientific strategy; this was reflected in the average output of refereed scientific papers from the Centre which must be considered modest by international standards. These conclusions were reinforced by discussions, both within MTT and externally, which suggested that there is scope for improvement in both the scale and the competitiveness of the scientific output from the Centre.

The evaluation group pointed out a special feature MTT has when compared to other research institutes - a significant yet unquantified part of MTT's scientific effort is used in providing technology services for industry and in experimental development and specialist advisory work, either for the rural advisory services or directly for farmers. Strong doubts are presented about whether the scale of MTT's role in this activity, which reflects the special circumstances that exist in Finland and which is of considerable national interest, has been fully recognised. However, the consequence of this is that MTT has in practice a much wider role and portfolio of activities than would be typical of most comparable research institutes in other countries, and that, as a result, at least part of its activities would not normally be classified as research under the definitions of the Frascati Manual.

It was considered that MTT could do more to identify and develop the core skills in which it considers it has particular strengths, and also add some areas of skill where it is at present rather limited. Here the evaluation group would place particular emphasis on the need to strengthen the Centre's capability in molecular biology; this should be concentrated in one central unit, rather than dispersed over several of the institutes, as at present. It is believed that this would greatly improve the effectiveness of collaboration with leading research groups, both in Finland and abroad, in this rapidly developing field.

Because of certain national characteristics MTT may need to engage in some basic research that in other countries might be considered more appropriate for the university sector, and may also have to carry out some of the development work generally done elsewhere by the advisory services.

The Finnish Environment Institute

The evaluation of the Finnish Environment Institute was carried out 1998. The international evaluation panel remarked that today there is no institution covering the entire spectrum of environmental research in Finland, either through in-house or contracted out activities. The Finnish Government supports a surprisingly large variety of institutions working in the environmental research field, including universities, research institutions and hybrid research/administrative bodies like the institute. On a smaller scale, there are also a number of environmental research institutes financed by private industry.

Around half (48%) of respondents of a questionnaire were adequately satisfied with the scientific quality of the institute's R&D work. In only two cases was the quality defined as poor; in one case, it was assessed as excellent. One indicator of the quality was also the good marks which scientific publications of the institute were given by scientists from Germany and the Netherlands. According to them the work is close to university level. The institute's positive success in obtaining EU finance for research projects is also an indication of high or satisfactory standards of scientific quality. The evaluation team singles out especially water research, water management and models which qualify as highly sophisticated and advanced. The same applies to hydrological and limnological research at the institute. Publications concerning acidification, eutrophication, environmental microbiology and biotechnology are also of top quality. Other fields of activity received a less positive evaluation as to their performance quality. These included terrestrial ecosystems, environmental economics and management of natural resources. Work

in fields such as tourism, social science, land use planning and environmental policy were deemed to have a more technical than scientific character.

The Finnish Forest Research Institute METLA

In the evaluation of the Finnish Forest Research Institute Metla in 1998 evaluators noted that the quality of research of most of METLA's work is of high standard and ranks favourably with research institutes in other countries: At first glance METLA gives an impression of strength due to the size of the institute and its high level of integration, which many research organisations in Europe could envy. METLA undertakes activities that all aim at solving problems in the forestry sector and range from basic research to applied research, some extension and services.

As a notable positive feature of METLA the panel mentioned the relatively strong emphasis on economics research. This is a definite advantage, providing the potential for interdisciplinary research if appropriately organised and managed. One indicator for the level of research can be found in the rapid increase in the number of articles published by METLA researchers in international journals with a peer-review system during the past couple of years.

Other factors listed as strengths of METLA are the following: a long and distinguished tradition in forest research; highly skilled research and support staff; good infrastructure including research stations that cover the whole country; well-equipped laboratories; large research forest areas; capable and committed to carrying out long term research; extensive data, information and knowledge base; capable of consulting and giving technical assistance in domestic and international issues; advanced information management system; good support by the government and the forest sector; capable of providing vital research results for the forest sector; high reputation in international forest research and good international networks.

The Finnish Geodetic Institute

In the evaluation of the Finnish Geodetic Institute in 1998 the evaluation team pointed out that the institute's researchers have been publishing fairly low numbers of papers in international reviewed journals. Changes are on their way although because in the most recent past the (publication) emphasis has changed and the number of papers published in the open literature has increased.

The institute has also played a major role in studying geodynamical processes and especially post-glacial rebound - Finland together with the Scandinavian countries is subject to an ongoing deformational process knows as the Fennoscandian post-glacial rebound. The evaluation team considers these studies important enough to suggest a formalisation of this aspect of the institute by creating a new department of Geodynamics.

The institute has instrumentation expertise in some specific fields for which there is an international demand. Absolute gravimetry and establishment of very precise calibration baselines are among this as well as digital photogrammetry and GIS data processing.

The Finnish Institute of Marine Research

The evaluation team of the Finnish Institute of Marine Research were generally impressed in 1997 with the output from a relative small science establishment. The evaluation team concluded that it would be beneficial to Finland if the institute had broader national responsibilities and this would require increased coordination with other sectors of government, academia and industry.

The evaluation team found the quality of science to be high and general satisfaction with the (research) programme was expressed throughout the client interviews. The panel recommended that in the further development of the biological sector of the institute's work plan, concerted action should be taken to develop an integrated concept for a well balanced study of the marine ecosystem of the eastern and northern Baltic and in the polar seas. The programme of the institute should be considered complementary to the work of other biological research groups in Finland and in neighbouring countries. The inshore and benthic work as well as the ecological modelling and the interaction with other marine disciplines has to be strengthened. The developmental work in ice research should be brought back up its former level and, if possible, strengthened by additional personal. There is a need for better national and international co-operation in this area. A distribution system joining ice and weather forecasts should be explored.

The evaluation team brought up also the necessity of expanding the general modelling activities of the institute with the implementation of a multipurpose universal marine model for various practical needs such as dynamics and thermodynamics of ice, wave and current, ecosystem and global change modelling.

The Finnish Institute of Occupational Health

The Finnish Institute of Occupational Health was evaluated by an international evaluation team in 1995. The overall result was extremely positive concerning the research relevance, as well as the research, service, information and training quality and productivity. According to the evaluation team the research activities of the institute have produced its outstanding international reputation. The quality assurance processes used by the institute are thorough, stringent, and a model worthy of emulation by any research institute anywhere. The institute has always employed systems of priority setting, and systematic reviews of protocols and reports, while preserving considerable latitude for researcher initiation of projects.

Also, the institute has intentionally sought opportunities to publish its findings in English in international peer-reviewed journals of high quality. For the evaluated period 1990-1995 the average output of scientific publications per person-year invested is an excellent 3-5 scientific articles. Its problem-solving orientation, and its continuing presence in workplaces all over Finland have assured the relevance of the institute's research to most important problems of occupational health and safety in the country. The institute has repeatedly done groundbreaking research, which has stimulated researchers in other countries. Consideration should be given to using the "Action Program" approach, which has succeeded so well in practical application of scientific findings, for research itself by initiating "Action Programs in Research" to address scientific issues of pressing interest.

The Finnish Meteorological Institute

In the evaluation of the Finnish Meteorological Institute in 1996 research activities were one of the issues addressed by the evaluation panel. Activities are divided into three research divisions: geophysical research, meteorological research and air quality research. The research program at the institute is mainly driven by service requirements, with the exception of geophysical research, which essentially is concerned with basic research. Synergy exists, however, with the other groups and more interactions are expected in the future, as the Institute for example intends to strengthen its commitments to stratospheric research.

Something about the level of research is revealed by the fact that a considerable part of the research is externally funded both nationally and internationally. There were 25 EU- projects in progress at the time of the evaluation. There is a high level

of international co-operation. The institute works closely primarily with other European and US groups in its field of interests.

The evaluators were pleased to see that the institute is committed to pursue the responsibility for supporting the international research programmes in geophysics, climate, weather and air quality. The institute has a unique capability in upper atmospheric research and can play a key role in studies of stratospheric ozone and the effect a potential depletion of stratospheric ozone may have in increasing harmful UV-radiation. The evaluators strongly give their approval to this policy, including a continued support for the Argentine station in Antarctica. This will provide a unique opportunity to monitor the evolution of ozone concentrations and associated changes in UV-radiation at a similar latitude to that of Sodankylä and thus the possibility of comparing the evolution in the two hemispheres. The evaluators also recommended that the institute should continue active participation in the international Baltic Sea Experiment programme, because in their view such research would be highly beneficial for the operational services in the long term in providing improved know-how for planning and prediction in areas of potentially economic value for the country.

The institute also has a very active research programme particularly in geophysical research, where the work is of a very high international standard. In fact the geophysical division at the institute is the leading group in space research in Finland. The evaluators are impressed with the standard of this research and strongly support its continuation. The institute should try to use all its efforts to draw benefits from this research in other fields of its work. To further enhance work on stratospheric processes together with the other research divisions is a natural step to take. One of the strengths of the institute is that the atmospheric chemistry and air quality research are a part of the institute's tasks. The chemical composition of the atmosphere is dependent on its physical state and flow patterns. Close co-operation between the researchers in traditional meteorology and in air quality is therefore strongly supported. The evaluation team especially praised much work done at the geophysics division. The space research group of the division has numerous activities on an international level and collaborates with the most renowned organisations in this field such as NASA and ESA. The strength of the geophysical research division is without any doubt at a high level of the scientific research and its international reputation. The institute has acquired a lot of specific experience in space technology through its collaboration with ESA, NASA and Russia, which is certainly of interest for all Finnish organisations interested in space research or industry. Weak points are the multiple independent

funding sources for the same project and the unclear decision-making processes in Tekes and the Academy of Finland. The geophysics division has only a very few permanent positions.

The Geological Survey of Finland

In the evaluation of the Geological Survey of Finland in 1996 it was remarked that at the moment of evaluation, the research profile of the institute was a kind of mix which takes into account both scientific interests (especially in the area of geoscience) and economically oriented interests. What did receive inadequate attention (at the time of evaluation) is the issue of the environment. In the view of the evaluation team the preferred field should be oriented more towards achieving maximum economic and environmental significance and less towards maximising geoscience interest.

Traditionally scientific research projects in the institute have been related to mineral exploration. The institute produces a wide range of excellent geoscience maps - its geophysical maps are amongst the best of their type being produced in Europe at the present time. The institute has also traditionally placed particular emphasis on metalliferous studies, and as a result has not only undertaken some excellent metallogenic investigations but has also found some significant mineral deposits and occurrences. Also bedrock/Precambrian studies by the institute have a significance well beyond Finland. Activities such as mapping, geochemistry, geochronology, petrology etc must continue to be supported, for they provide the knowledge base that is essential if there is to be a comprehensive understanding of the Precambrian geology and evolution in Finland and adjacent areas. Nor is this an academic pursuit; it provides vital information for any company wishing to explore in Finland; it provides the setting for disposing of nuclear waste or for carrying out deep tunnelling.

The institute has been fortunate in the high quality of its geoscientists in these areas, a number of them of the highest international standard. Its important that the institute ensure that it maintains the capacity to undertake comprehensive multidisciplinary investigations of bedrock geology. In the area of the environmental and surficial (quaternary) geology especially, investigations on peat have produced some outstanding results. At the same time, though, some scientific opportunities have not been fully pursued, because of the artificial separation of research, particularly palynology, from peat investigations.

The evaluation team suspected that the institute's peat and associated lacustrine investigations could be of world significance in terms of their relevance to climate change, CO2 sequestration and global warming, and the institute should make every effort to "capitalise" on this outstanding data set. There are also areas which are of increasing importance but which are covered rather weakly by the institute. The evaluation team mentioned non-metallic or industrial minerals and dimension stone as study areas where the institute has a relatively low level of activity despite the increasing importance of these areas. Other areas where activities at the moment were assessed as low or modest were hydrogeology and marine geology.

The National Research Institute of Legal Policy

In the evaluation of the National Research Institute of Legal Policy in 1997 the quality of research activities was assessed using two different methods. A few academics were asked to assess research done in certain thematic fields at the institute. In addition to academic opinions the evaluation team interviewed representatives from main stakeholder organisations in order to find out how high the quality of research was deemed to be by co-operators and users of the institute's services.

From the academic point of view the quality of research activities is generally deemed to be high. The quality of publications is generally good and even: studies are carried out professionally and thoroughly. The institute has proved to be competent in its field. However, during the last years the institute has been slow to produce new innovative openings in research, but instead has focused and developed further research on the areas which have been strong earlier. This has led on to the situation in which research units are not equally strong, and the research profile of the general research unit especially should be developed. Stakeholders' opinions on the quality issues were generally positive.

The National Public Health Institute of Finland

The evaluation of the National Public Health Institute of Finland was carried out in 1995. The international evaluation team considered much of the research done at the institute to be of the highest quality and besides that it has been of considerable public health importance. The high international standing of the institute reflects the outstanding contributions which have been made by the best of the staff and this has been facilitated by the unique opportunities for public health research which the institute offers.

The Division of Chronic Diseases and Health has a well-deserved international reputation in a number of fields for its research - most notably in the epidemiology of cardiovascular diseases and through the ATBC trial. The research in the newly created Department of Human Genetics is also internationally highly competitive and its strongly supported by the evaluation panel. Some of the projects in the Departments of Mental Health and Biochemistry are also of high quality and of considerable public health importance. At the same time, however, the evaluation panel remarked that the division as a whole is at a cross-roads and important strategic decisions need to be taken. An overarching review of the strategy of this division should be undertaken with a particular emphasis on its future role in cardiovascular research covering the Departments of Epidemiology and Health Promotion, Nutrition, Biochemistry and Human Molecular Genetics. There is a need to consider some reconfiguration of departmental boundaries to meet the needs of the strategy more effectively and enhance critical mass in key areas.

The future of the Departments of Immunobiology and Alcohol, Drugs and Traffic should also be subject to fundamental reappraisal. In the case of the Division of Infectious Diseases the evaluation panel assessed that a limited number of the activities do not fit within the current strategic framework - and some of these are of limited scientific value and should be discontinued. The panel wanted to draw particular attention to the need to ensure that there should be a review of the disposition of bacterial expertise within the institute (taking due account of skills available elsewhere in Finland) to ensure that it meets its public health and research responsibilities in the most cost-effective manner.

The panel was also concerned at the limited expertise in molecular and cellular immunology available within the institute and current and likely future needs in this discipline should also be an integral component of this review. It is the view of the Panel that immunology should be strengthened and that this can only be achieved through the recruitment of a senior immunologist to the institute to provide the necessary scientific leadership. Research activities at the Division of Environmental Health raised some concerns among the evaluation panel. At the time of evaluation the range of activities within the division does not appear to offer good value for money. The panel was also concerned at the small (and in some cases very small) numbers of staff in some the groups which are well below critical mass. The disadvantages which result from this are in part mitigated by the development of collaborative activities. The panel remains concerned, however, that many of the research programmes are small in scale and scope and of limited scientific value.

The National Veterinary and Food Research Institute EELA

In the evaluation of the National Veterinary and Food Research Institute EELA in 1998 the quality of research is considered to be quite good in some areas but there is still room for improvement in the overall quality. There are necessary steps to be performed in order to improve the quality and quantity of research. For a small country like Finland concentrating on only a limited number of major research topics is essential. The key to improvement is to use bigger research teams on a limited number of selected subjects, and to co-operate with other institutes nationally and internationally. It is the only way to be recognised in the scientific world today. Naturally it will be wise to concentrate on common problems of areas of interest in Finland itself.

The evaluation group considered the choice of topics quite relevant. However, the translation of these topics into research projects is considered to be on a very broad base. Too little attention is given to individual programmes and how they fit in the overall research strategy. Good quality research at the national and international level always demands a certain 'critical mass' and investment in research before it can be considered to be competitive.

Tekes - the National Technology Agency of Finland

The evaluation of Tekes was carried out in 1995. The international evaluation team found that the portfolio of activities by Tekes can - in general - be considered to be in line with the needs of industrial growth and structural change. The overall effectiveness of Tekes activities can be considered as good. In an economy however, where decentralization of decision making and internationalization are important characteristics, it is obvious that the overall effectiveness can only be maintained when the "market" can play its proper role and when the objectives and procedures of Tekes are adjusted over time. Therefore, in the funding of industrial product and process development activities, more attention should be given to business aspects. All of the activities of Tekes should be accompanied by clearly formulated targets and built-in monitoring and evaluation procedures.

The following summaries on quality issues are gathered from a number of Tekes' technology programme evaluations.

Evaluators of the Gene Technology Programme 1984-1987 concluded that the field does not have a world-class image in most areas and this is probably the result of

small group sizes (with poor inter-group communication) and uncertain funding restricting major scientific risk-taking, as well as some kind of modesty, problems with language and lack of training in public speaking. Evaluators observed that: the funding climate restricts the ambitions of excellent scientists; requirements for achieving Ph.D. status waste researchers' time unnecessarily; conditions for tenure push scientists to focus on quantity of publications; conditions mostly prevent scientists settling in Finland from abroad.

According to the evaluation report the Industrial Chemistry Technology Programme 1987-1990 has helped in strengthening many key areas in the field, and especially molecular graphic simulations, preparation and characterisation of organometallic clusters, enzyme catalysis, and surface science techniques for heterogeneous catalysis.

The mid-term evaluation of the Pharmaceutical Technology Programme 1989-1993 noted a distinction between research leading to optimisation of current technologies versus basic research which will create new materials and new technologies. Frequently, the research groups evaluated were very sound at the former activities, but poor at the latter.

The international evaluators who assessed the scientific and technological status of research in the Finnish Functional Paper Programme highlighted a need to invigorate and improve the research practices and quality at the core of Finnish paper R&D. The standard and rigour of much of the work left room for improvement. The evaluation team expressed their concern because the programme seemed to contain a high preponderance of projects which are of low scientific merit and limited industrial relevance. As a conclusion the evaluation team stresses the continued need for government-sponsored initiatives in the area. The lesson from FUPA is that government has a legitimate and justifiable role to play when there is genuine additionality, i.e. when programmes promote activities which would not otherwise occur.

The Electronics Design and Manufacturing Technology Programme was going on 1991-1995. The programme's projects were relevant to world science and technology agendas and to the overall goals of the ESV Programme. The work was adequately resourced and conducted in an efficient manner, producing outputs of high quality. Widespread impact in scientific terms is unlikely to be appreciable, but this is not unexpected given the pragmatic nature of the programme and its goals, many of which stand to be realised. Tangible impacts on individual

participants and on user communities are evident, and more are expected. Some 70% of participants felt that the benefits resulting from participation in the programme outweighed the costs. This compares well with other programmes abroad.

The Prodeal Technology Programme took place between 1992-1995. According to the evaluation team the PRODEAL programme has made significant contributions to science and technology. Researchers in the programme have developed innovative approaches to process and product modelling which have the potential to influence the direction of European standards such as CIM-OSA (Open System Architecture) in the future. Moreover, the researchers seem to be active in many European initiatives which can leverage this effort. The PROOMU-MUSYK (PROOMU = PRODEAL Project "Projektimuutosten hallinta", MUSYK = ESPRIT Project 6391 "Integrated Multi-level Control System for One-of-a Kind Production") synergy is probably the clearest example, but several other examples exists, including the GameView - TIME GUIDE (Eureka Project EU 1157) link.

The researchers are publishing the work developed in PRODEAL actively and have a strong presence at international conferences. (...) Several new tools have been developed to support product modelling and knowledge-based configuration. The connections for start-up and especially established software and consulting houses for technology transfer seem remarkably strong for such a young programme. At the same time, a criticism of the Programme is that the connections between the science and technology components of the research have not always been as strong as they should be.

The basic role which TEKES plays in supporting the advancement of nationally important technologies and in fostering the rapid exploitation of these technologies, especially in small companies, is exemplary. While not all Process Technology Programme projects were fully successful in this regard, an exceptionally large percentage were, demonstrating a high capability on the part of TEKES staff in picking the right projects, assembling the right teams and guiding the projects towards commercially useful results.

The evaluation of Industrial Applications of Engineering Materials technology programme, 1993-1997, includes a short chapter which discusses the international standing of the research carried out during the programme. According to the evaluation there were marked differences between various participating research groups - differences which made it difficult to assess the level of work done. A

questionnaire carried out during the evaluation resulted in industry responses which either showed a lack of knowledge of the international standing of the research or believed it to be comparable with other international efforts. The vast majority of research groups considered the research to either compare favourably at an international level or lead the world.

When responses were analysed individually it appeared that knowledge of other international research centres was far more marked in projects that had either performed a pre-study as a first phase or whose research organisation had already been active within the technology some time before the project started. It was also noticeable that the research organisations in such projects were more aware of their corresponding peer groups than the industrial respondents. Leading edge activities within the ceramics area, such as ceramic hot gas cleaning filters, are supported by a large research group at TUT, which guarantees a continuing research emphasis and support to Finnish industry within the development of ceramic components. Activities within active damping materials, whilst leading to innovative and world class research results, will be more difficult to support in the future owing to the relative long term nature of the resulting products.

The most important feature of the individual projects was their application orientation and hence a very practical and sometimes empirical approach to each specific problem area. Hence, when considering the international standing of the research, it is important to compare the evaluated group with an appropriate organisation (i.e. one that is itself focused upon industrial application). By comparing work this way the evaluation team found that, for example, for HVOF spraying an appropriate international standard would be the University of Aachen, who are internationally known for their application research. In this particular case, there is collaboration between the Universities of Aachen and Tampere through the exchange of PhD students and co-operation on European projects. The international standing of the Finnish organisations in this case is comparable to others within the field. When consulting leading international centres about certain research areas within the programme, the evaluators gained a less favourable picture related to the standing of the research. There were several cases where these centres were unaware of the detailed activities of the Finnish research groups. This was particularly true for those projects which did not have a pre-study.

The programme introduced some entirely new technologies to Finnish industry and it may be unrealistic to believe that all such activities could achieve a leading edge status within the timescale of the programme. The international quality of the

research in these cases will not become apparent for several years. One measure of the international standing was the extent to which the Finnish research organisations participated in European programmes. In many cases, such as HVOF and Thermal Fatigue, the current programme has helped develop the expertise to make such participation a reality.

The Electronic Publishing and Printing Technology Programme was running between 1995-1999. The mid-term evaluation included an assessment on projects' scientific and technological quality. Business Opportunity Projects were largely aimed at exploring new business opportunities and were of potential interest and relevance to most participants in the programme. The major project in this group, and in the programme as a whole was soundly conducted but had adopted an approach which, in the opinion of the evaluation team, was unlikely to satisfy the real needs of many of the industrial observers of this pivotal project. Progress in the newer second project was also slow, and communal hopes that these projects would inspire and catalyse industrial interest and actions had not been realised by the mid-point of the programme.

Paper Research Projects performed research of primary interest to paper-makers. In conception, all had the potential to satisfy industrial needs. Performance was excellent in half the projects, but achievements in the remainder failed to impress and lowered overall performance levels in the group as a whole, though there was still scope for recovery. Some of the projects in this group, along with some in other groups, would have benefited from more widespread and comprehensive search activities prior to the commencement of other project phases. This was especially so for teams moving into and building competence in new research areas. In projects such as these, extensive literature searches and visits to centres of excellence in other countries often pay large dividends and are worth considering in subsequent actions.

The Solo Adoption and Business Chain Projects occupied a different location in 'innovation space'. They were largely technology adoption feasibility studies or implementations, and hence much more pragmatic and of less intrinsic 'scientific' interest than applied research projects. Their 'commercial' interest to the printers and publishers who took part in them, however, was never in dispute, and performance as a whole across these groups was an exemplary model of competent implementation. This was especially so in Business Chain Projects, which were all the more impressive because of the intrinsic complexities associated with successfully implementing projects involving new business chains and links.

In most instances, the firms involved in technology adoption projects possessed the necessary competence to perform the initial technology search and project planning activities which are critical to success. Lack of such internal capability, however, can be a severe deterrent to participation in technology adoption programmes. The provision of external assistance via a budget for consultancy advice could lower entry barriers and attract other low capability SMEs to contemplate the adoption of digital printing.

Boundary Projects broadly occupied the 'applied research' corner of 'innovation space' and performed well enough to satisfy the appetites of the printers and publishers interested in exploring the boundary between digital printing and electronic publishing.

Overall the research oriented Business Opportunity, Paper Research and Boundary Projects went some way towards satisfying the knowledge accumulation goals of the programme. Even where performance was most suspect, there was still hope that longer-term beneficial impacts would accrue. The goal of advancing the spread of digital printing and increasing the market potential for electronic printing and publishing products and services was also furthered by the Solo and Business Chain technology adoption. The hope that export potential would be raised, however, remains only a long-term ambition in paper-related markets and a distant prospect in some publishing-related areas.

The Improving Product Development Efficiency in Manufacturing Industries Technology Programme went from 1996-1999. In general, the quality of research in the academic projects has varied but has been satisfactory overall. Some projects are extending the state of the art in knowledge and practice while others are applying existing methods in new ways and in new situations. There have been, and will continue to be, many refereed journal articles, conference publications, books, CDs, courses and training materials resulting from the RAPID programme research projects. Some of the academic research projects were oversold in the presentation of their results and the generalization of these findings. They were presented as more novel and more important than they probably are. When probing further, the reviewers realized that the ideas and methods were not very substantial.

The majority of industrial projects have been successful in achieving their own objectives and have produced results that are beneficial for their own competitiveness. This is true throughout all the focus areas. There are some very good results, either advancing the state of the art - also by generating innovative

commercial results - or demonstrating in depth the implementation of complex issues within the end-user company. However, in many cases, the results could have been more advanced and innovative.

Technical Research Centre of Finland, VTT

An extensive evaluation round has been carried out at the Technical Research Centre of Finland during the last years of the 1990's. All 9 research units of the Institute were evaluated by teams, which included both international and national experts. In each and every case evaluators were asked to produce expert opinions on issues related to the quality and relevance of work, among other things. In the following the main conclusions on issues of quality and relevance are listed:

The scientific competence of VTT Electronics (VTT ELE) is high and in some areas of world-class. The employee motivation and satisfaction are high. The performance of VTT ELE can be improved by better communication of the strategic plan and the visions to the personnel and by more vision driven management. To improve competitiveness more international exchange of staff is needed. The overall strategic plan for VTT ELE is good and relevant to the trends in the Finnish industry. However, to be relevant and competitive at a world class level in the future, a stronger focus on a few selected spearhead areas is required. The challenging management task is to obtain this focus on spearhead research and at the same time perform development contracts. This is the classical management dilemma of contract research organisations. The R&D portfolio is relevant in most areas and in tune with the needs of the Finnish industry. The extensive customer base indicates that the liaison with industry is good. The overall comments from customers are favourable. (1998)

The evaluators of the VTT Information Technology (VTT IT) came to the conclusion that the scientific quality of the work is excellent. The conclusion was in line with opinions of university, government, and industry sources contacted during the evaluation. The mix of short- and long-term research projects, while always a subject of debate, seems to be well within the parameters that will allow VTT IT to both serve the immediate needs of industry and maintain long-term relevance and in this way keep a balance between depth and breadth. Liaison with industry is healthy. While different industry sectors have different needs and expectations of VTT IT, these seem to be met. The evaluation team also paid attention to a phenomenon, which is common both at VTT IT and VTT ELE - the competition with industry for new knowledge workers. The ability of the units to

continue to attract students at the current levels, and even to increase this level is a critical factor in the future. (1997)

In the evaluation of VTT Automation an issue common to some other research units of VTT was brought up, namely the need to to scan competitors more closely. In the case of VTT Automation, competitors are other domestic and foreign research institutes, the internal R&D departments and institutes of industry, and privately and publicly funded innovation centres as well as domestic and European testing laboratories. In general, there is some information available from competitors, but the area of competitive information gathering and benchmarking needs more emphasis within VTT Automation. Being competitive in this type of environment needs a real business approach when planning future strategies and survival in an economic downturn. The evaluation team concluded that the project and product portfolio of VTT Automation fits nicely with the research goals of its units. The variations of the market pull must be taken into account to provide continuous correspondence with such goals. The scientific level of work is highly esteemed by the customers of VTT Automation, even if some details in the customer satisfaction survey need attention. The current R&D orientation in VTT Automation unit is an excellent basis for high-quality innovative work. Clear goals with respect to the most promising scientific research and development areas should be derived from close contacts with the international scientific community as well as from close co-operation with industrial customers. According to the evaluators necessary policies to increase industrial utilisation of the government budget-financed research and its results are available in VTT Automation. They need to be made more common practice within the units of VTT Automation: customer focus and efficiency of processes will be key success factors with respect to this question. (1996)

The accomplishments of VTT Chemical Technology (VTT CT) were found to be strong when evaluated against the background of scientific quality of the research. VTT CT staff continue to publish a large number of papers; are active as officers and participants in international conferences, workshops and seminars; and a number of staff are officers in professional societies and associations, both in Finland and internationally. VTT CT's activities are peer-reviewed as well as receiving a number of project awards through peer-reviewed processes. The staff is recognised as professional, competent, and responsive.

The quality of work is reflected also by the number patents: VTT CT accounted for nearly half of the entire patents received by VTT in 1997, suggesting the types of

"cutting edge" development work being undertaken by VTT CT. Scientists are encouraged to disclose their results and patents are filed for, further suggesting there are internal incentives and rewards for scientific discovery. Patented products are developed for example in the field of active noise reduction and sensors and in research in catalytic antibodies, in which VTT CT is one of the world's leading research institutes. Historically VTT CT's employees have had strong scientific backgrounds and have received significant recognition and acknowledgement by their peers. Core basic research continues to be an important requirement of VTT CT. The viability of VTT CT depends upon sound scientific enterprise which must be maintained if not improved in an increasingly competitive environment.

The strategic research goals of VTT Biotechnology and Food Research (VTT BEL) cover a wide area of technologies and customers. It seems that the needs of industry represented in the advisory boards are relatively well covered. According to the evaluation team the short- and long-term research goals and the present portfolio are relatively well balanced. There are, however, some research topics and areas which need closer analysis. However, the changes in the environment, especially in customer companies, have to be considered. VTT BEL maintains high standards and the level of work carried out is of high quality. In certain areas VTT BEL is well known internationally. This can be seen in the large number of patents and patent applications, prizes for innovations, industrial applications of innovations, EU R&D projects, and visiting scientists. There are also some promising areas where VTT BEL can achieve an international top level in the future. In the opinion of the evaluators there is still work to do at VTT BEL to increase industrial utilisation of research and its results.

In the evaluation of VTT Manufacturing Technology (1995) evaluators assessed different research fields of the institute. The competence was deemed to be at a high level in many areas of the research field of safety engineering. Especially interesting work was done with a new anti-noise control technology. The evaluators thought that there would be several areas of applications for this technology. The evaluators wondered though if it's always necessary to develop in-house software tools. According to them it is important that the personnel take advantage of mode information technology, but especially in the case of VAL, information technology needs to be seen only as a tool, not as a main target.

In the field of production engineering there was thought to be a need to make decisions as to which are the core areas of research and then concentrate the effort of basic research in them. In materials technology it was recommended that the

basic and applied research could be concentrated in the areas where the direct interest of Finnish industry can be foreseen. In the research field of materials and structural integrity VAL has been able to penetrate into markets outside Finland. This proves that the competence in this area is at the top level. The competence and resources in the field of maritime and mechanical engineering partly overlap with the four other fields. Overall, those who were interviewed during the evaluation appreciated the top technical capabilities of the personnel of VAL. As a potentially important part of the institute's work were also seen to be technology transfer and consulting services to Finnish industry.

The evaluation of VTT Building technology (1998) took as a starting point that scientific quality can and should be measured by co-operative international projects. Within the European Building Research Institutes VTT Building Technology plays a prominent role in the way it manages the institute as well as in the quality of research. VTT Building Technology collaborates in projects at the highest level and in some research fields has very specialised expertise which is world-class. There are some fields that can be improved, too. Co-operation with the USA and Japan should be increased in order to benchmark global quality. The project portfolio covers the needs of SMEs. It should be developed towards more long-term projects. Multidisciplinary research and strategic partnerships with industry should be further developed to strengthen the core competence development in accordance with the customer orientation.

In the evaluation of VTT Communities and Infrastructure YKI (1997) the quality of research work seemed to be generally very good and in specific areas it was the best in Finland. However, in some of the customers' comments in answer to this question there are remarks that YKI in certain broad, joint projects does not use the best know-how, but prefers to choose among its own staff instead. Because of the broad scope of YKI's research field the institute is also vulnerable. If some important researcher quits, a lack of competence can be the immediate results. Focusing on core competence and a smaller number of research fields would help in keeping or even raising the professional standard of YKI, which today both nationally and internationally (EU and World Bank) is well recognised. On the basis of the number of publications and doctorates, YKI reaches the VTT average.

In the evaluation of VTT Energy (1995) different research fields were assessed one by one. The evaluation team stated in the summary of remarks and recommendations that VTT Energy's personnel has, in general, a reputation for very high quality and customers are normally satisfied with the quality of work.

Working Papers

1. Reijo Miettinen & Torsti Loikkanen, *Teknologiapolitiikasta yritysten teknologiastrategioihin* (From technology policy to company technology strategies). Espoo 1993.

2. Sirkka Numminen-Guevara, *Katsaus teknologiaohjelmien arviointiin* (Review of the evaluations of national technology programmes). Espoo 1993.

3. Sirkku Kivisaari & Raimo Lovio, *Suomen elektroniikkateollisuuden merkittävien innovatiivisten liiketoimintojen menestyminen 1986 - 1992* (Success of the major innovative businesses in the Finnish electronics industry 1986 - 1992). Espoo 1993.

4. Reijo Miettinen, *Methodological issues of studying innovation-related networks*. Espoo 1993.

5. Sirkka Numminen-Guevara, *Yhteenveto VTT:n tutkimusohjelmien arvioinneista* (A summary of the evaluations of VTT's research programs). Espoo 1993.

6. Tuomas Hölsä, *Ulkomaiset T&K-yksiköt Valmetin paperikoneteollisuudessa ja Ahlströmin konepajateollisuudessa 1983 - 1993* (Foreign R&D units in Valmet paper machinery and Ahlstrom engineering industries 1983 - 1993). Espoo 1994.

7. Kimmo Halme & Eija Ahola, *Pkt-yritykset ja innovaatioiden tukijärjestelmä Suomessa* (SME's and innovation support system in Finland). Espoo 1994.

8. Eija Ahola & Kimmo Halme, *Innovaatiotoiminta pkt-yritysten strategiana* (Innovations as a strategy for the SME's). Espoo 1994.

9. Harri Luukkanen, *Ulkomaiset teollisuusyritykset ja niiden tutkimustoiminta Suomessa 1984 - 1991* (Foreign industrial firms and their R&D in Finland 1984 - 1991). Espoo 1994.

10. Tuomas Hölsä, *Suomalaisten suuryritysten ulkomainen T&K-toiminta* (Foreign R&D of Finnish multinational corporations). Espoo 1994.

11. Kimmo Halme, *Uudet yritykset biotekniikkasektorilla 1994* (New firms in the biotechnology sector 1994). Espoo 1994.

12. Sirkku Kivisaari, *Terveydenhuollon elektroniikan liiketoimintojen kehitys Suomessa* (Development of health care technology in Finland). Espoo 1994.

13. Reijo Miettinen, *Sosiologian ja toiminnan teorian näkökulma teknologiatutkimukseen* (A sociological and activity theoretical approach to technology studies). Espoo 1994.

14. Sirkku Kivisaari, *Management of continuity and change in Finnish health care technology: the Datex and Polar Electro cases*. Espoo 1995.

15. Reijo Miettinen, *Finnish biotechnology innovations in the 1980s and the 1990s: A preliminary study on innovative activity of the Finnish biotechnology sector*. Espoo 1995.

16. Mika Kuisma, *Pölypäästöistä kasvihuoneilmiöön: energiantuotantoon liittyvien ilmansuojeluliiketoimintojen kehityksestä ja kehitysmahdollisuuksista Suomessa* (From local dust emissions to global warming: the development and potential of the Finnish air pollution control and air quality measurement business and their relation to energy sector). Espoo 1995.

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Research evaluation in Finland

Practices and experiences, past and present

In Finland, the science and technology policy field has witnessed the emergence of a vital evaluation boom during the last two decades. The first efforts, inspired by international examples and local considerations, were carried out at the beginning of the 1980's. Since then the evolution and diffusion of the evaluation culture has taken place gradually and after years of development, evaluation is visibly anchored in the national research and development system. Today, evaluations cover all major parts of the system: under the evaluative eye are not only fields of science and technology or various research and development programmes, but also R&D institutes, universities and R&D funding agencies.

This report offers a concise, up-to-date review of the development and use of evaluation measures in the field of Finnish science and technology policy. It sets out to define the extent of research evaluation activities, to produce a synthesis of selected evaluation results, and to provide information about the role of evaluation in decision-making processes. The report draws on a broad selection of published evaluation reports and a number of interviews conducted among decision-makers with a vantage point over the Finnish R&D system.