PUBLICATIONS OF THE ACADEMY OF FINLAND 6/97

National Strategy for Centres of Excellence in Research

EDITA • HELSINKI

5.edition
ISBN 951-37-2343-7
ISSN 0358-9153

EDITA Ltd.
Helsinki 2000

To the Academy of Finland

On December 5, 1996, the Academy of Finland appointed a working group whose task was to:

1) submit a proposal for defining the content and objectives of the Academy of Finland's centres of excellence (CoE) policy;
2) draw up criteria for selecting new CoEs;
3) draw up instructions for evaluating CoEs;
4) lay down the conditions under which special funding for a CoE can be discontinued;
5) submit a proposal for a negotiation mechanism concerning CoEs, to involve the Academy of Finland, universities, research institutes and any other relevant parties;
6) establish the need for extra CoE funding in 1997; and
7) make any other submissions deemed necessary in order to implement the result agreement between the Academy of Finland and the Ministry of Education insofar as it concerns CoEs.

The working group has not gone into the need for extra funding in 1997, since submitting the supplementary budget for 1997 was put off from spring to autumn, and extra funding for 1997 is then no longer a current issue.

The chairman of the working group was Professor **Reijo Vihko**, President of the Academy of Finland. The invited members were Director of Research **Jorma Hattula** and Administrative Director **Heikki Kallio** of the Academy of Finland, Deputy Head of Department **Arvo Jäppinen** of the Ministry of Education, Deputy Director General **Heikki Kotilainen** of the Technology Development Centre Tekes, Senior Vice President **Juhani Kuusi** of Nokia Corporation, Professor **Keijo Paunio**, Rector of the University of Turku, Academy Professor **Lea Pulkkinen** of the University of Jyväskylä, Professor **Kari Raivio**, Rector of the University of Helsinki, and Professor **Elianne Riska** of Åbo Akademi University. The secretary of the working group was Secretary General **Anneli Pauli** of the Academy of Finland

On March 17, 1997, the Academy of Finland organized a meeting for the heads of the present CoEs nominated by the Ministry of Education, the Board of the Academy of Finland and the working group on national CoE strategy in order to discuss the main guidelines of the new strategy.

For background information, the working group carried out a survey of the resources and personnel of the CoEs nominated by the Ministry of Education for the 1995-98 period, and made a survey on selective research funding in 13 OECD countries. These surveys were made by **Annamaija Lehvo**, MSc.

Esko-Olavi Seppälä, Chied Planning Officer of the Science and Technology Policy Council of Finland, provided valuable feedback at the draft report stage.

The working group was required to report by May 31, 1997. It decided to call itself the Working Group on the National Strategy for CoE Policy.

Having completed its work, the working group hereby submits its report to the Academy of Finland.

Helsinki, June 2, 1997

Reijo Vihko

Jorma Hattula | Arvo Jäppinen | Heikki Kallio

Heikki Kotilainen | Juhani Kuusi | Kejjo Paunio

Lea Pulkkinen | Kari Raivio | Elianne Riska

Anneli Pauli

Contents

1. Background 7
1.1 Developing creative research environments 7
1.2 Finland's previous science policy guidelines 9
1.3 Finland's current science and technology policy guidelines 11
1.4 Present centres of excellence in research and their resources 13

2. Selective funding policy in some OECD countries 17
2.1 Content and objectives of centres of excellence policy 17
2.2 Selecting and assessing centres of excellence 19
2.3 Funding 20
2.4 Graduate schools as part of centre of excellence programmes 21

3. Content and objectives of the centre of excellence programme in Finland 22

4. The national research system and the centre of excellence programme ... 27

5. Selection and evaluation criteria for centres of excellence 34

6. Application, selection and evaluation procedures for centres of excellence36

7. Providing resources for centres of excellence 41

8. Negotiating mechanisms 44

9. Summary 45

Sources 49

Appendices

1. Background

1.1 Developing creative research environments

A research environment should be scientifically inspiring, challenging and interactive, and sufficiently versatile in terms of the research fields represented and the human and material resources available. A creative research environment often evolves around a single innovative top researcher with management and organization skills. The core, then, consists of expertise that is the best in its field, of international standard or even world leader calibre. The original group may be joined by new groups, or the group may remain small while still being internally dynamic and renewing itself as needed. What constitutes the most advantageous research environment differs from field to field. A creative research environment is not defined by the size of the research group but by its intellectual capacity, expertise and cooperation. Active exchange of ideas and thoughts is a key element in bringing about new solutions and procedures. A sufficiently large research group or a consortium can constitute a particularly good research environment. The members of the research group (including ancillary personnel) must cooperate closely and smoothly, and must all be committed to achieving the common goals.

In research needing well-equipped labs which require major investments, creative research environments often evolve around flexible networks formed by researchers or research groups in different fields but addressing the same problem or the same kinds of question. A network must be close-knit, with strong nodes. Not only can research groups in close geographical proximity use the same equipment; they can also learn from each other's methods and acquire new ideas and approaches. In fields where lab work is paramount, the trend seems to be towards larger research groups and networks. Examples of this can be seen in the existing umbrella organizations at such centres of excellence (for convenience, this text often uses the abbreviation CoE) as the Biocentrum Helsinki, Biocenter Oulu, BioCity Turku and the Digital Media Institute at the Tampere University of Technology. Such a unit can have dozens of research groups, with a total personnel in the hundreds.

In traditional humanities and social sciences research, a shared infrastructure does not — apart from shared premises — generate the same sort of added value as

in lab-based sciences. In these fields, the individual research approach has been dominant, meaning that even small research groups or individual researchers that maintain active contacts, possibly even working in different universities, have been able to create functional research networks. This, however, is changing. In humanities and social sciences, too, a need is arising to create cluster-type research units consisting of several research groups.

Graduate schools and other high-level researcher training form an integral part of a creative research environment characterized by active international cooperation with other top groups. It is important that the best researchers participate in various ways in both graduate and post-graduate university teaching, to convey the latest research results to university courses as fast as possible. However, university personnel numbers must be balanced against student numbers so that neither teaching nor research suffers relative to the time available. Nor must administrative duties take up unreasonable amounts of the researchers' time. Top researchers must be able to dedicate most of their time to research.

Outstanding researchers are characterized by mobility, both in Finland and abroad. Top-level research is clearly professional, well managed and well organized. The research group structure is versatile, including senior researchers, post-doctoral researchers (doctors who have had their dissertation approved recently) and doctoral students preparing their dissertations, in appropriate proportions.

The administrative structures of universities and other research organizations (departments, faculties) often make it difficult for creative research environments to evolve and function. Indeed, creative research environments do not usually evolve following conventional administrative boundaries (cf. the existing CoEs, section 1.4). A CoE can be formed as a combination of the best researchers from several departments, or even several organizations.

The premises provided and other infrastructure features (including special services) have a great influence on the interaction of researchers and on other activities in the research environment. The premises available are, in fact, a strategic resource for a creative research environment, and increasing attention is being paid to this aspect. Shared premises within walking distance of one another, enable close and informal communication between researchers. Experience has shown that the daily personal contacts between various research organizations (universities, research institutes, enterprises) and those who actually use the results generate all kinds of fruitful interaction that even the best electronic communication cannot yield. In shared premises or in a science

park, it is possible to use a common infrastructure; this is economically feasible and often also generates new ideas and applications. Shared premises, equipment, research services, etc. (core facilities) can also promote cooperation between various research organizations and between research and business, and hence increase mobility of researchers. Infrastructure solutions are of key strategic importance in nearly all fields of science. Infrastructure is particularly important in empirical fields where expensive equipment and special expertise in using it is needed. The most expensive equipment can only be acquired for one, perhaps two, research units in Finland. For example, the concentration of functions at biocentres provides human and material synergy benefits.

There are relatively few research environments in Finland that could be described as creative at the moment. Development of such environments requires forward-looking attitudes and decisions in all parts of the research system. Internationally competitive research can only be created through long-term work and support. The heterogeneity and geographic dispersion of Finland's university system also present challenges for the creation of functional networks that generate active cooperation.

A working group appointed by the Ministry of Education has recently made proposals on how to develop and professionalize careers in research and, in connection with this, examined also the development of creative research environments (Ministry of Education 1997). These actions are closely linked to the CoE strategy, too. The working group stressed the need to increase cooperation with universities, sectoral research, trade and industry, administration, schools and other parties. It encouraged universities to seek flexible solutions in developing their appointment structure and in promoting mobility of researchers. It was also considered necessary to develop the structure of the research posts at the Academy of Finland.

The activities of the working group appointed by the Academy of Finland on October 21, 1996 to examine the development of women's research careers are also related to careers in research and research environment development. This working group will report by September 30, 1997.

1.2 Finland's previous science policy guidelines

Since the 1960s, individual researchers have, through their actions and statements, been laying the foundation for selective research funding policy and thus for CoE policy. The present report will discuss the development of

selective funding policy in Finland from the early 1980s onward. The report of the Basic Research Working Group appointed by the Ministry of Education stated at that time that exceptional measures would be needed to support very successful or scientifically promising basic research projects (Ministry of Education 1980). The working group proposed the setting-up of units, with joint and determined support from universities and the Academy of Finland, for a fixed period (five years).

Basic Research Working Group II emphasized more strongly than its predecessor that funding policy should support research that produces results and aims at scientific breakthroughs (Ministry of Education 1984). The working group stated that this would require a new approach and a new distribution of research resources.

In fact, the Basic Research Working Group '89 found that the selective funding principle was gradually gaining ground (Ministry of Education 1989). The Academy of Finland had set up only four fixed-term research units in the late 1980s and early 1990s, but it had used other means to create large research groups. The working group emphasized that, in addition to selective research funding, resources should be pooled in what it called centres of excellence for basic research. The English term 'centre of excellence' had emerged a few years earlier in statements regarding pooling of resources (e.g. lecture by Olli V. Lounasmaa on February 28, 1986, ref. Numminen 1987).

At about the same time, the Academy of Finland outlined its selective research policy, with goals including support for high-level research aiming at breakthroughs but also catalyzing innovative research and developing research growth points and creative research environments (Academy of Finland 1988).

In a policy document published in 1993, the Academy of Finland stressed that it would continue to allocate more research funds to top research in various fields (Academy of Finland 1993). Top research groups do not just grow by themselves; they need a broad and multi-valued scientific base out of which to grow. The policy document also stated that the Academy would not provide funding for permanent research groups or units.

The Ministry of Education and the Academy of Finland have agreed in their result agreement for 1997-1998 that the Academy will clarify its CoE policy by, for instance, defining its content and objectives more precisely. The Academy will commit itself to funding CoEs together with universities and take responsibility for constructing and maintaining the CoE network, together with universities and research institutes. The agreement further states that the

Academy will allocate most of its research resources to major high-level research projects and CoEs, to improve their operative potential. At the same time, the Academy will lay the groundwork for the emergence of new units of this kind. The result agreement is a good basis for the creation of a national network of cooperation between the producers and users of information.

The need to promote innovation and nationally competitive new production was recognized as early as the 1980s (Technology Policy Committee 1985). The Technology Policy Committee also stressed the need to improve research cooperation between enterprises and research institutes in order to use resources more efficiently and to increase personnel exchange. The Committee advocated the founding of a system of joint professorships. The proposals made by the Committee are still valid.

1.3 Finland's current science and technology policy guidelines

Increasing knowledge and expertise has been defined as the general development objective of Finland's science and technology policy. The means used to attain this objective include developing a national innovation system, consisting of factors affecting the development and use of new information and expertise. The innovation system will be based on cooperation between information producers and information users. Its basic elements include research environments with good human and material resources for producing high-level research. The aim is to create a network of international centres of excellence in research and education in Finland. The main point made in the survey 'Finland: A Knowledge-Based Society' published by the Science and Technology Policy Council of Finland in 1996 is the need to promote positive developments in the economy and employment.

The Finnish Government has also given special attention to supporting high-level research. The Development Plan for Education and Research for 1995-2000 approved by the Council of State on December 21, 1995 includes a provision on safeguarding the resources needed to create and strengthen centres of excellence in research (Ministry of Education 1996). Thus, there is political support for nurturing creative research environments — and, by extension, for supporting CoEs. On September 6, 1996, the Cabinet Economic Policy Committee decided that the proportion of Government research funding in GDP will be increased from the present 2.5% to about 2.9% by 1999. The extra funding will be used to boost the national innovation system so as to benefit the economy, enterprises and employment. The public sector will account for 40% of the

overall increase. The added cost will be covered with income from the sale of State-owned companies. The objective translates into an increase of FIM 1.5 billion over the 1997 budget. This investment will make Finland one of the leading countries in Europe in terms of research funding, measured as the percentage of GDP accounted for by research investments.

The Science and Technology Policy Council of Finland has drawn up a plan for using the extra funding (December 17, 1996). One of the main ways to attain the goals set by the Government is to allocate the funding specifically but not too narrowly. The funds will be allocated following an open competition.

Most of the funding will be allocated to the Technology Development Centre, Tekes (a total of FIM 1805 million in 1997-99). At Tekes, the extra funding will mostly be spent on strengthening basic functions and international cooperation, and expanding functions to new fields and enterprises that have previously not received Tekes funding. This expansion will cover primarily technology programmes implemented in cooperation between industry and various public bodies, research reinforcing the technology base, R&D projects in the service sector, projects aiming at generating new enterprises and business functions, and support for R&D in industrial clusters (food, forest, communications, transport, welfare, employment and environment clusters) in Finland. Research equipment acquisitions for the Technical Research Centre of Finland (VTT) and universities can also be funded through programmes and projects. Development of innovations in SMEs (small and medium-sized enterprises) is a primary target. Tekes will also finance competitive development projects within the centre of expertise programme of the Ministry of the Interior.

The extra resources available to the Academy of Finland in 1997-99 will total FIM 630 million. These will be allocated to strengthening CoEs in research and creating new ones, to research programmes in strategically important fields, to creating a post-doctoral research system and to otherwise promoting the careers of young researchers and expanding international cooperation.

The extra resources available to universities in 1997-99 will total FIM 635 million. They will be allocated to strengthening graduate schools and starting up new ones in selected fields of technology and natural science, to updating equipment and other research infrastructure, to networking and to developing communications mechanisms in order to enhance dissemination of results, and to increasing expert training in mathematics, natural sciences and technology.

During 1997-99 a total of FIM 140 million in extra funds will be allocated to the Ministry of Agriculture and Forestry, the Ministry of Transport and

Communications, the Ministry of Social Affairs and Health, the Ministry of Labour and the Ministry of the Environment. This will be allocated to support R&D in the industrial clusters mentioned above in cooperation between industry, the Ministry of Trade and Industry, Tekes, the Academy of Finland, universities and research institutes.

1.4 Present centres of excellence in research and their resources

In drafting the 1994 budget, the Ministry of Education adopted centres of excellence (CoEs) as one criterion in distributing its performance-based funding, asking the then National Council for Higher Education to nominate ten CoEs with a high standard of research and teaching. Since then, the Ministry of Education has requested proposals for CoE nominations in research from the Academy of Finland, which submitted a total of 17 candidates (Appendix 1). Of these 17 CoEs, 12 were first granted CoE status for the two-year period 1995-96, which was then extended to 1997-98. Five further CoEs began their first two-year period at the beginning of 1997. The working group conducted a survey of the resources and personnel of these 17 CoEs in 1995-96 to obtain background material for its work. For the five newest CoEs, the survey describes their situation at the end of 1996, before their term as CoEs.

The present CoEs differ greatly in size. One centre or institute can house many different types of research. The CoEs include three umbrella organizations conducting cellular and molecular biology research (Biocentrum Helsinki, Biocenter Oulu, BioCity Turku). These biocentres have as many as 48 research groups, with over 500 personnel. The Digital Media Institute at the Tampere University of Technology is also large (24 groups, 160 personnel). The other 13 CoEs are smaller, consisting of one to 15 groups (12 to 100 personnel).

The biocentres (indicated by the letters A, M and N in Appendix 1) partly come within the purview of the Research Council for the Environment and Natural Resources and partly that of the Research Council for Health. Five of the CoEs (indicated by the letters B, D, E, G and O in Appendix 1) are mostly within the purview of the Research Council for Natural Sciences and Technology, three (F, H, P) that of the Research Council for the Environment and Natural Resources, one (C; also covered by the umbrella organization of Biocentrum Helsinki) that of the Research Council for Health and five (I, J, K, L, Q) mostly that of the Research Council for Culture and Society.

Universities can use performance-based funding from the Ministry of Education received on the basis of the existence of the CoEs in any manner they see fit. Generally, universities allocate part of this funding to the CoE in question. According to a survey conducted by the working group, the share of CoE funding channelled to the CoE in question was 50% on average in 1996 (varying from 21% to 93%). Although the Academy of Finland has not actually yet provided CoE funding as such, it has supported present CoEs as part of its normal research funding. The survey shows that the Academy contribution to total funding for CoEs was 23% on average in 1996 (varying from 9% to 46%); (Appendices 2 and 3). In 1997, the Academy made its first allocation of funds specifically for CoEs, using this to engage 44 post-doctoral researchers.

The total funding for the present 17 CoEs in 1996 was about FIM 366 million, of which CoEs started in 1995 accounted for FIM 158 million and CoEs started in 1997 for FIM 208 million (Figures 1a, 1b, 1c). The sources for the total funding for CoEs in 1996 were: 50% from universities (includes performance-based funding from the Ministry of Education), 23% from the Academy of Finland, 5% from Tekes, 14% from other Finnish funding, 5% from the EU and 4% from other foreign funding. In 1996, performance-based funding from the Ministry of Education accounted for an average of 11% of the total funding for CoEs started in 1995.

On December 31, 1996, most (62%) of the academic personnel at the present CoEs were doctoral students (Figure 2); 17% of the personnel were senior researchers and 16% were post-doctoral researchers, giving a total of 33% acting as supervisors. According to the working group discussing the development of careers in research, the appropriate ratio between supervisors and doctoral students is just the opposite in many fields: 60% to 70% of post-doctoral and senior researchers and 30% to 40% of doctoral students (Ministry of Education 1997). None of the present CoEs have this personnel structure (Appendix 4).

On average, 42% of the academic personnel of the present CoEs are women (Figure 3). Women are in a clear minority only in the senior researcher category (19%). Variation between units is great (Appendix 5). The age range of doctoral students and post-doctoral researchers is extremely broad (Figures 4a, 4b). The average age of doctoral students is 29 for women and 30 for men; the average age of post-doctoral researchers is 32 for women and 31 for men. Foreigners account for 15% of academic personnel on average: 15% of senior researchers, 26% of post-doctoral researchers and 12% of doctoral students are from abroad (Figure 5).

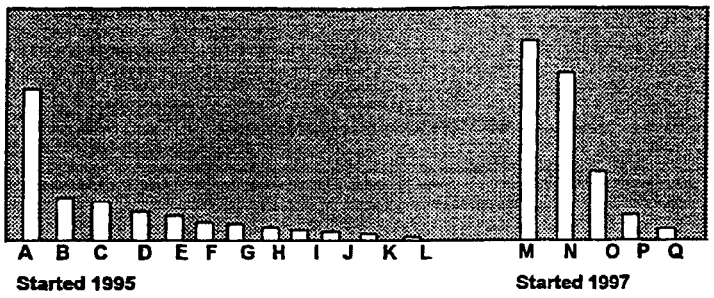


Figure 1a. Total funding in 1996 for centres of excellence (FIM 366 million).

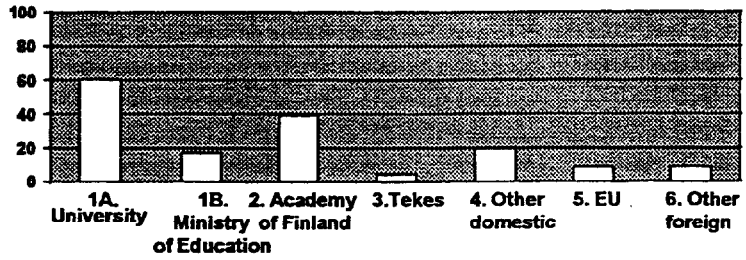


Figure 1 b. Total funding in 1996 for centres of excellence that started in 1995 (FIM 158 million).

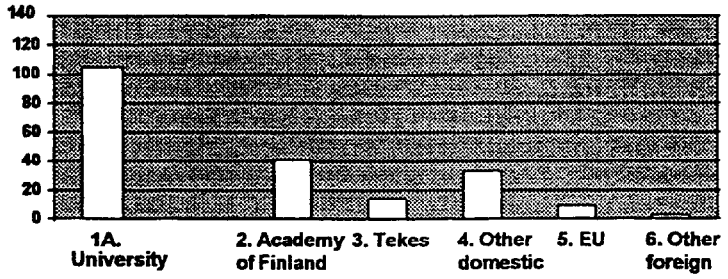


Figure 1 c. Total funding in 1996 for centres of excellence that started in 1997 (FIM 208 million).

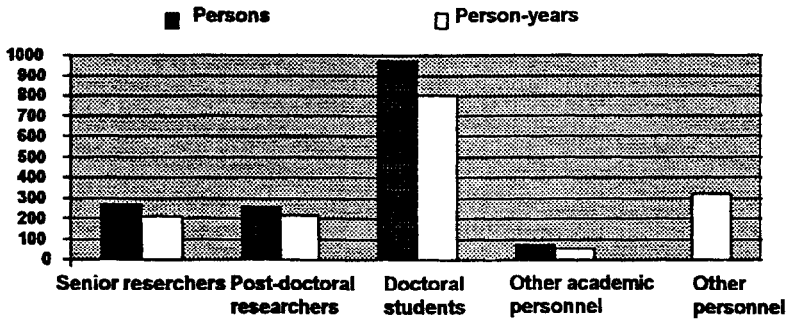


Figure 2. Personnel at centres of excellence on December 31, 1996.

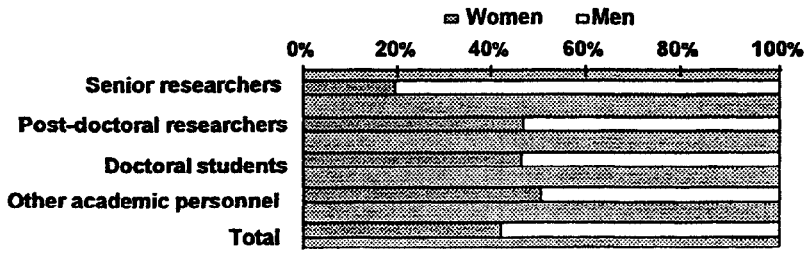


Figure 3. Distribution of gender among personnel at centres of excellence on December 31, 1996.

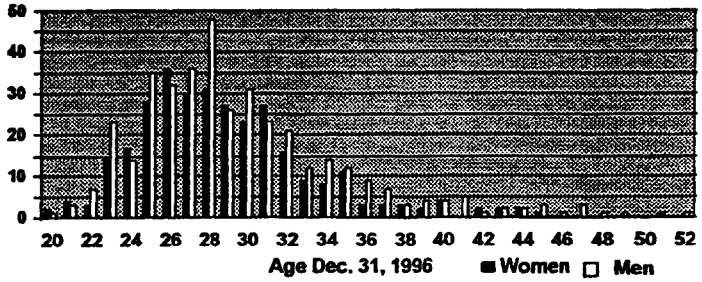


Figure 4a. Distribution of age and gender among doctoral students at centres of excellence on December 31, 1996.

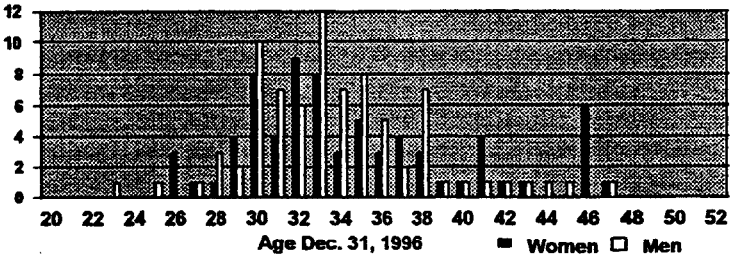


Figure 4b. Distribution of age and gender among post-doctoral researchers at centres of excellence on December 31, 1996.

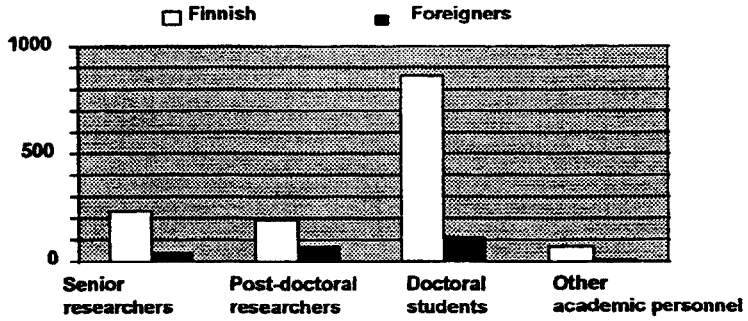


Figure 5. Proportions of Finns and foreigners among academic personnel at centres of excellence on December 31, 1996.

2. Selective funding policy in some OECD countries

2.1 Content and objectives of centres of excellence policy

Content

To gain background information, the working group examined selective research funding in thirteen OECD countries (Australia, Austria, Japan, Canada, Korea, Denmark, the Netherlands, Britain, Norway, France, Sweden, Germany, Switzerland). The first six of these have a centres of excellence (CoE) policy. The Netherlands is planning a CoE programme. In the other countries, funding is generally allocated to research projects through research programmes and directly to competent researchers. In some countries (e.g. Britain), selective funding is allocated to the universities with the best track record in research. Also, some countries provide special funding for top research and its quality is then assessed regularly (e.g. France, Germany).

All the examined countries that have a CoE policy have set up a separate CoE programme administered by a ministry, a science council or a science foundation. Units are grouped to form CoEs in research, in research and teaching, or in technology, with a long-term (five to ten years) but not permanent mandate. Usually, a CoE is a multi-disciplinary national R&D group. A CoE can be a research unit run by one or more universities, or a research institute associated with or cooperating with a university. Cooperation with enterprises is also possible. The CoE programmes usually focus on fields of national strategic importance.

Austria and Japan are funding promising high-level research groups that are expected to develop into CoEs. The objective of the Austrian CoE programme is to enable the formation of research CoEs at universities and research institutes. The Japanese programme is tripartite, involving the development of research units into CoEs, support for CoEs already operating, and general development of research environments. Potential CoEs are identified and encouraged through a separate programme.

In all countries, CoEs are set up in an agreement involving at least the unit itself, the host institution and the party providing the funding. Usually, the host institution contributes to the funding by providing basic resources for the CoE

to use. Concentrating resources reduces personnel and equipment costs, brings the best researchers together and promotes national and international cooperation. The aim is to create an efficient and flexible administration and research infrastructure.

Evaluations show that CoE programmes have been a great success, even exceeding the original expectations. CoEs have been found to boost research activity greatly, to improve research environments and to raise the profiles of their host institutions.

Objectives

In many countries, the general objectives of CoE policy include developing top national know-how and competitiveness in fields that can involve basic and/or applied research, supporting top-rank researchers, guiding multi-disciplinary cross-sector research programmes, marshalling scientific resources at universities and promoting results exchange and exploitation. For example, Denmark has set a tangible goal: each of its CoEs should aim to be among the top five to ten in their respective fields in Europe. Austria aims to integrate CoE personnel and equipment into the host organization in stages during the funding period.

Several CoE programmes cooperate with trade and industry in order to promote information provision and commercial utilization of innovative ideas and technologies. Such corporate participation helps prioritize research to take the needs of trade and industry into account. In Canada, for example, the CoE programme has become a model for optimizing scientific and technological resources.

2.2 Selecting and assessing centres of excellence

Methods

CoEs usually go through a multi-stage selection process. The party providing the funding usually assesses the outline plans of the research groups and draws up a shortlist of groups that are asked to submit detailed applications. Independent international evaluators are involved in evaluating the detailed applications. The selection committees or evaluation panels may also include representatives of financers, ministries or even host organizations of potential CoEs. If the CoE programme involves industry, industrial representatives and economists may also be on the selection committee. In some countries, a representative of the potential CoE is given the opportunity to present the application to the selection committee.

CoEs are usually evaluated at three-year intervals. Evaluation is based on a number of factors, such as reports from the units themselves and monitoring of past implementation of cooperation agreements. Any corrective action, such as reorganization of the unit, or increasing or decreasing the number of sub-projects or research groups, is taken on the basis of evaluation. CoE funding can be discontinued if the unit is unable to solve problems within a given period. Units with an excellent record are allowed to continue, while those not succeeding as well will cease to operate. CoE effectiveness is evaluated internally in discussions, seminars, workshops, lectures and courses.

Criteria

The selection and evaluation criteria vary from field to field. The high international standard of the research is the most important criterion. Another important one is the potential of a country to become a world leader in a particular field or that of a unit to become the national leader in its field (if the country is large); national and international contacts within the field are also important.

The research groups in a CoE must constitute a 'critical mass'. The researchers must also assess the effects and economic and social values of their work. The researchers must be ambitious and of international calibre. The research

environment must be problem-oriented and interactive. The creation of unconventional new training strategies that promote inter-disciplinary approaches is also considered.

A CoE must have an efficient administration to optimize the efficiency of internal allocation of funds, for instance. The unit must link its research groups and involve information users in order to improve communications. Research resources must be maximized and overlapping purchases avoided, for instance through shared equipment.

CoE programmes that involve trade and industry face a number of further selection and evaluation criteria. The significance of an interdisciplinary and cross-sectoral approach is further heightened in such cases. The priorities of industry, universities and society must be taken into account. The research must anticipate future needs and address the problems and opportunities of the country's economy, productivity and welfare. Great attention is paid to networking, and efficient contacts between participants in the public and private sectors are called for.

Academic research must extend up to, but not include, commercial utilization. Basic and applied research should preferably intermingle during the entire lifespan of a project. Thus, basic research would continuously feed ideas into the entire system. Information users can be flexibly involved at various stages.

Information exchange and technology exploitation are assessed in terms of the successful commercialization of new products, processes or services, technology transfer opportunities and growth in the technology base of participants in the private and public sectors. Other factors that may be considered are the protection of intellectual property, its exploitation in national companies as broadly as possible, and safeguarding the contributions of investors.

2.3 Funding

Many CoE programmes are given permanent status after a trial period. However, a new CoE is nominated once the funding period for one unit ends. The duration of the funding period and the number of funding periods available to any individual CoE depends on the research field and measured success. The longest funding period so far is ten years (Austria and the future CoE programme in the

Netherlands). In Australia, the funding period is nine years, in Canada seven years and in Japan and Denmark five years. Canada has recently increased the funding period for CoE networks from four to seven years.

The annual funding granted to CoEs varies greatly, depending on size, the evaluation results and, often, the budget proposals made by evaluators. For example, in Australia, funding for CoEs with a low success rate was cut by 40% in the year following the negative evaluation and then discontinued.

2.4 Graduate schools as part of centre of excellence programmes

One key element in building up national special expertise is the training of doctoral students and post-doctoral researchers with top researchers. Teaching and research are usually closely linked, and researcher training is considered an important part of the CoE's work. Australia has separate CoEs in teaching for training experts. Austria is in the process of linking graduate schools to its CoE programme, while the Netherlands is turning the graduate schools producing the best results into CoEs in research.

3. Content and objectives of the centre of excellence programme in Finland

The general objective of science policy in Finland is to raise the level of objectives and quality in Finnish science and to improve its international competitiveness, visibility and esteem. This will contribute to creating the information base required for cultural, social and industrial development, and consequently to forming a solid base for a national innovation system, i.e. a system of factors influencing the development of new information and expertise and their exploitation. The objective of the centre of excellence (CoE) strategy is to enable the emergence of creative and efficient research and training environments of a high level that can generate top international research with a social as well as scientific dimension. This strategy would be implemented through fixed-term CoE programmes.

The CoE strategy must be a flexible and stimulating entity that allows for renewal. It must be followed with farsightedness, stability and logic. Top research cannot isolate itself from society. The CoE programme must ensure that research is not only the spearhead of development in its field but can also anticipate needs and trends in society. Finland's entire national research system must be fully enlisted in implementing this programme. As a result, the training of both professional researchers and top experts will be enhanced. Thus, a successful CoE strategy will provide one way of identifying the top researchers in the country and of ensuring the overall development of research, researcher training and the research system as a whole. Top research is also an important element in improving the profile of research organizations.

The CoE strategy is not just a 'hard science' strategy. It is of prime importance to include the humanities and social sciences in order to ensure balanced multi-valued development. On the one hand, these sciences have their own CoEs, but on the other hand they should be linked in a feasible way to the activities of other CoEs. Multi-disciplinary and interdisciplinary units are valuable.

In a small country like Finland, resources for attaining an international cutting edge exist only in certain fields or subjects. Thus, all good, creative research environments would not be covered by the CoE programme. High-quality units remaining outside the programme also need sound operating conditions. In addition to supporting the very peak of Finnish research, attention must be paid to maintaining and promoting broad, high-level expertise in several fields if

Finland is to maintain the capacity to recognize promising new research objectives and problems and to tackle them in an innovative way. Openness towards new ideas and emerging fields of research must be maintained.

In supporting top research, the division into basic and applied research is irrelevant. Quite the contrary: the aim is to increase interaction between different types of research. Completely new applications cannot come about without a solid scientific foundation and, conversely, researchers can gain fruitful input and ideas from the result users. The CoE programme can also pay attention to the effect of the research field of a particular CoE on employment, the economy and the business sector in Finland.

The core of a creative research environment can comprise research CoEs of several sizes. The working group defines a CoE as follows: *A CoE is a high-quality research and researcher training unit that has the potential to become an international leader in its field. It consists of one or several research groups of a high international standard with clear common goals. It can also include individual top researchers who do not belong to any group. The top units and top researchers working on the same research subject or problem can come together under a shared umbrella organization, which can be called a cluster-type CoE. A cluster-type CoE can include other groups and researchers of internationally high quality, in addition to cutting edge researchers.*

Over time, a research community that began life as a CoE can evolve into a cluster-type CoE, as a result of the attraction of a good research environment.

Cluster-type CoEs enjoy numerous benefits provided they are sufficiently coherent. Regular scientific discussion with a large and varied group provides a wide variety of methodological potential and new approaches, makes it easier to assemble and find funding for large projects, rationalizes and enhances researcher training, maintains healthy and stimulating competition and ensures strict quality control. It should be noted that not every large unit or 'conglomerate' is, in itself, a cluster-type CoE. Conversely, management, administration, communications and research focusing are easier in a smaller unit than in a large one.

A CoE can accommodate several groups researching the same subject (broadly understood) or problem from different viewpoints, as long as the objectives are shared, and there is sufficient cohesion and good communications. Research is often multi-disciplinary or interdisciplinary. A CoE will have sufficient 'critical

mass' and density, and will form a coherent entity with its own identity. In order to gain synergy benefits, it is usually advantageous to have the unit operating in sufficiently close physical proximity.

Future top researchers and research groups must be sought and actively supported as part of the policy of universities, research institutes, enterprises, financers, science policy actors and result users (cf. proposals of the Working Group on the Development of Careers in Research, Ministry of Education 1997). Promising talented researchers should already be identified at the start of their careers. Lounasmaa (1996) has written an apt description of the evolution and dynamics of a CoE from the researcher's point of view. He says that all financers and people responsible for allocating resources (rectors, deans, research directors) should determinedly and systematically aim to locate the researchers and groups that seem to have the potential to form a CoE. Once a top researcher and his/her group have been found, they must be provided with more generous resources than usual for a few years, combining resources from a variety of sources. If the results are good, the funding should continue. A researcher and group receiving exceptionally good funding must be aware that they have been selected as a potential CoE and understand the responsibilities that this entails. A CoE can only be formed through systematic long-term work and support.

In addition to the best researchers, we should also identify the research fields and subjects of national strategic importance for which internationally competitive research must be systematically generated in Finland. The generation of new top research or the improvement of existing top research can be accelerated both by offering opportunities for researcher training abroad and by recruiting top foreign experts in the relevant field to come to work in Finland. Getting top foreign researchers to come to Finland usually requires a number of support measures (good pay, flexible salary terms, employment for family members, children's day care and education, etc.).

The rise in the standard of Finnish scientific research and its improved international visibility will, in turn, increase Finland's potential for recruiting top researchers from other countries. Good research environments will become even better, generating a sort of upward spiral.

An excellent research environment will attract ambitious young researchers. On the other hand, some researchers in a unit will be recruited for other work in Finland and abroad. There will be international competition for the best researchers. Thus, a CoE will constantly be renewing itself. A high-quality training and research environment also promotes researcher independence. The

units will train new top researchers who may leave the original unit and form new creative research environments and CoEs. Furthermore, CoEs can set a good example, also carrying other research forward.

It is vital to keep CoE policy dynamic but with a long-term perspective. To ensure its dynamic nature, CoEs should be nominated for a fixed period. Evaluations are an essential tool in quality control and in maintaining dynamism. Units are assessed internationally both at the selection stage and at the end of the funding period. Their work is also monitored during the period. The allocation of further resources will depend on the results of the evaluation.

CoEs must be able to improve themselves on the basis of their own results. Their turnover must not be too great, since a CoE can only develop through long-term work. Expansion of CoEs would be supported as needed and as negotiated when their results are good. If results did not meet expectations, funding would be cut progressively (cf. chapter 6). The main rule is, however, that any expansion would be discussed after an interim evaluation or when applying for a new CoE funding period.

There must be a sufficient number of creative, high-quality research environments in Finland, covering enough fields of science, to enable Finnish research and training to keep up with international advances. However, to prevent available funding from being divided up into too many small lots, a CoE status should not be granted to too many units. The increase in Finnish research and technology funding will enable the Academy of Finland and Tekes to provide over 20 CoEs with substantial long-term support.

Research at a CoE must be clearly professional and also otherwise fulfil the criteria of a creative research environment (cf. section 1.1). Challenges faced by a CoE include getting results amid keen international competition, obtaining international funding, and involving foreign researchers.

Success for a CoE requires not only excellent research but also professional management. This is particularly important for large units. Resources must, therefore, be allocated to management. In a small unit, the manager's scientific merits are more important.

It is important for university departments and CoEs to cooperate closely to ensure interaction between research and training and the recruitment of new researchers. A CoE can also be an entity outside a university. The researcher training function of this kind of unit is indirect, realized through cooperation with a university.

CoEs can compete not only for CoE-specific funding, but also for the general research and technology funding available. Foreign research funding, in particular, should be applied for. However, care should be taken that CoEs do not become too dependent on outside allocated funding to be able to pursue their own research programmes, independent of the financers. Here, the support provided by the Academy of Finland, Tekes and the host organizations plays a key role. The aim of the Academy of Finland is to provide CoEs with enough contract-based resources for a given funding period to ensure that they do not need to apply to the Academy for any further funding during this period (except for research programmes, graduate school subsidies and post-doctoral research posts; see chapter 7).

4. The national research system and the centre of excellence programme

The centre of excellence (CoE) programme must be integrated into the whole of Finland's research, training and technology policy, including sectoral research and, as applicable, enterprises (specifically through the Tekes funding policy). The programme must be a functional and coherent entity, in which all components of the research system play their own clear role, the whole being more than the sum of its parts. All actors — the Science and Technology Policy Council, the ministries, the Academy of Finland, the universities and research institutes, Tekes and enterprises — must have their own objectives and strategies for creation of the operating environments required for high-quality R&D and researcher training. The Science and Technology Policy Council and the ministries are meeting points for science policy and political decision-making.

Science and Technology Policy Council of Finland

The Science and Technology Policy Council is a Government organ chaired by the Prime Minister. It has published an outline statement on CoE strategy (Science and Technology Policy Council 1993). This states that Finland must lay the groundwork for the emergence of a network of CoEs through cooperation between financers, research organizations and users of research findings. The main criterion for creating CoEs is quality. Potential applications are another important criterion in fields aiming at social and economic applications. Defining the key fields is an important element in creating the network. CoEs must be linked to the graduate school system. According to the Council, the Academy of Finland and Tekes carry the main responsibility, in addition to the research organizations themselves, for creating and maintaining the CoE network. CoE policy in sectoral research is also examined as part of overall development of the research system (Science and Technology Policy Council, January 25, 1996). The report of the present working group is part of the operationalization of the Science and Technology Policy Council policy guidelines.

The Ministry of Education and other ministries

The role of the Ministry of Education is to guarantee, together with the universities, the basic prerequisites for the emergence of good research and training environments and consequently of CoEs in Finland. Until now, CoEs have been a component in the guidance system whereby the Ministry encourages universities to achieve good results and to lay the foundation for the emergence of top research. Thus, the Ministry of Education has used top research as a research quality gauge, with CoE status as its indicator, and as one of the criteria for distributing its performance-based funding to universities.

Performance-based funding is allocated to a university, which can then further distribute it in any way it sees fit to further its strategic objectives - for instance, to create new CoEs or expand existing ones.

The Ministry of Education would not directly be funding any of the units or projects in the CoE programme currently being planned. This will be done by the Academy of Finland, in accordance with the results agreement between the Ministry of Education and the Academy. The Ministry of Education, through management-by-results, will ensure that its own functions and those of the Academy and the universities form an appropriate framework that supports the CoE programme.

Other ministries would provide basic resources for research institutes under their administration. They could also support top research as part of management-by-results at their institutes.

The Academy of Finland

The CoE policy of the Academy of Finland will be a key element in the national CoE strategy. So far, the Academy has not provided any specific CoE funding; instead, CoEs nominated by the Ministry of Education have been provided with funding through the normal research funding procedure (apart from the 44 post-doctoral positions granted to CoEs in 1997). In 1996, the Academy contributed 23% of the funding of the present CoEs (17, including those that gained CoE status in 1997; see section 1.4).

In the future, the Academy will play a more important role in funding CoEs. The Academy will be committing itself to both funding CoEs and to providing core facilities funding for umbrella organizations.

The working group examining careers in research has proposed that the Academy should set up a post-doctoral researchership programme to promote the careers of talented young researchers and create a new type of funding, called start-up funding. Post-doctoral researcherships would start immediately after the candidate's dissertation has been approved. Start-up funding could be granted after the post-doctoral researchership. Promising young researchers (20 every year) could set up their own research groups with this funding. The working group report is currently being circulated for comment. For scheduling reasons, implementation of the proposals concerning the post-doctoral researchership programme has already begun, and the first 90 post-doctoral researchers will take up their posts in the autumn term of 1997.

The working group proposes that the CoE funding provided by the Academy of Finland be allocated mainly to units operating at universities. In cooperation with the relevant ministries, Tekes, business and industry, and any other financers, the Academy could also support CoEs in other organizations.

The working group further proposes that the Academy of Finland should assume responsibility for coordinating and updating the national CoE strategy, and actively promote the generation of appropriate CoE networks.

Universities

Universities have a vital role to play in both nurturing top research and providing basic resources for CoEs once they have been set up. Universities should actively support the emergence of high-quality research units and groups and the development of strong fields through their own active measures. It is important to identify researchers with the potential to rise to the top of their field as early as possible and to provide them with the necessary resources. After a research unit or cluster has been granted CoE status, universities should commit themselves to providing at least the same level of resources as the unit or cluster had before it obtained CoE status.

Research institutes

Research institutes should also actively seek out and identify top researchers and potential CoEs within their own organizations and actively support them. International evaluations of research institutes, which have already been carried out on quite a few institutes in Finland, with more to come in the near future, are a good aid here. Top expertise should also be actively nurtured in sectors where knowledge gaps exist that may hinder the balanced and sustainable development of society, and that could be eliminated through research. Research programmes are a good tool for creating and promoting top research and fruitful networks between researchers and users in nationally important fields.

In research institutes that have other functions besides research (e.g. monitoring, inventories, surveys, various expert duties, statutory duties), supporting top researchers and research groups presents the management with a particular challenge. The best researchers should be given enough time to conduct and publish their research. At the same time, it is important to safeguard good contacts with those who need the results (the host ministry and other information users) in order to keep the research relevant. Many research institutes have a long tradition of cooperation with the parties that use the information they produce, and this is an asset in developing the innovation system. Research institutes are excellently placed to act in networks with universities, trade and industry and other information users in society, combining top research with social effectiveness. The cooperation potential of research institutes should be used more efficiently in science policy aimed at developing the national research system, where the CoE strategy is a key component.

Many government research institutes are users of research results in addition to carrying out research. The research done by a CoE at a research institute is mainly applied. This does not mean that the institute could not conduct basic research if this was necessary in order to solve the problem addressed by the research. Research institutes can convey research results and information rapidly to both the host ministry and other information users. The organization and communications of a research institute must be designed so that the CoE is not isolated from the rest of the institute but acts as both contributor and recipient in the organization.

The components in the research system are jointly responsible for supporting the CoEs at research institutes, where support from research users should in general play a more important role than at the universities. This requires a more

long-term and strategic outlook from users and a commitment to funding research in their fields of interest. The research institutes themselves and the relevant ministries should safeguard the basic resources. Also, a CoE in a research institute could receive CoE funding from the Academy of Finland and Tekes under a separate agreement, and of course they can apply for any generally available research funding (in principle the Academy grants funding outside the CoE agreement only for research programmes, graduate schools, post-doctoral researchers and research posts; cf. chapter 7).

The Technology Development Centre of Finland (Tekes)

Tekes is a major financer for research at universities and research institutes. About one third (FIM 420 million in 1996) of funding provided by Tekes (objective-oriented research) was allocated directly to universities and research institutes. Projects covered by this funding can involve basic research, but they must contain elements that can be expected to lead to commercial applications in the long term. Cooperation with enterprises is also desirable at an early stage. Universities and research institutes also receive nearly 10% (FIM 121 million in 1996) of total Tekes funding through Tekes-funded corporate R&D projects.

Tekes has also defined Finland's basic research needs in its technology programmes. Together with the CoE programme, the technology programmes could lead to a more significant and higher-quality type of objective-oriented basic research in Finland. Tekes could help to fund CoEs whose research not only fulfils the scientific criteria but also conforms to the terms Tekes has laid down for its present objective-oriented research funding, i.e. that the centre cooperates with enterprises and the work has commercial application potential. It is most important that CoEs actively seek out ways of commercially exploiting their research and of making corporate contacts. This will generate fruitful cooperation between pure research, applied research and development, thus eliminating the boundaries between them.

From the Tekes point of view, one criterion for granting CoE status, apart from the quality of the research, is the future needs of industry and other business. Because predicting these needs, especially over a time span of several years, is very difficult, researchers should have the opportunity to develop completely new ideas whose usefulness cannot be reliably assessed beforehand.

A technology-oriented CoE is assessed using somewhat different criteria than other CoEs. In assessing a technology-oriented CoE, it is important to focus not only on scientific quality but also on the applicability of research results in business or other economic activities. Technology-oriented CoEs must have particularly good communication skills, reception capacity and results transfer skills.

All CoEs can apply for normal Tekes funding on a case-by-case basis. Project funding can be a good way of supporting CoEs networking with enterprises.

Enterprises

CoEs can function as innovation centres where new business can be generated on the basis of research results. Thus, CoEs can be major players in new industrialization projects, acting as interfaces to the business world.

Enterprises can cooperate with CoEs both in conducting research and in using its results. As research conductors, enterprises can network with a CoE or even function as part of one. The best researchers in companies and CoEs can participate flexibly in each other's research groups on a fixed-term basis. The post-doctoral researchership system of the Academy of Finland provides excellent opportunities for this. Science parks offer a particularly good framework for this type of close cooperation.

Tekes is the largest outside financer for enterprises in Finland. Tekes funding is channelled through enterprises in the form of commissions to universities and research institutes. Tekes plays a major role in supporting the start-up of high-tech companies set up to exploit innovations originating from CoEs.

Foundations

Private foundations are particularly important in supporting researcher training and young researchers. Their grants are not usually very large, but they may be strategically important to the career of a researcher or in certain special fields. Foundations can also support research that for some reason does not fit in with the research policy of other financers ('excluded' fields, completely new fields), since they usually have greater than average potential for risk-taking in their

funding. Some foundations have systems for granting a senior researcher independent full-time researcher status on a professorial level for a fixed term, with research funding provided.

Foundations have a light and flexible organization which allows them to take on board new procedures quite easily and to make quick decisions if needed.

In the national CoE strategy, foundations could play an important role, for instance in identifying and supporting talented young researchers and in enabling top researchers to concentrate on research full time.

5. Selection and evaluation criteria for centres of excellence

An appropriate evaluation model must be found for each field of science. Units should be evaluated relative to the international standard in their respective fields. Units in different fields are not directly comparable with each other.

The selection and evaluation criteria for centres of excellence (CoEs) must be announced by the application stage at the latest. The primary selection criteria for a CoE are its scientific merits, products and activity, and its research and operating plan. The research environment and the success of the unit in researcher training are also given particular consideration.

Scientific merits and output are evaluated on the basis of factors such as:

- the status of researchers in their field, internationally and domestically;
- the scientific significance and innovativeness of the research and its effect on the progress of science;
- the quality, quantity and distribution of scientific output (particularly publications in internationally respected series);
- patents;
- researcher mobility internationally and domestically in leading research groups in the field;
- number and quality of foreign researchers working in the unit;
- international and domestic elected posts held by researchers.

In addition to and in connection with these criteria, the significance and feasibility of the research plan is evaluated together with the unit's research environment, using the criteria for a good environment (cf. section 1.1):

- research group structure (senior researchers, post-doctoral researchers and doctoral students) and division of labour among researchers;
- closeness of cooperation between researchers in research groups to attain common objectives;
- critical mass and density appropriate to the field in question;
- sufficient cohesion between research groups (usually a unit in the same research organization; a consortium of several organizations may be considered if they have a common goal and management);
- activeness, nature and volume of domestic and international cooperation;
- synergy benefits;
- effect of the research unit on the advancement of research potential in its immediate vicinity;

- contacts with other research conducted at the same organization and by partners;
- professional approach in research, researcher training, unit management and unit administration;
- commitment of the host organization to support the unit;
- premises, instrumentation, special equipment and other infrastructure
- varied and sufficiently stable funding structure (including volume of international funding).

The success of a unit in researcher training, or its potential for becoming good and efficient at researcher training, is evaluated on the basis of the following:

- general potential for researcher training;
- involvement in the work of graduate schools;
- practical arrangements for researcher training;
- success of supervisors in researcher training;
- numbers of graduate students and supervisors (ratio);
- need for researchers and experts in the unit's field.

6. Application, selection and evaluation procedures for centres of excellence

Application and selection procedure

The application, selection and evaluation mechanisms for centres of excellence (CoEs) must maintain competition so that all research groups and units have equal opportunities at the application stage regardless of their host organizations.

The working group proposes that CoE status could be applied for by researcher communities consisting of one or more research groups in close cooperation. This community could also include researchers who do not belong to any group.

Funding for strategically vital core facilities and expensive infrastructure shared by several research groups could also be applied for not only by the single group or unit, but also by a large cluster-type unit consisting of several high-quality research groups operating under a joint umbrella organization, with groups studying the same subject or problem. It should be noted that the individual units within such an umbrella organization would have to apply for a CoE status and their own funding independently, competing for it on an equal basis with the other applicants.

The application process must be designed to enable thorough scientific evaluation of the applicants and deliberation of science and technology policy without making the process unnecessarily cumbersome and time-consuming.

The working group proposes that, at the first stage, CoE applicants be asked to submit an outline plan. Umbrella organizations applying for core facilities funding should also submit an outline plan. This plan should contain a brief description of the objectives and implementation of the unit's research, its researcher training and personnel structure, and the significance of the core functions for which funding is needed for the research work of the organization. Units within an umbrella organization applying for CoE status should submit separate outline plans, including a description of connections with the rest of the organization.

The Board of the Academy of Finland would appoint a preparatory group consisting of representatives of the Academy and its research councils and

possibly other scientific experts. The working group could be expanded to include representatives of ministries, Tekes and other financers and result users, if this proved feasible for discussing the outline plans and for future funding negotiations. The preparatory group could circulate outline plans for comment to outside Finnish or foreign experts. On the basis of the outline plans, the preparatory group would make a proposal for a shortlist of units and umbrella organizations that would be invited to submit a detailed plan in English. To speed up and simplify processing, the financers could authorize the Board of the Academy to decide to request such detailed plans on the basis of the preparatory group's proposal. Otherwise, the decision on who to ask to submit detailed plans would be made by the financers interested in contributing to the funding of units submitting applications and/or umbrella organizations applying for core facilities funding.

The applications should be submitted on a form available from the Academy, Tekes or some other financer, as the case may be; the form should be filled out according to the instructions of the financer in question. A detailed plan in English should be appended to the application form; the same plan should be submitted to all financers. The plans would be circulated for international evaluation in such a way that statements on all the major fields covered by the unit would be obtained. The evaluators would be selected by the preparatory group referred to above.

In practice, selection would start by choosing the CoEs. The units representing the cutting edge would be granted CoE status, but other units of international standard would be identified, too. Core facilities funding would be available to an organization containing units with CoE status and several other groups of proven scientific quality and/or innovative groups in a key position in technology development. Thus, an organization of this kind has good potential for providing a broad research and training environment of exceptionally high quality. Core facilities funding is a special subsidy designed to further improve an already outstanding research environment. This funding helps to keep good researchers and groups together and to attract new researchers and groups interested in vying for CoE status. In a cluster-type organization, the groups that have attained CoE status form the core with the greatest pull.

The application process for university CoEs must be timed so that CoE decisions can be made before the result negotiations between the Ministry of Education and the Academy of Finland, on the one hand, and between the Ministry of Education and universities, on the other. The same schedule could well be observed for CoE candidates not affiliated with universities.

The working group proposes the following schedule:

At the end of April, applicants for CoE status and core facilities funding are asked to submit their outline plans by mid-August. In September, the preparatory group provides the Board of the Academy of Finland and, if necessary, other financers with a shortlist of the units and organizations from which detailed applications in English should be requested. By the end of September, the Board of the Academy of Finland and, if necessary, other financers would decide on the units and organizations asked to submit a detailed application. The deadline for detailed applications would be the end of October. At the beginning of November, the applications are sent to the international evaluators for statements. By mid-January, the preparatory group submits a proposal on CoEs and core facility funding to the Board of the Academy of Finland and, if necessary, to other financers. The Board of the Academy selects the CoEs and decides for its own part on their funding and on core facilities funding by the end of January. Other financers may be expected to make their decisions in March at the latest. The resources for the chosen CoEs are agreed on during the spring as per chapters 7 and 8 of this report. The units gain CoE status and funding, and the cluster-type organizations gain their core facilities funding at the beginning of the following year.

Interim and final evaluations

To ensure the high level of research and to maintain dynamics encouraging better results, CoEs are selected for a fixed period.

The working group proposes that the CoEs be selected on the basis of international evaluations for a period of six years and that they be subject to interim evaluations three years after selection. If the interim evaluation is positive, the funding would be continued and may be increased. If the evaluation is negative, the unit is given one year in which to correct the shortcomings identified. If it fails to do so, it loses its CoE status, and its separate CoE funding is discontinued in a controlled way. All units would be subjected to international evaluation after the six-year period.

A CoE could be regranted CoE status immediately after one successful six-year period if it did well in competition with the new applicants. There would be no limitation on the number of times CoE status can be extended.

The same principles would apply to the separate core facilities funding granted to cluster-type CoEs.

The criteria outlined in chapter 5 would be used for evaluation. In interim and final evaluations, particular attention is paid to whether the objectives have been attained and the plans presented at the application stage realized, and whether planned research, training and cooperation projects have been successfully concluded. It is also important to evaluate the CoE's capacity for reform and its management. The added value generated by CoE funding in the unit's work and in the development of Finland's research and training environments and innovation system should also be evaluated. A unit's strengths, weaknesses, opportunities and threats are identified in evaluations.

The results of other evaluations still current can be used in the evaluations described above. In general, evaluations made for various purposes should be well coordinated to avoid duplication and unnecessary costs.

In comparing the applications of an existing CoE and a new applicant, attention should be paid to how the existing CoE has developed during its CoE period and how it has benefited from its extra funding. If the existing CoE and the new applicant come out equal in the evaluation, the new applicant should be selected if it is not possible to select both.

Evaluations help to develop the field in both the unit under scrutiny and, as applicable, in the field as a whole. Evaluations must not control research so as to ensure that it aims at minimizing risks and producing only certain results and a lot of publications. Innovative approaches, which may be risky in the short term, should be rewarded. Evaluations should promote the advance of science even in cases where evaluation results in a unit's not attaining CoE status or losing its CoE status.

In addition to the selection process evaluation, the interim evaluation and the final evaluation, CoEs should perform internal evaluations annually.

The working group proposes that a high-level scientific consultative committee, possibly with international members, be appointed for CoEs (including cluster-type CoEs) to support the head of the CoE and evaluate the work of the unit annually. This annual report would be distributed to the Academy of Finland and other financers.

The present CoEs operate for two-year periods; the current period will end in 1998. Most (12) are in their second CoE period, 1998 being their fourth year of operation. The other five units only gained CoE status from the beginning of 1997. In order to launch the CoE programme based on the new strategy at full strength as soon as possible, the evaluation for the existing CoEs should deviate somewhat from the 3+3 year interim evaluation and final evaluation plan proposed for the new CoEs by the present working group.

The working group proposes that the 12 CoEs that started in 1995 be evaluated in 1998 and the five CoEs that started in 1997 be evaluated in 1999.

These evaluations would also be the final evaluations for the current CoEs. They could reapply for CoE status and funding in accordance with the programme following this strategy.

The existing CoEs whose work has recently been subjected to international evaluation would not be re-evaluated but the earlier results would be used.

7. Providing resources for centres of excellence

Centre of excellence (CoE) funding should be long-term and stable, or at least predictable in volume. Present funding is troubled by its short-term nature and fluctuations, which has made it difficult to plan activities. Any changes should be gradual (including controlled discontinuation, if a unit does not qualify for continuation in the interim evaluation).

The purpose of the CoE programme is to concentrate resources in places where research of high scientific quality and significant innovative potential already exists or could be created, and where concentrating resources could generate major synergy benefits.

Resources should be guaranteed for the basic needs of CoEs at both universities and research institutes. For universities, the premises and other basic needs and resources for CoEs are agreed on in four-party negotiations with the Ministry of Education, the Academy of Finland and the university or universities in question (cf. chapter 8). Performance-based funding for universities and any issues arising in the four-party negotiations are discussed in the result negotiations between the Ministry of Education and the Academy of Finland, and between the Ministry of Education and the universities. For research institutes, basic resources are agreed on with their respective host ministries in result negotiations, following the principles described in chapter 4. Other funding for CoEs at research institutes is negotiated separately with financers (e.g. the Academy of Finland, Tekes, result users) willing to commit themselves to contributing funding for the unit for a fixed period.

The working group proposes that the CoE host ministries and organizations, financers and in some cases result users commit themselves, under agreements between the parties involved, to long-term, but fixed-term provision of basic resources and funding for the units. This could also include core facilities funding. This principle would also apply to the separate core facilities funding granted to cluster-type CoEs.

In granting a cluster-type organization core facilities funding it is important to guarantee that the research environment will maintain its excellent quality in all respects for at least the agreement period.

The working group proposes that CoEs within a cluster-type CoE should be required, as a condition in the agreement on their overall funding, to remain within this organization for the whole of their funding period.

This principle would be applicable, mutatis mutandis, to an independent CoE. However, if the head of a CoE moved elsewhere during the agreement period, or if the working conditions of the CoE otherwise deteriorated significantly from the agreed level, the continuation of CoE funding or controlled discontinuation would have to be negotiated separately.

If a significant network of CoEs is to be created, the programme must be broad enough. However, in order to maintain quality standards, the number of CoEs cannot be determined in advance.

The working group proposes that any CoEs discontinued on the basis of evaluations carried out in 1998 and 1999 be replaced by new CoEs, which could be the same as the present ones if they did well in their final evaluations and competed favourably with other applicants, and were set up according to the principles laid down in this strategy. Also, a maximum of four new CoEs would be appointed. Funds for the existing and new CoEs (a maximum total of 21) would be allocated from the extra Academy of Finland funding that may be available for 1998 and 1999.

The working group further proposes that funding for no more than four new CoEs be allocated from the extra funding for 2000.

The funding for new CoEs to be set up in 2000 does not fall within the scope of the current extra funding programme. The working group's proposals would mean that there could be up to 25 CoEs altogether in Finland in the year 2000.

Generally, a CoE should agree on funding with its host organization and various financers so that it will not have to apply for further funding from the Academy of Finland during its funding period, apart from any research programme funding, graduate school subsidies, post-doctoral research funding and research posts. Groups joining the CoE after its agreement has been concluded can apply to the Academy for further funding, but this must be separately negotiated.

The working group estimates that slightly over one quarter of the extra funding proposed for the Academy of Finland would be allocated to the CoE programme (a total of FIM 630 million in 1997-1999). The programme would account for an average 10% of the entire research funding of the Academy (excluding

research posts) over the three-year period 1997-1999. This proportion would grow steadily, being 13% at the end of that period. By comparison, in 1996 17.5% of the conventional grants awarded by the Academy went to the present CoEs (13.2% of the person-years of researchers holding Academy research posts). Thus, the new CoE programme would not anomalously increase the funding share of CoEs in the Academy; above all, it would give the funding a more planned and long-term framework. Since the CoEs can apply for research programme funding, graduate school subsidies, post-doctoral research funding and research posts in addition to their separate CoE funding, the overall share of CoEs in Academy funding will probably be somewhat better than in the present system based on evaluations on a project-to-project basis.

Host organizations of CoEs should commit themselves to allocating CoEs at least the same resources as they had before attaining CoE status. Thus, contributions from the Academy of Finland, Tekes and other financers should increase the resources of the CoE and hence clearly improve its operating environment.

Many universities have outdated equipment. Libraries also suffer from a shortage of funds for purchases. Equipment replacements and library resources are key areas for which universities should assume the main responsibility. This also applies to research institutes.

8. Negotiating mechanisms

In order for the centres of excellence (CoE) programme to succeed, it is important that both researchers and financers commit themselves to an agreement for long-term implementation of the programme. Funding must be guaranteed at least for the first three years of the CoE period; after that, a further funding framework will be agreed on, based on the results of the interim evaluation.

The working group proposes that CoE funding from universities not deriving from the Academy of Finland or other financers be agreed on in the result negotiations between the Ministry of Education and the universities, which take place in April. Before these negotiations, separate negotiations would be conducted on the overall resource provision in four-party negotiations attended at least by the Ministry of Education, the Academy of Finland, the relevant university or universities and the head of the CoE in question. If necessary, other parties such as Tekes, a research unit closely connected to the CoE outside the university, or result users could be involved in the negotiations. The outcome of these negotiations would be taken into account in the result agreements.

For research institutes, funding negotiations would be conducted between the relevant host ministry, the research institute, outside financers (e.g. the Academy of Finland, Tekes) and result users (e.g. other ministries, enterprises, local authorities).

In the case of cluster-type CoEs, the head of the relevant organization would participate in four-party negotiations on core facilities funding. However, the heads of individual CoEs within such an umbrella organization would each negotiate their own agreements, although the head of the umbrella organization could take part in these negotiations, too.

9. Summary

The working group appointed by the Academy of Finland has drawn up a national centre of excellence (CoE) strategy, laying down the objectives and content of Finland's CoE programme, and has made proposals for its implementation. The strategy is based on Finland's science and technology policy guidelines. For background information, the working group examined selective funding policy in 13 OECD countries and the funding and personnel structure of the existing 17 CoEs in Finland.

The general objective of Finnish science policy is to raise the level of objectives and quality in Finnish scientific research and to improve its international competitiveness, visibility and esteem. This will also contribute to creating the information base required for cultural, social and industrial development, and consequently to forming a solid base for a national innovation system, i.e. a framework influencing the development of new information and expertise and their exploitation. The objective of the CoE strategy is to lay the foundation for the emergence of creative and efficient research and training environments of an internationally high standard that can generate top international research. This strategy would be implemented through fixed-term CoE programmes.

In a small country like Finland, resources for attaining an international peak level exist only in certain fields or subjects. Thus, all good, creative research environments would not be covered by the CoE programme. High-quality units remaining outside the programme also need sound operating conditions.

The core of a creative research environment is a CoE, the size of which may vary. *The working group defines a CoE as follows: A CoE is a high-quality research and researcher training unit that has the potential to become an international leader in its field. A CoE consists of one or several research groups of a high international standard that have clear common goals. It can also include individual top researchers who do not belong to any group. The top units and top researchers working on the same research subject or problem can come together under a shared umbrella organization which can be called a cluster-type CoE. A cluster-type CoE can include other groups and researchers of internationally high quality in addition to researchers at the cutting edge.* A CoE may evolve into a cluster-type CoE over time as a result of the attraction of a good research environment. Interdisciplinary units are particularly valuable.

The research groups in a CoE form a coherent entity with its own identity. It has sufficient critical mass and density. In order to gain synergy benefits, it is usually advantageous to have the units working in sufficiently close physical proximity.

Future top researchers and research groups must be sought and actively supported as part of the policy of universities, research institutes, enterprises, financers, science policy bodies and result users. In addition to the best researchers, research fields and subjects of national strategic importance where internationally competitive research should be systematically generated in Finland should be identified. The generation of new top research can be accelerated by recruiting top foreign experts in the relevant field. The rise in the standard of Finnish scientific research and its improved international visibility will, in turn, increase Finland's potential for recruiting top researchers from other countries; this will further improve our scientific research and international visibility. Good research environments will become even better, generating a sort of upward spiral.

An excellent research environment will attract ambitious young researchers. On the other hand, some of the researchers in a unit will be recruited for other work. There will be competition for the best researchers. Units will train new top researchers who may leave the original unit and form creative new research environments and CoEs.

It is important for university departments and CoEs to cooperate closely to ensure interaction between research and training and recruitment of new researchers. A CoE can also be an entity outside a university. The researcher training function of this kind of a unit is indirect, realized through cooperation with a university.

The aim of the Academy of Finland is to provide CoEs contract-based resources for a given funding period to ensure that they do not need to apply to the Academy for any further funding during this period (except for research programmes, graduate school subsidies, post-doctoral research posts and research posts).

The CoE programme must be integrated into Finland's research, training and technology policy. The programme must be a functional and coherent entity, in which all the components of the research system play their own clear role, the whole being more than the sum of its parts. Ministries, universities, research institutes and enterprises should support basic resource provision for CoEs through their own measures. Financers should commit themselves to long-term support of CoEs as part of their selective funding policy based on competition.

The working group proposes that CoE funding provided by the Academy of

Finland be allocated mainly to units operating at universities. In cooperation with the relevant ministries, Tekes, business and industry and any other financers, the Academy could also support CoEs in other organizations. The working group further proposes that the Academy of Finland adopt responsibility for coordinating and updating the national CoE strategy and actively promote the creation of appropriate CoE networks.

Research CoEs would be selected through competition and international evaluation. The selection and evaluation criteria would be public. Appropriate evaluation models would be used for each field of science. The units representing the cutting edge would be granted CoE status, but other international-standard units would be identified, too. Individual units within an umbrella organization would have to apply for CoE status and their own funding independently, competing for it on an equal basis with the other applicants. Core facilities funding would be available to an organization containing units with CoE status and several other groups of proven high scientific quality and/or innovative groups in a key position for technology development. Thus, core facilities funding is a special subsidy designed to further improve an already outstanding research environment. This funding helps to keep good researchers and groups together and to attract new researchers and groups interested in vying for CoE status.

CoE policy should be dynamic but with a long-term perspective. To ensure its dynamic nature, CoEs should be nominated for a fixed period. Evaluations are an essential tool in quality control and in maintaining dynamics.

The working group proposes that CoEs be selected on the basis of international evaluations for a period of six years and that they be subject to interim evaluations after three years. If the interim evaluation is positive, the funding for the CoE would be continued and could be increased. If the evaluation is negative, the unit is given one year in which to correct the shortcomings identified. If it fails to do so, it would lose its CoE status, and its separate CoE funding would be discontinued in a controlled way. All units would be subjected to international evaluation after the six-year period. A CoE could be regranted CoE status immediately after one successful six-year period if it did well in competition with the new applicants. There would be no limitation on the number of times that CoE status can be extended. The same principles would apply to the separate core facilities funding granted for cluster-type CoEs.

The working group proposes that the 12 CoEs that started in 1995 be evaluated

in 1998 and the five CoEs that started in 1997 be evaluated in 1999. These evaluations would also be the final evaluations for the current CoEs. They could reapply for CoE status and funding in accordance with the programme following this strategy. The existing CoEs whose work has recently been subject to international evaluation would not be re-evaluated; the earlier results would be used.

CoE funding should be long-term and stable, or at least predictable in volume. *The working group proposes that CoE host ministries and organizations, financers and, in some cases, result users commit themselves, under agreements between the parties involved, to long-term, but fixed-term provision of basic resources for the units. This could include core facilities funding. This principle would also apply to the separate core facilities funding granted to cluster-type CoEs.*

In order to create a significant network of CoEs, the programme must be broad enough. *The working group proposes that new CoEs be nominated in 1998-2000 so as to result in a maximum of 25 CoEs in the year 2000.*

In comparing the applications of an existing CoE and a new applicant, attention should be paid to how the existing CoE has developed during its CoE period and how it has benefited from its extra funding. If the existing CoE and the new applicant come out equal in the evaluation, the new applicant should be selected if it is not possible to select both.

The working group proposes that CoE funding from universities not deriving from the Academy of Finland or other financers be agreed on in the result negotiations between the Ministry of Education and the universities, which take place in April. Before these negotiations, separate negotiations would be conducted on the overall resource provision, between at least the Ministry of Education, the Academy of Finland, the relevant university or universities and the head of the CoE in question. If necessary, other parties such as Tekes, a research unit closely connected to the CoE outside the university, or result users would be involved in the negotiations. The outcome of these negotiations would be taken into account in the result agreements.

For research institutes, funding negotiations would be conducted between the relevant host ministry, the research institute, outside financers and result users.

Sources

Academy of Finland. 1988. Outlook for a Science Policy 1988. Helsinki. 100 pages.

Academy of Finland. 1993. A Forward Look 1993.
Salpausselän kirjapaino. 48 pages.

Lounasmaa O. V. 1996. Huippuyksikköä ei perusteta vaan se syntyy. (A Centre of Excellence is not Founded but It Emerges). Memoranda of the Working Groups of the Ministry of Education 3:1996. Helsinki. Yliopistopaino. 158 pages and 7 tables.

Ministry of Education. 1980. Perustutkimustyöryhmän mietintö. (Report of the Basic Research Working Group). Helsinki. 54 pages.

Ministry of Education. 1984. Perustutkimustyöryhmä II:n muistio. (Report of the Basic Research Group II). Memoranda of the Working Groups of the Ministry of Education 1984:20. Helsinki. 61 pages.

Ministry of Education. 1989. Perustutkimustyöryhmä 89:n mietintö. (Report of the Basic Research Group 89). Committee report 1989:42. Helsinki. 118 pages.

Ministry of Education. 1996. Koulutuksen ja korkeakouluissa harjoitettavan tutkimuksen kehittämissuunnitelma vuosille 1995-2000. (Development Plan for Education and University Research for the Period 1995-2000). Decision in principle of the Council of State 21.12.1995. Education & Research 2000. Helsinki. 13 pages and 3 appendices.

Ministry of Education. 1997. Tutkijanuran kehittämistyöryhmän muistio. (Memorandum of the Working Group on Research Career). Memoranda of the Working Groups of the Ministry of Education 5:1997.(in Finnish) Helsinki. 28 pages.

Numminen, J. 1987. Yliopistokysymys. (University Issue). Helsinki. Otava.

Science and Technology Policy Council of Finland. 1993. Towards an Innovative Society. A Development Strategy for Finland. Helsinki. 94 pages.

Science and Technology Policy Council of Finland. 1996. A Knowledge-Based Society. Helsinki. 110 pages.

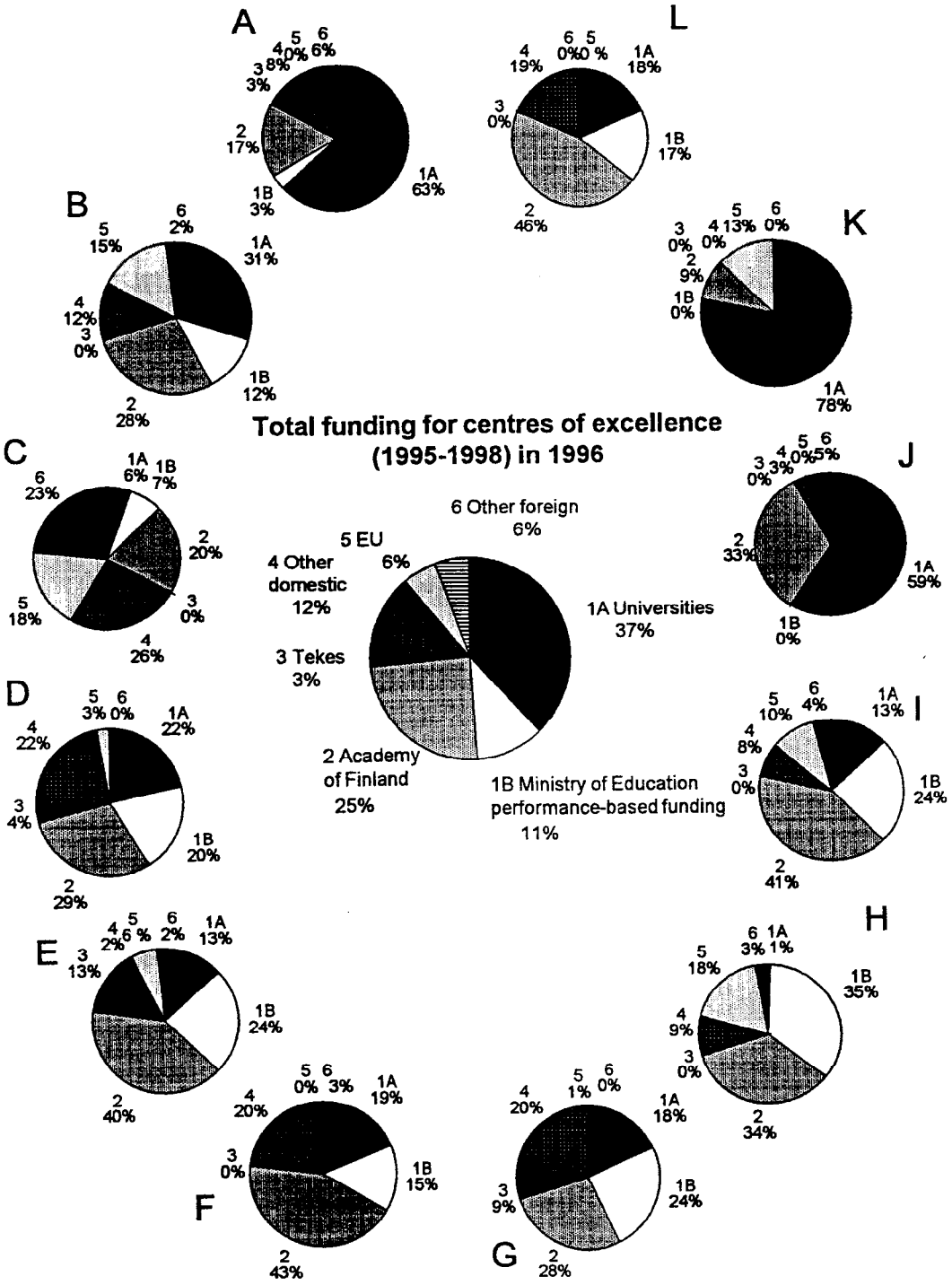
Suomen Akatemian ja opetusministeriön välinen tulossopimus vuodelle 1997-1998. (Result Agreement between the Academy of Finland and the Ministry of Education for 1997-1998). Ministry of Education.

Technology Policy Committee 1985. Opetusministeriön hallinnonalan teknologiapolitiikkaa koordinoivan työryhmän muistio. (Memorandum of the Working Group Coordinating Technology Policy in the Administrative Sector of the Ministry of Education).

Appendix 1.

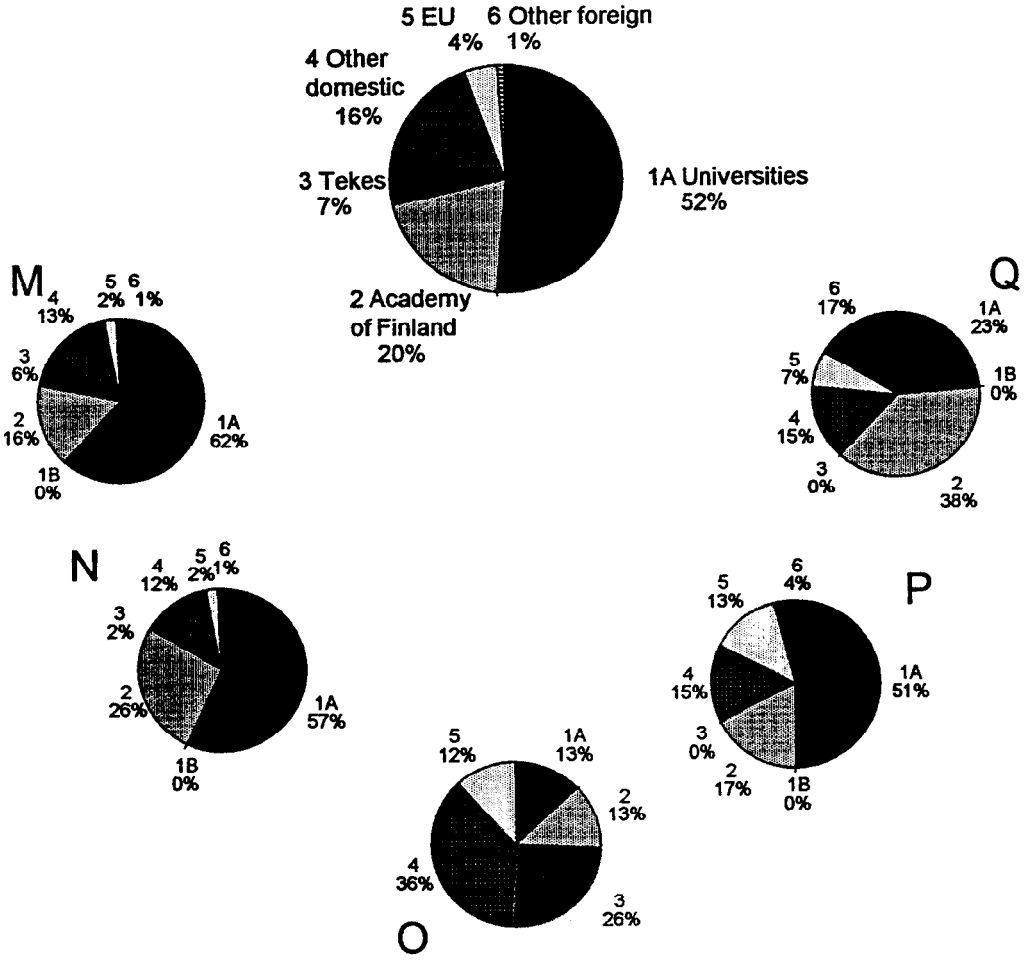
Centres of excellence in research nominated by the Ministry of Education

A. *Biocenter Oulu*, 1995-1998, University of Oulu
B. *Low Temperature Laboratory*, 1995-1998, Helsinki University of Technology
C. *Hereditary Disorders Research Unit*, 1995-1998, University of Helsinki
D. *Turku Centre for Computer Science*, 1995-1998, University of Turku, Åbo Akademi University, Turku School of Economics and Business Administration
E. *Laboratories of Compound Semiconductor Technology and Surface Science*, 1995-1998, Tampere University of Technology
F. *Research Team for Ecology and Animal Systematics*, 1995-1998, University of Turku
G. *Neural Networks Research Centre*, 1995-1998, Helsinki University of Technology
H: *Research Team Investigating Climatic Change, its Silvicultural and Economic Implication in Forestry*, 1995-1998, University of Joensuu
I. *Cognitive Brain Research Unit*, 1995-1998, University of Helsinki
J. *Research Team for Biblical Exegetics*, 1995-1998, University of Helsinki, Åbo Akademi University
K. *Multilingual Language Technology Unit*, 1995-1998, University of Helsinki
L. *Research Unit on Economic Structures and Growth*, 1995-1998, University of Helsinki
M. *BioCity-Turku*, 1997-1998, University of Turku, Åbo Akademi University
N. *Biocentrum Helsinki*, 1997-1998, University of Helsinki
O. *Digital Media Institute*, 1997-1998, Tampere University of Technology
P. *Department of Ecology and Systematics*, Division of Population Biology, 1997-1998, University of Helsinki
Q. *Human Development and its Risk Factors Programme*, 1997-1998, University of Jyväskylä


A
6 6%
5 0%
4 8%
3 3%
2 17%
1B 3%
1A 63%
L
6 0%
5 0%
4 19%
1A 18%
3 0%
1B 17%
2 46%
B
6 2%
5 15%
1A 31%
4 12%
3 0%
1B 12%
2 28%
K
5 13%
6 0%
4 0%
3 0%
2 9%
1B 0%
1A 78%
Total funding for centres of excellence (1995-1998) in 1996
C
1A 6%
1B 7%
6 23%
2 20%
5 18%
3 0%
4 26%
6 Other foreign 6%
5 EU 6%
4 Other domestic 12%
1A Universities 37%
3 Tekes 3%
2 Academy of Finland 25%
1B Ministry of Education performance-based funding 11%
J
5 6%
4 0%
3 3%
0%
2 33%
1A 59%
1B 0%
D
5 3%
6 0%
1A 22%
4 22%
3 4%
1B 20%
2 29%
I
6 4%
5 10%
1A 13%
4 8%
3 0%
1B 24%
2 41%
E
4 2%
5 6 %
6 2%
1A 13%
3 13%
1B 24%
2 40%
H
6 3%
1A 1%
5 18%
1B 35%
4 9%
3 0%
2 34%
F
5 6%
0% 3%
4 20%
1A 19%
3 0%
1B 15%
2 43%
G
5 1%
6 0%
4 20%
1A 18%
3 9%
1B 24%
2 28%

Appendix 3.

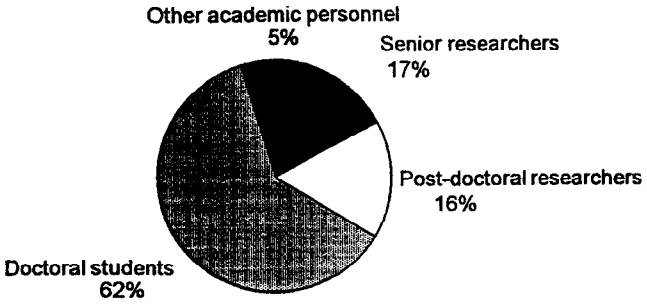
Total funding for centres of excellence (1997-1998) in 1996



Academic personnel at centres of excellence

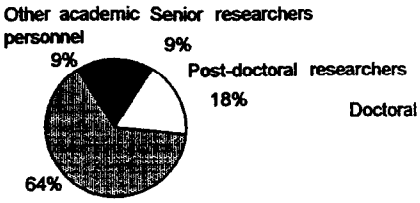
Appendix 4.

Overall

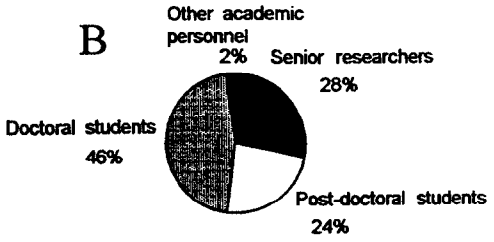


Individual centres of excellence

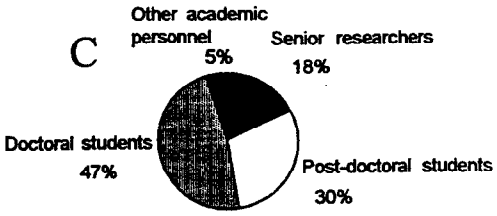
A



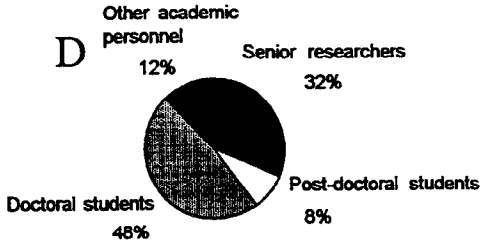
B



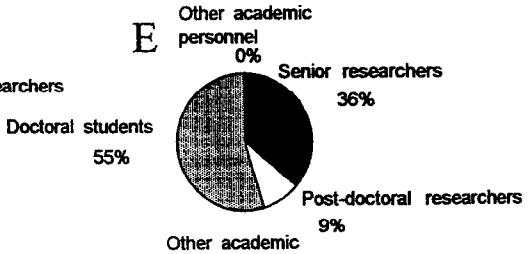
C



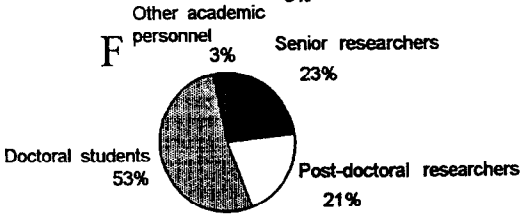
D



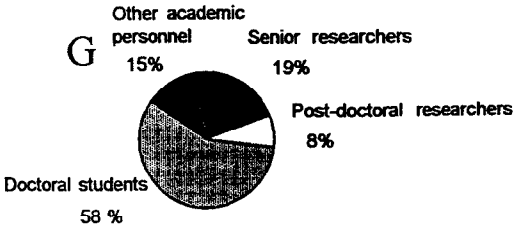
E



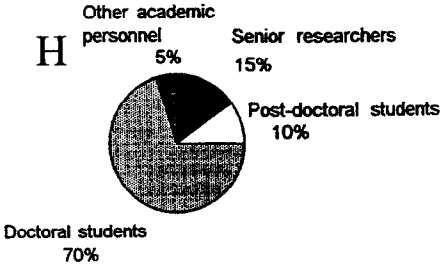
F



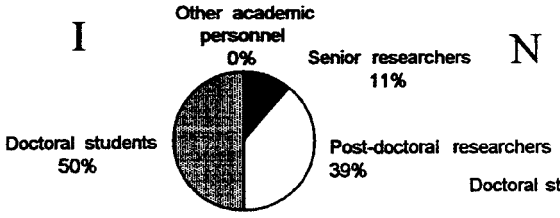
G



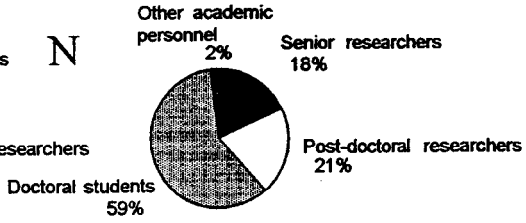
H



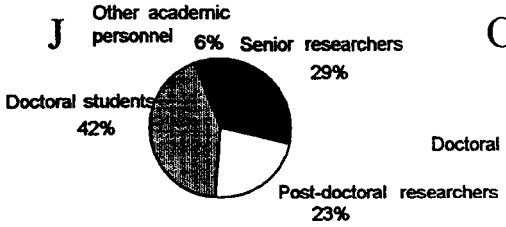
I


Other academic personnel 0%
Senior researchers 11%
Doctoral students 50%
Post-doctoral researchers 39%

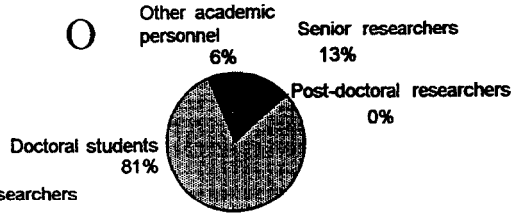
N


Other academic personnel 2%
Senior researchers 18%
Post-doctoral researchers 21%
Doctoral students 59%

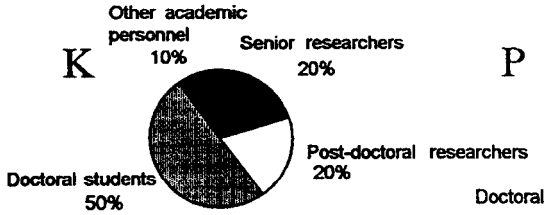
J


Other academic personnel 6%
Senior researchers 29%
Doctoral students 42%
Post-doctoral researchers 23%

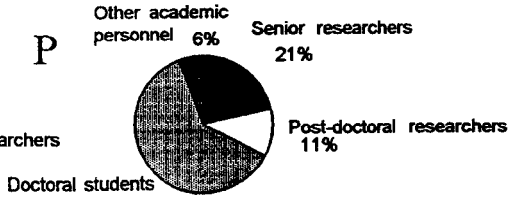
O


Other academic personnel 6%
Senior researchers 13%
Post-doctoral researchers 0%
Doctoral students 81%

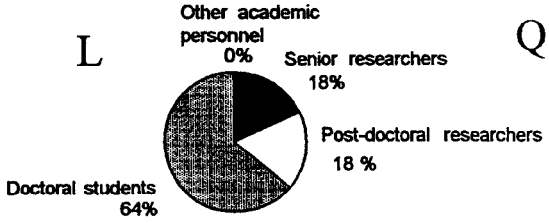
K


Other academic personnel 10%
Senior researchers 20%
Post-doctoral researchers 20%
Doctoral students 50%

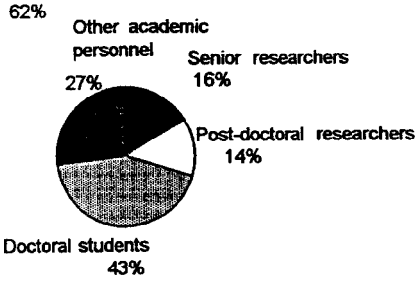
P


Other academic personnel 6%
Senior researchers 21%
Post-doctoral researchers 11%
Doctoral students 62%

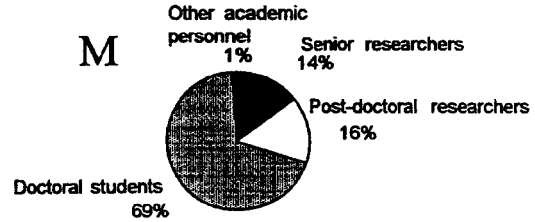
L


Other academic personnel 0%
Senior researchers 18%
Post-doctoral researchers 18 %
Doctoral students 64%

Q


Other academic personnel 27%
Senior researchers 16%
Post-doctoral researchers 14%
Doctoral students 43%

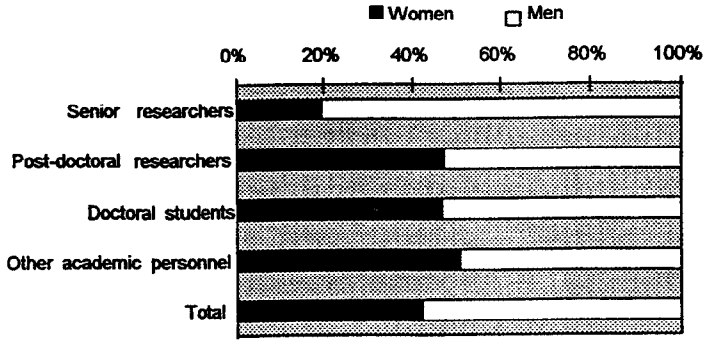
M


Other academic personnel 1%
Senior researchers 14%
Post-doctoral researchers 16%
Doctoral students 69%

Appendix 5.

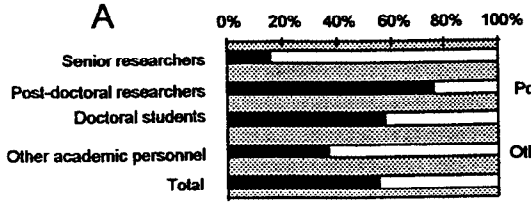
Academic personnel at centres of excellence

Overall

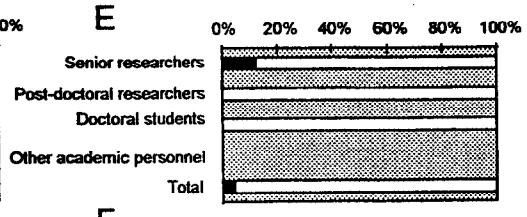


Individual centres of excellence

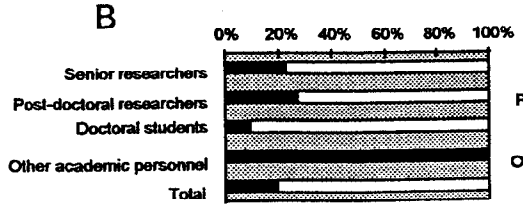
A



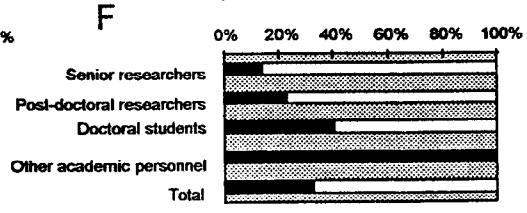
E



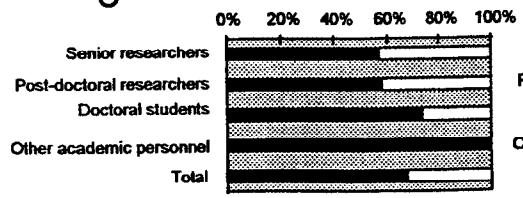
B



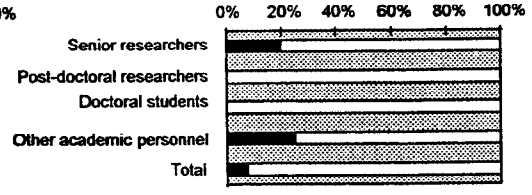
F



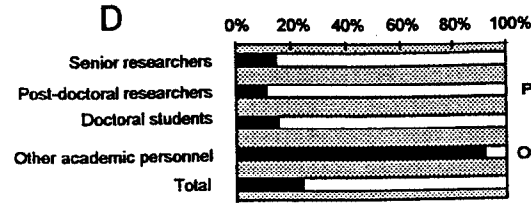
C



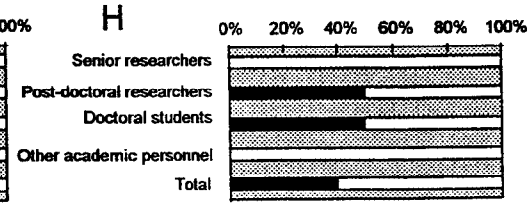
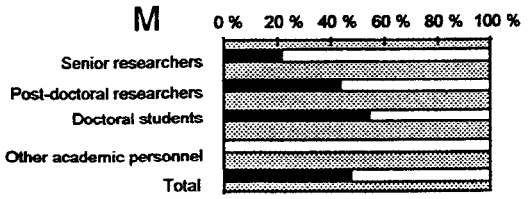
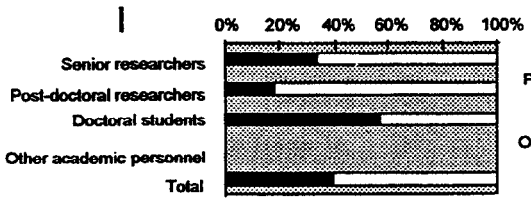
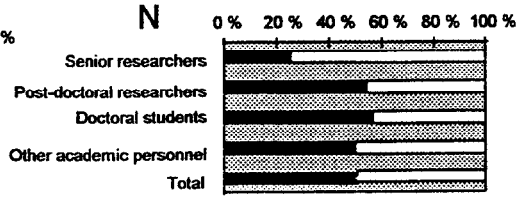
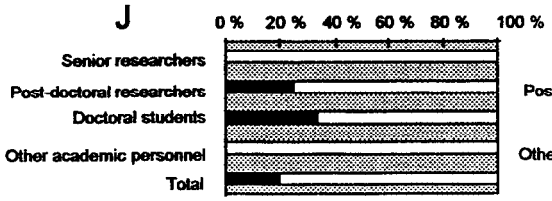
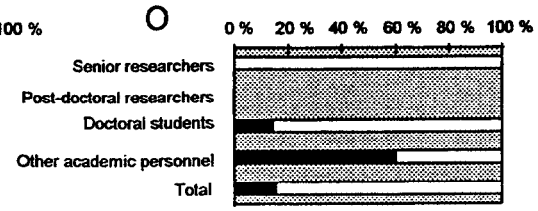
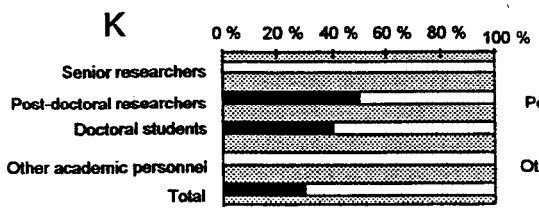
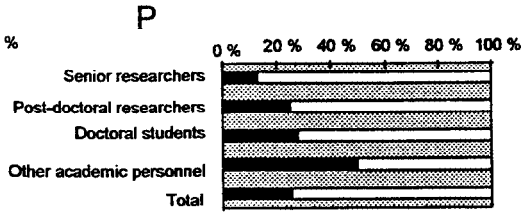
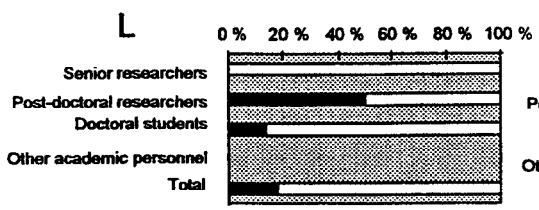
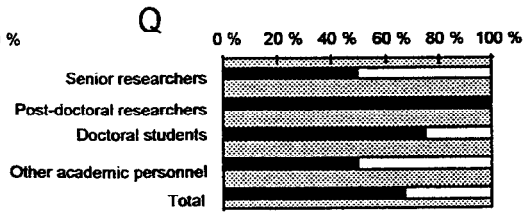
G



D



H



Individual centres of excellence