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ABSTRACT

This report is a written synthesis of opinions and observations on the role of emerging information technology in Finnish society. It surmises that such technology will benefit the educational system and increase research activity, thereby creating new channels of information access for the public, as long as national policymakers commit themselves to strategies for building education programs that are flexible enough to adapt to changing definitions of information literacy and technological expertise. These programs must not only train students and teachers but extend to citizens at large, providing opportunities for their continuing education. Finland needs to participate in the global electronic library by making more information available in digital format, guaranteeing education and research facilities high-performance computing capacity and reliable network connections, and continuing development of Internet links between schools, businesses, and their communities. Policy issues for the proposed open national information infrastructure are discussed, including the practicality of establishing regional networks and the need to examine questions of copyright, Internet security, and tariffs for online information. A glossary is included. (BEW)

EDUCATION, TRAINING and RESEARCH in the INFORMATION SOCIETY
A National Strategy

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A National Strategy

MINISTRY OF EDUCATION · HELSINKI 1995

TO THE MINISTRY OF EDUCATION

On 13 September 1994, the Ministry of Education set up an Expert Committee to prepare a strategy for education, training and research in the information society. The deadline set for this work was January 31 1995.
The assignment given to the committee was

1. to consider how the level of education and research can be raised by applying information technology and how thus to promote national competitiveness and employment;
2. to assess the needs and identify the means of giving citizens basic skills in using information and information technology and of promoting the availability of information;

   to estimate the need for high-performance computing capacity in scientific research;

   to appraise the prerequisites for the production and utilization of network-based multimedia in Finland;

   to assess how the information networks for education and research should be structured and tto define what their role is in the national information infrastructure;
3. to draw up the outlines of information and communication policy for education, training and research into the 21st century.

The Expert Committee met six times.
Chairman of the Expert Committee was **Markku Linna,** Director General, Ministry of Education, and Vice-Chairman was **Jukka Liedes,** Special Government Advisor, Ministry of Education.

Members of the Experts' Committee were
Maija Berndtson, Director, Helsinki City Library - Central Library for Public Libraries
Dr **Vilho Hirvi**, Director General, National Board of Education; from 1 January 1995 Secretary General, Ministry of Education
Professor **Fred Karlsson**, University of Helsinki
Dr **Juhani Kuusi**, Director General, Technology Development Centre TEKES

Ritva Launo, Head of Information Service, Oy Alko Ab
Dr **Olli Martikainen**, Vice-President (R&D), Telecom Finland Ltd.
Dr **Martti Mäenpää**, Industrial Counsellor, Ministry of Trade and Industry
Dr **Yrjö Neuvo**, Senior Vice President, R&D, Nokia Mobile Phones Ltd.
Risto Nevalainen, Managing Director, Information Technology Development Center (TIEKE)
Professor **Risto Nieminen**, Scientific Director, Center for Scientific Computing (CSC)

The Experts' Committee invited **Anu Lamberg,** Special Government Advisor, Ministry of Transport and Communications, to participate in its work.

When Vilho Hirvi was prevented from attending he was substituted by Senior Engineer **Ella Kiesi**; Juhani Kuusi by Dr **Pauli Heikkilä**, Director, Information Technology; and Yrjö Neuvo by Dr **Pekka Heinonen**, Scientist, Audio & Speech Technology (R&D).

Senior Advisor **Helena Savolainen**, Ministry of Education, and Project Manager **Anders Hagström**, Helsinki University of Technology, as well as Senior Advisor **Annu Jylhä-Pyykönen**, and Special Researcher **Markku Suvanen**, both from the Ministry of Education, acted as secretaries to the Committee. The Committee was further assisted by Special Planning Officer **Keijo Mäkelä** from the Ministry of Education.

The Expert Committee was assisted by the project group set up by the Ministry of Education to prepare a strategy for the application of information technology to education and by the Delegation for Information Provision.

Having completed its task on time, the Expert Committee respectfully submits this document proposing a strategy for education, training and research in the information society to the Ministry of Education.

Helsinki, 31 January 1995

Markku Linna

Maija Berndtson

Olli Martikainen

Pauli Heikkilä

Martti Mäenpää

Vilho Hirvi

Yrjö Neuvo

Fred Karlsson

Risto Nevalainen

Ritva Launo

Risto Nieminen

Jukka Liedes

Helena Savolainen

Anders Hagström

EDUCATION, TRAINING
and RESEARCH in the
INFORMATION SOCIETY.
A NATIONAL STRATEGY.

MINISTRY OF EDUCATION
P. O. BOX 293
FIN-00171 HELSINKI
FINLAND
TEL. +358 0 134 171
FAX +358 0 656 765
This document is available at the Internet URL address
http://www.mined.fi/infostrategy.html
gopher://gopher.funet.fi/11/FUNET/infostrategy

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Contents

SUMMARY

Education and research are crucial factors for the development of Finland as an information society[1]. For the citizens of such a society to prosper, they must possess a good general education, a wide variety of capabilities to act and solve problems, and the professional competences and skills required by the continuous changes inherent in a working life based on networks. High-quality education and the balanced development of both basic and applied research are prerequisites for successful innovation.

In the information society, knowledge is the key resource. Advances in technology which facilitate production and improve communication have an essential effect on the structure, content and methods of education and research.

On 13 September 1994, the Finnish Ministry of Education set up an Expert Committee to prepare a national strategy for education, training and research in the information society. This strategy document contains both the Expert Committee's opinions and proposals for methods of utilizing information technology to raise the levels of education and research, thus improving the opportunities available to citizens to obtain and use information. A more detailed action programme accompanies the strategy.

From one-off training to lifelong learning

Networking methods and the changing requirements for professional competence demand that the education system is both flexible and adaptable. Educational authorities and organizations must promote networking of the education system and create open learning environments to support the development from "once-and-for-all" training towards lifelong learning. Individual study opportunities must be

1 In Finnish, the word "tieto" stands for both "information" and "knowledge". Whereas this strategy addresses the more profound needs of the "knowledge society" rather than the "information society", the latter, more universally used term, is used in this document.

improved at all levels of education, and study methods, teaching material, as well as the required information services need to be developed.

To ensure that the adoption of new teaching methods and the use of information technology is effective, their development and application must become a part of the everyday activity of universities and educational establishments.

Basic information society skills for all

The task of comprehensive school is to give every girl and boy the multifaceted basic skills and competences required to find and manage information and to communicate. These are basic requirements in the information society and are essential for further education. All levels of the education system should support the continous updating of these skills.

Adults must have the opportunity to learn the basic skills of obtaining and managing information, communicating and understanding information technology. They must have the opportunity to improve these skills continuously.

Vocational skills in the information society

Vocational education should provide such skills for living in the information society that correspond to the requirements of a networked working life, one which is continuously changing and becoming increasingly international. Educational authorities and organizations should together ensure that the initial and continuing education that supports the information industry is sufficient, at the right level, and of the required quality. A national goal should be that professional competence in the different sectors of the information industry in Finland is counted among the best in the world.

The know-how of professionals in the information industries need to be extended to meet the diverse needs of changing job requirements. The introduction of information technology causes particular needs for change throughout initial and continuing education in the fields of library and information services.

Focus on the teachers

In implementing the principle of lifelong learning, teachers' professional skills are absolutely essential. Teachers need not only to know how to manage and communicate information in their own field, they must also be able to teach methods of obtaining and using information to enable learners to work independently. Teachers should have the ability to use the media necessary for open and flexible learning and be able to modify and develop material in ways which make it suitable for them to use. The prerequisites and content of basic and supplementary teacher training must be developed to respond to these requirements.

Development of information products and services

The availability and competitiveness of high-quality Finnish information products serving education and research must be guaranteed.

Using the new methods which technology makes available, information resources need to be made available for both national and international use. To ensure that Finnish information services function smoothly as a part of a global electronic library, the technological capacity and know-how required to achieve this need to be developed.

The production, distribution and utilization of information products published in digital form must be increased in a variety of sectors, especially in education and training, research and public administration, and in the libraries, information services and archives which serve these sectors. Support is needed for Finland's emerging multimedia production facilities and related businesses through commissioned work and subcontract work.

Research in the information society

Developments in information technology impact all fields of research, from basic to applied. Nowadays, in almost all cases, information technology is an essential part of the research process. The prerequisites of scientific computing, such as adequate high-performance computing capacity, workstation facilities and high-speed network connections are crucial factors in competitive research.

Finnish universities and scientific research aim to be at the international forefront in applying information technology. Participation in the information technology programmes of the European Union should be active. Finnish education and research should be among the first to attain the goals set by the EU for applying information technology and telecommunications.

Developments toward the information society, the application of information technology and increased networking have far-reaching economic, social and cultural impact that requires further research. The focus of pedagogical research should be on the fields of media and learning, and on the interaction between humans and machines.

Education and research networks

The national information infrastructure, the Finnish Information Highway, should be assembled as a multi-layer, seamless system. The information network for education, training and research will be a part of a global open network. The Internet and emerging standards for broadband networks and services should provide the foundation for the education and research information network in Finland.

Schools and educational establishments must be integrated with their local environment. Links between schools and educational establishments at different levels and operating in different fields must be increased, and links with community and business life improved. The information networks should be structured so that they support these developments. The most effective technical way of achieving this is based on regional networking and cooperation.

Information network services are to be made available to all schools and libraries. An adequate level of service should be guaranteed to all educational establishments. Both scientific and public libraries must be guaranteed not only adequate facilities, but also the telecommunications links and expertise required to utilize these effectively. Special attention should be paid to the development of public library information network services and to the development of libraries as nodes in the open information network.

General framework

When implementing this strategy, many legislative and other special prerequisites must be taken into account. These include, among others, questions concerning copyright, standardization and privacy protection, as well as issues of openness, data security and the price that is charged for information.

In the information systems of education and research, the goals are openness and flexibility while at the same time making sure that personal integrity is respected in data processing which can affect individual rights. Openness and transparency are the aims for providing information on the work of public authorities which affects the lives of citizens.

In fixing the tariffs for publicly produced information network services, the nature of the service should be taken into account. The aim is to promote the use of information and services. The areas in which information network services are provided free of charge in accordance with the principle of public service should be defined. Areas where flexibility of pricing is possible should also be identified, as well as those sectors where the price of the service should reflect the actual cost of providing it .

INTRODUCTION

1. INTRODUCTION

In most industrialized countries, extensive programmes are being carried out

to accelerate the development and use of information technology and its applications in the different layers and functions of society. In many countries, high-speed telecommunications and the construction of information infrastructures have been made national priorities. Information technology is not only expected to raise the level of research and technology, it is also expected to clear the way for profound improvements in education, health care, communications, telework, and administration. The controlled, dynamic introduction and development of information technology are generally regarded as an essential national strategy.

In Finland, extensive preparatory work for the information society is carried out by different sectors of government. A working group set up by the Ministry of Finance has drawn up a national information technology strategy for developing the information society. The Ministry of Transport and Communications has outlined the directions for the national development of information networks during 1995–1998. Many technology projects essential for the development of the information society have been initiated by the Ministry of Trade and Industry. The most important of these is the multimedia programme of the Technology Development Centre TEKES.

On 18 January 1995, the Council of State decided on the principles for the development of Finland as an information society. In this decision, the Government set out the most essential development goals, outlined the most important directions for action, and gave the different ministries the task of preparing action plans by the beginning of March 1995 for the achievement of these goals.

According to this Government decision in principle, the Ministry of Education is responsible for achieving the following goals in its own sector:

Education. *All levels of education and training from comprehensive school upwards must teach the necessary basic skills in information technology (IT), management of information, and communication. Teacher training is a key development area, especially in the adoption of new competences and skills.*

Training of professionals for the information technology and information industries will be developed to reflect the diversity of changing professional roles. Students in vocational and higher education should learn information technology, information management, and communication skills that meet the needs of a fast-changing and increasingly networked working life.

Education and training in the information sectors at universities and in vocational education will be increased. Continuing professional education and training will be developed to stay abreast of technological advances and to meet the needs of the information industry.

Adults will be given opportunities to learn basic information technology skills by expanding the range of training available and by improving library services. Exclusion from the labour market must not occur because of a lack of these basic skills.

The whole education system will be brought within the reach of information network services, ensuring that educational establishments can use these services. Open and distance learning will be promoted at all levels of education and training.

Research and development (R&D). *Research that reinforces the industrial and service base in the information sector and safeguards product development will be increased, both through major spearhead projects which develop leading-edge technology, and through networking projects which increase the know-how and export potential of small and medium-sized companies.*

Government agencies, business and industry must work together to guarantee adequate, high-level development work on information and communication technology and its applications, as well as the resources required.

Finland will participate actively in international research and technology cooperation.

Continuous development of the national and international telecommunications links needed for research and development as well as the availability of sufficient computing capacity will be ensured.

Research on the economic, social and cultural prerequisites for and impact of the information society will be supported.

Research on the reorganization of work through the application of information and telecommunications technology will be accelerated. Research results will be utilized in work organization development programmes for businesses and public administration.

National information resources. *Use of national information resources by new technological means will be promoted, as will their further processing into products of the information industry.*

Basic registers, statistics and other information resources will be developed as a foundation for decision-making and to ensure a smoothly functioning democracy. Use of these resources by new methods will be encouraged.

The division of responsibilities in national information provision, cost allocation and pricing principles of information will be studied, and the information services that will be available to all free of charge will be defined.

Public libraries will be supported as nodes in the open information network, and information network services will be introduced throughout the library system as soon as possible.

The possibilities will be guaranteed for scientific libraries together to acquire and make available the information and material that is needed in Finland to achieve the aims of education and research policy.

Culture. *The information society will have a profound influence on the everyday life of people, on their interaction and communication, as well as on their cultural environment and the supply of cultural services. In terms of global information networks, Finland is a small linguistic and cultural area. The supply of products of Finnish culture – literature, music, drama, art, design, architecture, media and audiovisual culture – on the information superhighways are to be guaranteed.*

The creation of Finnish information products and related applications will be ensured. The establishment and development of Finnish multimedia enterprises will be furthered, and the production, distribution and use of digital information products will be promoted.

In addition to the above, the decision in principle by the Council of State deals, among others, with issues related to legislation, international cooperation and those having a bearing on the sector which falls under the jurisdiction of the Ministry of Education.

The Council of State charged the Prime Minister's Office and the ministries within their respective sectors to prepare detailed action plans for the development of Finland as an information society by the beginning of March 1995.

The present strategy document deals with the role and task of education, training and research in the information society. In accordance with the task assigned to the Expert Committee, this document contains proposals for applying information technology to meet the needs of education, training and research and proposals for improving the possibilities available to citizens to obtain and use information.

The Ministry of Education has also initiated a strategy project in the field of cultural policy. In this project, the outlines of cultural policy in the information society will be laid out and the effects of

digital media on Finnish national culture investigated. This work is scheduled to be completed by the end of 1995.

The strategy for education, training and research in the information society is related to many other national strategies, such as

- A Finland of Knowledge and Know-how (Science and Technology Policy Council)
- National Education Strategy (Ministry of Education)
- Development Plan for Higher Education and University Research for 1991–1996 (Government Resolution)
- The employment committee of the President of Republic (the so-called Pekkanen Committee)
- Industrial Strategy (Ministry of Trade and Industry)
- Information Provision Strategy (Delegation for Information Provision)
- The strategies of professional organizations, among others a resolution by the Finnish information sectors

BACKGROUND

2. BACKGROUND

2.1 A networked information society

The effects of information technology are revolutionizing almost every sector of society. Few areas of human activity remain untouched, the results are felt most strongly and immediately in the economy, in business and industry, as well as in education, training and research.

As the information society develops, information and the know-how based on it will become more and more decisive as factors of production. Networking based on the application of information and communications technology, especially telecommunications, is a major trend. As well as creating new ways of communicating and working, information technology has made possible new methods of producing and distributing products and services.

With the help of information networks, it is possible to transmit different types of service to different audiences via a single channel. This also makes possible the improved provision of education and other services to small target groups and special audiences. Through increased cooperation and by exploiting the potential of technology, regional equality can be enhanced and the opportunities for individuals to acquire information can be improved. More effective use of resources will be possible.

Networking has further accelerated internationalization in all fields. The keys to success in international competition are know-how, ingenuity and innovation based on high-quality education, training and research. Sound knowledge and adequate know-how lead to increased economic activity and more jobs.

A typical feature of the industrial society was that as a production factor, human labour was increasingly replaced by capital, machines and equipment. In the information society, electronic communication and information networks handle huge amounts of information which is continuously being updated. In this flood of information citizens need to be independent, critical and analytical in their acquisition, use and production of information. Increasingly, the

problem is to locate relevant material in the mass of data available.

In future communities, members of many cultures, nations and language groups will live and work. With the help of information technology, boundaries between languages, cultures, races and sexes can be crossed in real time. New kinds of social communities will emerge. Citizens living in a networked, increasingly technical, multicultural environment need multi-faceted communications skills.

2.2 Foreign programmes

In many countries action programmes are under way and measures are being taken to promote the use of information technology and the development of information networks. In several countries these issues have been dealt with at the highest political level.

In the **United States,** President Clinton's administration has launched its National Information Infrastructure (NII) initiative. The initiative covers the areas of telecommunications, information policy and applications. A special programme, High- Performance Computing and Communications (HPCC), funds research and development to develop more powerful computers, faster communication networks and more sophisticated software. The US initiatives have attracted great national and international attention, in particular with the introduction of the "information superhighway" concept.

In **Japan**, a programme for the development of the information society, "Program for Advanced Information Infrastructure" was published in 1994. Education and research are two priorities in this programme. Networking of schools and development of teaching materials as well as the improvement of teaching skills are seen as important issues. In the field of research, the development of massively parallel computers and "super-high-speed" networks serving research as well as the development of "ultra-high-performance" computing are priorities.

In December 1993, the Commission of the **European Union** (EU) published a White *Paper Growth, Competitiveness, Employment – The challenges and ways forward into the 21st Century.* It served as the basis for a high-level group chaired by Mr Bangemann, the then Vice-President of the Commission, which produced a report on the development of the information society, *Europe and the Global Information Society – Recommendations to the European Council,* for the meeting of the European Council in Corfu in June 1994. Following the Corfu meeting, the Commission developed an action programme for the development of the information society, *Europe's Way to the Information Society. An Action Plan,* which is now being implemented.

In its educational policy, the European Union considers the development of human resources throughout working life to be

crucial. The objective is to give individuals the ability to develop their own skills and thus the capability to work in an advanced, complex technical environment where the extensive use of information technology is typical.

In the EU's IV Framework Programme for Research and Technological Development (1994–1998), there are several programmes aimed at the development of information and communications technology as well as applications for the information society. From the point of view of Finland's national strategy for education, training and research in the information society, the most important of these programmes are the Telematics Applications Programme (TAP) – especially its Area B (Telematics for Knowledge); the Information Technology Programme (ESPRIT 4) – especially its area for High Performance Computing and Networking (HPCN); and the Advanced Communications Technologies and Services programme (ACTS).

Education and research are also highlighted in strategy documents published in **Sweden** (*Wings to Human Ability*) and in **Denmark** (*Info-samfundet år 2000*) in 1994.

2.3 The starting point in Finland

Finland has a good base for development as an information society. The network of educational establishments is dense and there is an extensive supply of training opportunities after comprehensive school. About 60 percent of each age group go on to upper secondary school. Over 90 percent of each age group, after completing comprehensive school or upper secondary school, go on to attend a vocational training institution, polytechnic or university. The supply of adult education has increased rapidly since the 1980s.

Information is readily available to people throughout Finland. The nationwide public library system has been designed according to a networked model based on cooperation and division of responsibilities. Every Finnish municipality maintains a public library. In total, these public libraries have over 2,000 service units providing services which are available to all citizens. About 80 percent of public libraries have computerized library systems, and this percentage continues to increase. Currently, libraries use over ten different computer systems.

There are some 800 scientific libraries in Finland and university libraries represent a central part of this network. Unlike the situation in many other countries, scientific libraries in Finland are public services and open to everyone. The joint data network of university libraries is the backbone of the computer systems in scientific

libraries. The uniform structure of this system makes it unique in the world.

In some sectors, the information technology and telecommunications industry in Finland is a world leader, and the development targets set by the EU have already been reached. The quality of Finnish information technology has been recognized in OECD reports, among others. The level of information technology employed in society and business life is relatively high, this is also true in some sectors of education and training.

Major improvements in information technology and telecommunications have also taken place in the science and research sectors, especially during the last five years.

Scientific computing and symbolic data processing have both solid traditions and established positions in Finland. Internationally, computational science and research are at the leading edge, and the results obtained are transferred to companies for use in their product development. Finnish research leads the world in some sectors of the data processing field.

Progress in very exacting areas such as supercomputer projects and information network development has been made possible by effective national cooperation and division of responsibilities between the universities. The number of Internet connections per capita in Finland is one of the highest in the world.

In the 1980s, substantial hardware investments were made in schools providing general education and in vocational institutes. At the same time, continuing education for teachers was organized on a large scale. In recent years, as a whole, the school system has not kept pace with the rest of society in terms of information technology, even though a number of advanced regional communication network projects are in progress and several development projects in open and distance teaching and multimedia materials are under way.

The use of information technology in education and training has also been held back by a lack of applications. Finland is a small market and language area, and hence production of electronic information products has got off to a slow start. This is clearly seen in the production of educational software. The weak economic situation has also reduced demand for such software.

Currently, the level of information technology equipment available differs from school to school, and some of it is obsolete. The situation is worst in primary education. Even where adequate equipment exists, it is often not fully utilized. Teachers have differing abilities in using information technology. The level of utilization of telecommunication services and information networks is still low in Finnish schools, mainly due to the slow development in equipment resources. Cooperation between educational institutions in using teaching resources has been rare. All these factors have slowed down the development of an organizational culture that utilizes information technology.

The CHANGING CONTENT and FORM of EDUCATION and TRAINING

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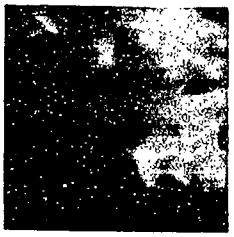


In its development programme for higher education and university research, the Council of State has defined the main goals for Finland's education and research policy:

- maintaining a high, broad level of education
- promoting the intellectual growth of the nation
- encouraging initiative and enterprise
- improving the quality of education and research
- strengthening and broadening the industrial base
- nourishing the innovation system
- integrating work, education and changing life situations, and
- developing professional competence and improving employment

The foundations of the information society are the cultural education and competence achieved through high-quality education and research. The changing structures of society and economic developments create pressure to improve the impact and effectiveness of education, and to increase the level of interaction between the public and private sectors. On the one hand the goal is a broad education and a critical attitude towards knowledge, on the other, thorough professional competence.

In a rapidly changing society, the education system is faced by continuous challenges. Decisions affecting the education system must be flexible, must react quickly to changing circumstances, and, above all, must be able to anticipate change. The education system should also try to bring about desired change.

Changing requirements in working life mean that a person's life is no longer divided into the two distinct phases of a period of education and training in youth, followed by a long period of working life. Education and training throughout working life becomes increasingly

necessary, and in more and more cases people must be retrained for a new, different profession. Boundaries between the professions are becoming blurred and working methods are changing. The importance of universal working and problem-solving capabilities are growing.

The change from once-and-for-all education to lifelong learning can be supported by promoting cooperation that increases the level of networking in the education system. It can also be encouraged by improving those forms of education and training which support independent learning, such as open and distance learning.

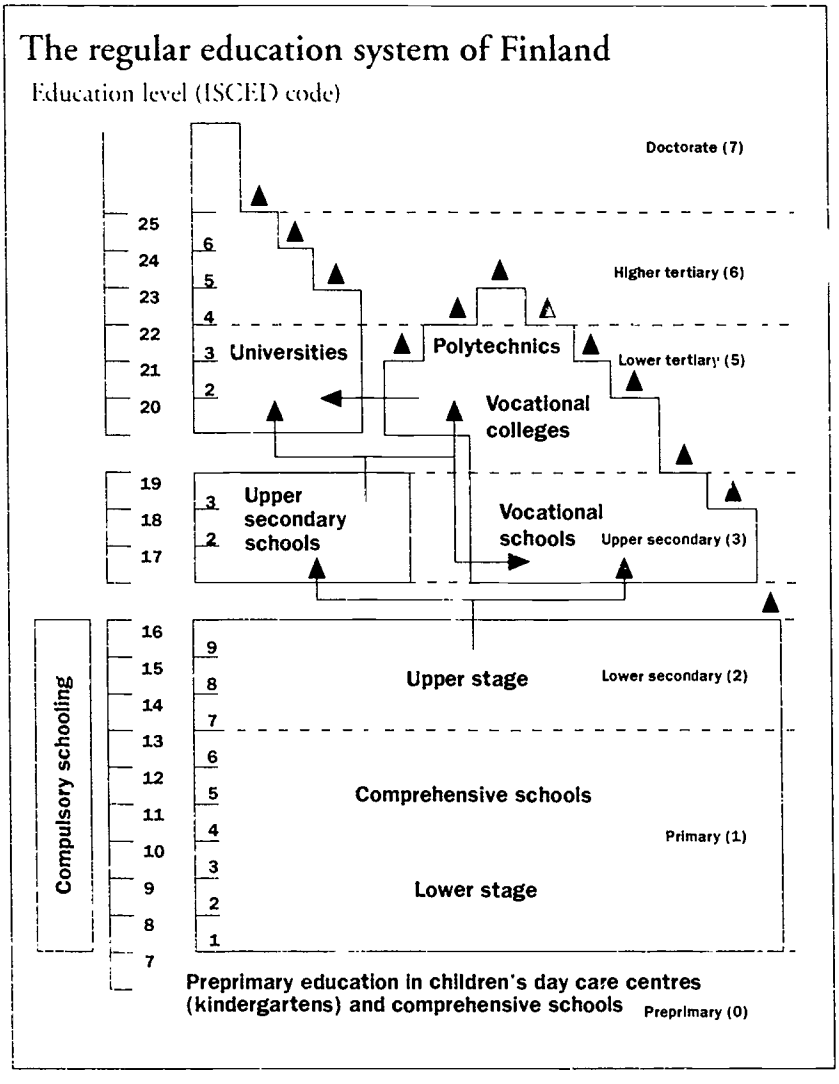
3.1 Curricula are changing at all levels of education

Curricula at all levels of education in Finland, from preprimary education to university postgraduate programmes, are in a process of change.

The National Board of Education is carrying out an extensive reform of curricula in general and vocational education. Decision making concerning the organization and content of general and vocational education has been transferred to those who maintain the schools: the municipalities and federations of municipalities. At national level, general criteria for curricula provide the framework for steering education.

New national criteria for curricula for comprehensive schools and upper secondary schools were approved in January 1994. The national criteria for curricula for upper secondary vocational education were approved at the beginning of 1995. The criteria for curricula for higher level and institute level are expected to be approved by 1996. At present, national criteria are under preparation for the vocational diploma and special vocational diploma in adult education, as provided for in the law concerning vocational diplomas.

Requirements of technical basic education, including information technology skills, are incorporated in the curriculum criteria for basic general education. The principles for how these skills should be taught vary from one curriculum to another.



Comprehensive schools and upper secondary schools

In the national criteria for curricula for comprehensive schools, pupils are expected to learn how to utilize information technology applications. The study goal is that the pupil, irrespective of previous experience, learns how to use computers and the most common software applications and is also able to make a realistic assessment of the possibilities of utilizing information technology in different subjects.

In the criteria for curricula for comprehensive schools, information technology has not been allocated a separate number of lessons; it is regarded as an integrated theme. Study goals for information technology have been set, but since it is an integrated theme, teaching takes place either in conjunction with other subjects or, in the upper levels of comprehensive schools, as an optional subject, depending on the local curriculum.

In the curriculum for upper secondary schools, information technology is not specified as a subject, course, or separate integrated

theme, and no specific goals are set for the skills to be acquired. However, upper secondary school studies include optional, applied courses which can be taken either at the student's own school or at another educational establishment. These optional courses may include studies in information technology. In both comprehensive school and upper secondary school, information technology is used as a tool when studying other subjects.

Vocational education

According to the curriculum criteria for vocational education, information technology must be taken into account from a variety of points of view in all studies, both as a subject in its own right and as a tool for learning other subjects. In general studies, from which a student may choose courses worth between one and four credits (study weeks), information technology is an optional subject available to all students. Information technology is also an optional subject in adult vocational education.

General studies are intended only for those students who enter vocational education from comprehensive school. No general studies are separately defined for students entering from upper secondary schools. The goals of the general studies are included in the national criteria for curricula in every field and degree. This means that the emphasis on the teaching of information technology varies according to the field and the degree. The general goal is to teach the students to use the hardware, software and information resources available in their own field and for them to gain an understanding of the basic functions of computers.

At institute and higher vocational level, students may choose from one to five credits in information technology studies. Drafting of the criteria for curricula in this sector is only just beginning, so the appropriate study goals have not yet been defined.

Universities

The universities in Finland are autonomous and they are responsible for developing their own curricula. Recently initiated evaluations of university activities have clearly encouraged the universities to pursue this work. The evaluations have been the basis for the development of degrees and degree programmes. A new two-level basic degree system has already been adopted in six academic fields. During 1995, the intention is to have new degree statutes in force in six or seven additional disciplines. Once this has been achieved, 90 percent of new students will be studying in accordance with the new two-level system. The reform of diplomas concerns both structure and content. The goals are to make study more effective and to improve the quality of research work.

In the performance agreements made between the universities and the Ministry of Education, it has already been decided that universities carry out regular evaluations of their teaching and that students take part in these evaluations.

3.2 Evaluation of education and training

Management by results and evaluations are the essential tools for steering the education system. In order to reach the goals of educational policy, it is important to have an adequate information base as well as the telecommunications links necessary to collect and transmit information. As working methods change with the development of the information society, information and communication technology also need to be included in the evaluation criteria.

General and vocational education

The National Board of Education has started a project for the evaluation of general and vocational education. This project creates an evaluation strategy, develops evaluation methods and standards, produces evaluation publications, consultation and training services, and carries out tailor-made evaluations.

In 1994, the outlines for evaluation were drawn and the areas of focus for evaluation in the next few years were defined. Among these areas are self-evaluation by different kinds of schools and educational establishments, the functioning of the education system and network, national curricula, and educational experiments. In an extensive evaluation of the upper secondary school, the teaching of mathematics and natural sciences was among the areas of focus.

In 1995, the focus of evaluation will be on the accessibility and equality of education as well as on content options. One of the objects of evaluation will be the supply of optional subjects and integrated themes taught in connection with other subjects at the upper stage of comprehensive school and upper secondary school.

Universities

The evaluation of universities has started with thorough evaluations of individual scientific disciplines. This evaluation process is being continued by the Academy of Finland. The Universities of Oulu and Jyväskylä have already undergone a general evaluation. Currently, the Universities of Lapland and Vaasa and the Sibelius Academy are under evaluation. In addition to these institutions, the University of Industrial Arts is included in an evaluation being carried out by the European Union. At the University of Tampere, evaluation is being specially focused on the quality of instruction. Some universities have created their own evaluation systems.

The most extensive evaluations by scientific discipline have been carried out in the humanities, the natural sciences and pedagogy. The overall evaluation of all education in business and commerce following comprehensive school can also be included in this category.

The most extensive evaluation of the academic system in Finland is the overall evaluation of national education policy carried out by

the OECD. This evaluation was completed in November 1994. The non-university sector of higher education (polytechnics) was also included in this evaluation.

In all these evaluations, the quality of teaching has been singled out as one of the areas in the most urgent need of development.

3.3 New ways of learning and teaching

Modern concepts of learning emphasize the students' responsibility for their own learning and their active role in seeking and using information. The role of the teacher changes from being a distributor of book learning into being a tutor guiding the students. The school environment becomes a centre for learning and activity. In libraries and information services, telecommunication and digital information products are increasingly found alongside traditional services as information sources of equal value.

The development of information technology has facilitated new types of teaching arrangements and a more flexible division of responsibilities between universities and educational establishments. Education units can agree on joint distance teaching which is able to reach students throughout the country. This makes possible an increase in educational opportunities while reducing costs resulting from the duplication of teaching. Locally, the focus can be on tutoring support for students and on reinforcement of the learning process. For working people, the possibility of studying without time and place constraints is important.

In Finland, several small-scale experiments on networked training arrangements have already been carried out or are currently under way. Several of these projects have been executed within the framework of the EU telematics programme. The large-scale introduction of new learning methods demands that the development and application of these methods and the technology required to support them become part of the day-to-day activity of universities and educational establishments. Universities and educational establishments are responsible for developing their own teaching methods.

At all levels of education, possibilities for individual study should be increased. Teaching material and information services should be developed, the quantity of open and distance teaching should be increased. Networking of the education system should be promoted and open learning environments created to support the move from "once-and-for-all" education to lifelong learning.

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1 Open and distance learning should be recognized as being equal to other forms of study. The criteria for obtaining financial support for studying and training need to be changed so that the form of study chosen or the study arrangements which are made do not prevent the receipt of support.

2 Open and distance teaching should be recognized as being equal to traditional teaching methods. The regulation and contracts concerning teachers' wages and working hours need to be changed. The compensation criteria for planning, carrying out and tutoring open and distance teaching must be clarified and adjusted to the job descriptions and the amount of work required for open and distance teaching.

3 Both for experts in the field and for all teachers within the education system, specialist education for open and distance teaching should be increased.

4 The universities need to prepare plans for restructuring their teaching with estimates of the need for training in their faculties and departments caused by new teaching arrangements. In particular, teacher training departments have a key role to play in developing pedagogy as regards the application of information technology.

5 The tasks of university service institutions, such as computing centres and libraries, need to be planned and adjusted to support as effectively as possible new forms of teaching, study and research which are based on utilizing information technology.

6 The development of teaching, the use of modern teaching methods and materials, and the application of information technology are quality aims of teaching which should be specified in performance agreements between the Ministry of Education and the universities, and between the Ministry of Education and the National Board of Education.

7 The Ministry of Education should support research and development projects which apply information technology to education and training. Experimental results should be collected and the introduction of good solutions and applications be promoted.

4. INFORMATION SOCIETY SKILLS for ALL

4.1 Basic skills while at school

It is characteristic of the information society that information is available through many different media. The digitalization of communication channels that is currently in progress is leading to a fusion of the different media: publishing, press, cinema, radio, television and information technology are merging. A new media culture is about to emerge in which people need, in addition to the traditional reading and writing abilities, a new type of ability, "cultural literacy" – the ability to communicate, handle, understand and interpret information. As society becomes increasingly technical, the importance of a basic understanding of mathematics and the natural sciences increases.

It is the task of general education to provide every girl and boy with the versatile basic skills in acquiring, managing and communicating information which are necessary in the information society and essential for successful further study.

8 The comprehensive school must ensure that every pupil learns how to acquire information independently from different sources, how to manage and process information, and how to use information in an analytical and critical manner.

9 The task of the comprehensive school is to provide every pupil with basic skills in using information technology. Girls in particular need to be encouraged to use information technology.

10 The use of information technology as a learning tool in initial general and vocational education should be increased as specified in the new national criteria for curricula. Information technology should not be taught as a separate subject, it should be a factor that is integrated into the teaching of other subjects.

11 The municipalities need to ensure that the schools have the equipment and network facilities necessary for teaching the basic information technology skills. Continuing education should be increased to guarantee that teachers and necessary support staff possess an adequate level of competence.

12 In school work, the characteristics and possibilities provided by different media should be studied. The skills required to communicate in different interactive situations should be practised. Special attention needs to be paid to the acquisition of skills in both the pupil's mother tongue and in foreign languages. By increasing cooperation and the joint teaching of languages and other subjects, the possibilities available for learning international interaction and communication should be improved.

13 Including mathematics as an obligatory subject in the matriculation examination should be considered.

14 The educational authorities should monitor and evaluate the implementation of the new criteria for curricula from the point of view of how well the criteria correspond to the requirements of the information society. The authorities should also determine how well the necessary basic information society skills are taught in schools.

15 Vocational institutes and universities need to ensure that the basic skills needed by students in the information society develop as technology changes.

4.2 Adult skills in the information society

In addition to the public education leading to a degree or diploma and the staff training organized and financed by employers, there are many independent training opportunities for adults which people attend mostly in their leisure time and at their own expense. These opportunities are provided, for example, by civic institutes, by open course centres run by a variety of organizations, and as open university courses. In addition to these opportunities, the labour administration finances retraining schemes for the unemployed. These training channels offer good opportunities for teaching information technology skills to adults.

The opportunities for adults to learn the basic skills of acquiring and managing information, communicating, and using information technology, and to subsequently upgrade these skills, must be improved.

16 The supply of training opportunities related to information society skills and especially the teaching of information technology need to be increased in adult education and independent training establishments. It must be possible to use the premises and equipment of schools and other educational establishments for offering these learning opportunities to adults.

17 The use of open and flexible learning methods and teaching materials should be increased in adult education establishments, civic and workers' institutes, as well as in open university education. Students should be shown how to benefit from the use of information technology as a learning tool.

18 The ability of libraries and information services to serve the public in acquiring information should be improved. The libraries should be developed as nodes in the open information network, and their role in providing user support for information networks and electronic information products should be strengthened.

19 Through nationwide communications channels, such as The Finnish Broadcasting Company, knowledge of the applications and possibilities of information technology should be disseminated, encouraging people to learn information technology skills.

20 In cooperation with the broadcasting and cable television companies, the Ministry of Education should assess the possibilities of making training accessible to homes via radio and television.

4.3 Focus on the teachers

All teachers need new knowledge, skills and competences in order to be able to use information technology as a tool in their teaching work. They must also become familiar with applications in their respective fields. Teachers of all subjects need to know how to utilize information technology and take account of the requirements of the information society in their work.

The conditions and content of both the initial and continuing education of teachers must be developed to correspond to the demands of the information society. Teachers need to be trained to use the equipment required for open and flexible learning, to be able to tailor existing teaching material to suit their purposes and also to be able to develop their own material. Teachers must be able to manage the information relating to their own field as well as being able to handle the media used for communicating that information.

21 The form, content and practice of teacher education should be revised. Open and flexible learning should be included in the curricula of teacher education. Practice in using information technology skills should become part of teacher training.

22 The continuing education of teachers should be developed and directed particularly towards methods of open and flexible learning and self-directed learning. As a matter of urgency, adequate continuing education for teacher trainers and a sufficiency of appropriate teaching materials must be ensured.

23 The university subject departments which organize teacher education, the teacher education units and practice schools need to be equipped with adequate, up-to-date information technology facilities. This will also result in new requirements for their premises.

4.4 New vocational skills for the information society

*In the information society, the skills related to the acquisition and manage-*ment of information are an increasingly essential part of professional competence in every field. In addition to basic general skills, mastery of the working methods and equipment essential for the practice of a chosen profession is essential. For all persons, information technology skills become increasingly important as a factor affecting employability.

The information and communications technologies develop so rapidly that continuous updating of knowledge and skills is required in all sectors of industry – not only in information content, but also in the production of equipment, software and services. Advances in technology arrive at an ever increasing rate, and the race to achieve developments and produce applications is global. Businesses need to produce a continuous stream of new products and services which are

competitive. This situation requires that the quality of education and research is guaranteed in the long term.

In some fields, the need for new personnel has grown so rapidly that the educational system has not been able to take proper account of this when estimating the requirements for education and training.

General vocational skills

In vocational education, the skills and competences needed for the information society should be taught to take account of the requirements of a working life which not only changes continuously but is also becoming increasingly international and network-based.

24 **In all fields, the basic skills of acquiring and managing information, communicating and using information technology should be reinforced, and teaching should be provided for the special professional skills needed in different occupations.**

25 **The content and methods of vocational and university education should be continuously developed, not only to keep pace with changing requirements in the professions but also as a way of anticipating future developments.**

26 **Opportunities for further and continuing education and training must be guaranteed. The content of courses need to be developed to keep pace with the changes in job requirements.**

Education in the field of library and information services

Education in the fields of library and information services is offered by three universities in Finland. In addition, training for information specialists is organized as continuing education. This training strives to provide competence and versatility in handling the different tasks within the field of information provision.

Education in the field of library and information services at institute level and in the non-university sector of higher education has been reduced substantially in recent years: both the number of educational establishments running courses and the number of students have fallen. Over the same period, the importance of information in society has grown, the amount of information available has increased, and information technology has developed rapidly.

The new role of libraries and information services in the information society should be taken as the basis for developing education and training in these fields.

27 **In both vocational education and the universities, sufficient initial and continuing education in the field of library and information services, as well as the matching of course content with changing job requirements, must be guaranteed. In particular, professionals**

working in libraries and information services need to acquire new skills in information technology and pedagogy.

Professional competence and skills needed in the information industry

The information industry in Finland is very successful and growth is rapid. This has led to a shortage of competent personnel, and an growing number of professionals will be needed in the future. It is crucial that success of industry in this sector is secured. Education and training, or the lack thereof, must not be an obstacle to the development of the Finnish information industry. There is a current need to define clearly the education and training tasks which are the responsibility of universities and vocational education, and those which fall to business and industry.

Sufficient, high-level and high-quality initial and continuing education and training necessary for the development of the information industry in Finland must be guaranteed. It should be a national objective that professional competence in the different sectors of the information industry in Finland is at the international leading edge.

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28 To meet the ever broader requirements of changing job descriptions, the competence and skills of the different professions in the information industry need to be developed. Cooperation between different fields in the information industry should be encouraged by support for a variety of cooperative projects. Training in the information field should be broadened by adding modules from related subjects to basic degree programmes.

29 In the new, growing areas of the information industry, student intake into initial education as well as the provision of continuing education must be increased. This requires both new resources and the transfer of resources from fields where the need for personnel is decreasing.

30 Know-how centres for multimedia and other digital media should be established and training that underwrites development of this sector should be increased.

Cooperation between educational organizations and business

The objective of initial education is for the student to acquire fundamental strategic skills and competences while also learning the basic skills necessary for a successful working life. Because the time spent in initial education is long, the results of changes made in its structure and content appear very slowly. The education system cannot therefore react to each economic fluctuation, and this would [illegible] even be wise. Increasingly, the response to the rapid pace of change must come from continuing education.

To make the education system responsive to the requirements of working life, it is important that developments in initial education are based on a profound understanding of the long-term need for education and training. Closer links between the education system and working life must be established.

The European Union has repeatedly paid attention to the development of cooperation between industry and education. Finnish companies and educational establishments have participated actively in the EU programmes in this area. Even though the situation in Finland may be better than in many other European countries, opportunities offered by the EU, such as the LEONARDO programme, should be utilized more effectively.

Interaction between educational establishments, the educational authorities, and business and industry needs to be increased. This should make possible a better understanding of the changes required in education and training and should also improve communication between the worlds of education and working life.

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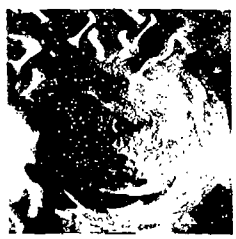
31 Curricula and study methods should be changed to support alternating periods of study and work. Representatives of business and industry should be appointed onto the administrative bodies of universities.

32 Training required particularly by small and medium-sized enterprises should be supported by developing training and services that meet their special requirements. New models of cooperation between small and medium-sized enterprises and educational organizations should be created so that problems relating to business competence, especially those involving applications of information technology, can be identified and solved.

33 Participation in international cooperation in education and training should be active, especially in postgraduate education and in the development of forms of cooperation between education and industry.

5. RESEARCH, INFORMATION TECHNOLOGY and NETWORKS

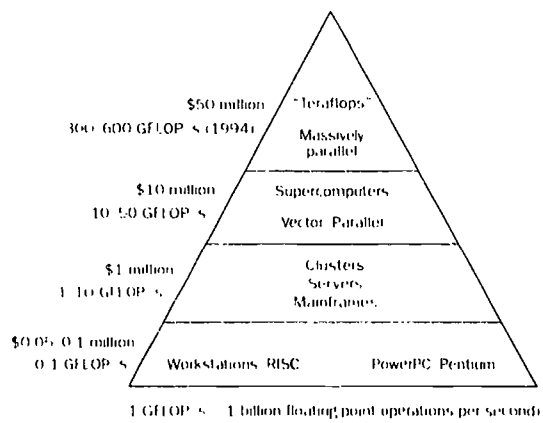


Information technology is a crucial element in high-level research and product development. Nowadays, information technology is an essential part of the research process in almost all disciplines.

Information technology in the service of research includes different computers and peripheral devices, the global information network and the software and applications that make it possible to utilize these resources. Scientific computing uses powerful computers in both research and product development, in particular for the numeric simulation of different phenomena, visualization and animation. The phenomenal growth in the processing capacity of machines used for scientific computing has created new computational sciences that cross the borders of traditional disciplines. For example, research on languages and other intellectual functions of the human being has been revolutionized by working with computers carrying out symbolic data processing.

Scientific databases and archives make possible the rapid updating and dissemination of research material. They have rapidly become indispensable resources in research work carried out in disciplines such as microbiology and the environmental sciences.

The computers used in research can be described as a pyramid, the base of which is made up of personal computers and workstations. The centre of the pyramid consists of file servers available to a group of users. The top of the pyramid is made up of supercomputers being used for the most demanding tasks.



A similar three-part conceptual division can be used to describe information networks. Local area networks in research institutes and laboratories are the foundation. These form campus and metropolitan area networks, which are themselves interconnected through a national trunk network. A further, fourth level is the global information networks, such as the Internet, which are made up of the national networks.

Finnish universities spend about FIM 300 million (ECU 52 million) per year on information technology; two-thirds of this sum is spent on equipment and maintenance. It is difficult to allocate this expenditure according to its exact use, but the share taken by research is clearly the largest. Telecommunications costs are growing because the construction, maintenance and upgrading of campus networks and their external links requires a continually increasing level of funds. To balance this expenditure, it is clear that good telecommunications links grow ever more important for science and research. Scientific libraries, for example, already make extensive use of information networks to retrieve and disseminate information.

A high-speed broadband network is a key prerequisite for the whole scientific community. Only by means of such a network can increased cooperation and proper integration of the Finnish university system be realised at national and international level.

Effective use of equipment make it possible to address increasingly difficult research problems and to model ever more complex issues. High-speed network links, transfer of images and sound, massive file servers, archives, and the use of multimedia reduce the limitations on access to information: the researcher's individual creativity, innovation and imagination are emphasized. The key to successful research work becomes the researchers' ability to understand extensive and complex entities and to make use of the information available at their fingertips.

5.1 Information technology in the service of science and research

Tools based on information technology and networked working methods have revolutionized both basic and applied research. Information technology has diversified research methods, radically improved the opportunities for researchers to interact on an international basis, increased the information services available, and given researchers much more rapid access to the results achieved by others. High-speed communication networks also make it possible to use and operate equipment from a remote location.

The following examples illustrate some possibilities for applying information technology to different fields of research.

Computer linguistics is one example of multidisciplinary research where Finnish researchers have achieved success by combining linguistics and information technology. Universal models and work-

station-based methods developed at the University of Helsinki facilitate the automatic analysis of texts in different languages. Texts in, among other languages, English, Swedish, German and Finnish have been analyzed. In this field, Finnish research is currently a world leader.

In the field of medicine, image processing and visualization are rapidly advancing technologies which can be employed using information networks. As an example, computer tomography makes it possible to render on screen an exact three-dimensional image of a non-visible object such as a tumour or organ, and this can then be examined and analysed remotely using network connections.

The target of universities and scientific research in Finland must have as their target the international leading edge in the application of information technology.

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34 **Information technology needed by high-level research must be secured through long-term public funding programmes which invest in the balanced use and development of the whole pyramid of information technology. Investments should be made at all levels: researchers' workstations, servers, supercomputers, local area networks and high-speed national and international trunk connections.**

35 **In the next few years, a special area of investment should be the development and testing of applications using broadband networks which serve education and training, research and industry.**

5.2 High-performance computing

As computers have become more commonplace and their processing capacity has increased, the use of information technology in research has become more effective. A new computational way of carrying out research has emerged. The realistic numerical simulation of complex phenomena and systems has created completely new opportunities. Examples of this can be found in scientific and technological research, product development, the biosciences, climatological and meteorological modelling and environmental monitoring.

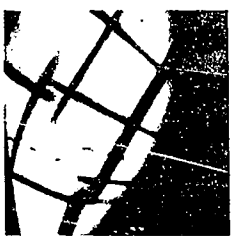
The procurement decisions for a new supercomputer for Finnish research made in 1994 initiated a gradual transfer in high-performance computing towards parallel computing, a technology where peak performance is achieved by connecting together a large number of processors. This not only makes it possible to scale hardware systems, it also allows the use of the same processors in combinations applied to different purposes.

To secure the basis of scientific computing, resources for high-performance computing in particular must be guaranteed.

36 Finland needs to be an active participant in international programmes involving high-performance computing and broadband networks for research, in particular the European Union's High-Performance Computing and Networking programme (HPCN), and joint initiatives by the Nordic countries.

37 The resources for high-performance computing should be guaranteed through long-term programmes which underwrite, in particular, the continuous development of parallel computing. The target is to achieve a capacity of one terafiop (10^{12} or one trillion floating-point operations) per second by the end of the current decade. In 1994, the peak capacity available to Finnish researchers was just one percent of this.

6. RESEARCH and the INFORMATION SOCIETY



Basic research in many fields plays an important role in the development of the information society. Applied research, which supports product development and industrial activity, builds on the achievements of long-term basic research.

As in education, investment in research at universities needs to targeted on new, developing fields. In engineering and technology, additional resources are required in fields which support the information industry, especially those of the electrical and electronic industries.

Today, information technology is a tool used in almost all product development, as well as being used for the underlying research. The contribution made by information technology is also growing in the development of products and services in fields other than the information industry itself.

6.1 Research, product development and the information industry

The automated data processing, telecommunications and media industries in Finland are expanding rapidly, and they represent great export potential. It is not only the information industry – information technology products and services, telecommunications, content production – that is becoming an increasingly important business activity in Finland, research and development into information technology is a fast growing field in its own right.

The tools and methods available to manage and organize information create added value for the information industry. File servers, electronic archives and information networks, as well as the data storage in many types of organizations contain a wealth of information in digital form, but this mass of data cannot be fully exploited because it is not structured sufficiently. The structuring, condensing, abstracting and indexing of information produced and needed by society, research, business and industry become major targets for study. Multidisciplinary research, involving disciplines such as communications and information science, linguistics and computer science, needs to focus on these areas.

In tomorrow's information industry, language engineering – the automatic processing of natural languages – will grow in importance. As an information society, Finland will need to develop technologies and applications for the automatic processing of the Finnish language. This is essential for nurturing the national culture; otherwise the dominance of, in particular, English may grow too strong. New network-based services must also be available in the national languages of Finland.

In order to maintain and enhance the competitiveness of business and industry, research which supports research and development must be promoted. Research in software engineering needs to be increased, especially in fields which support the development of industry.

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38 Long-term R&D funding in Finland needs to be directed towards developing the software and information product industries.

39 Finland's position in the field of automatic language analysis should be further strengthened, and R&D in the field should be supported.

40 Interaction between enterprises and the scientific community should be increased in order to assist, in particular, in the definition of areas where short-term and long-term research is needed, and to facilitate joint research and development projects.

41 Universities and research institutes need to participate actively in EU research and technological development programmes to ensure, among other objectives, that Finnish industry has access to the research results it needs.

6.2 Research on education and training

The purpose of introducing information technology into education and training is not only to instruct people on how it can be used as a tool, but also to stimulate the development of teaching and working practices that enhance learning. Some research has been carried out in Finland on computer-aided teaching, on attitudes towards the use of computers in education, and on methods of applying information technology to different subjects. Little research, however, exists on types of teaching material what encourage learning.

Pedagogic research should be directed towards self-directed learning, the learning process, and the new communication and interaction methods and intercultural communication made possible by technology.

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42 In order to develop teaching and working methods, research on the pedagogical effects and social impact of information technology, and on the interaction between man and machine should be increased and receive support. The focus of pedagogical research should be on media and learning, and on the role of the different media in teaching.

6.3 The information society as a focus for research

The development of the information society, networking and the application of information technology have far-reaching economic, social and cultural effects, into which little research has so far been carried out. Also, the prerequisites for achieving any desired changes are not well understood.

There are many areas in the networked society where little or no research information is available. Some examples of these are: ways of working and communicating, practices and routines employed when using technology at the individual level, changes in ways of thinking and in job descriptions, the management of change, the ethics of using information networks, and the virtualization of phenomena.

Scientific research needs to be directed towards studying the effects of the information society on different walks of life, thus supporting the transformation to a network economy.

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43 Research on aspects of the information society should be increased in order to gain an overall understanding of the probable economic, social and cultural changes that could take place.

44 The prerequisites for the development of the information society should be targets for research. An interdisciplinary research programme on the information society, communication networks and access to information should be initiated.

45 Research work on the practices employed in the information society and network economies should be increased.

7. DEVELOPING INFORMATION PRODUCTS and SERVICES

National information resources are made up of many different types of material, such as books, newspapers and magazines, statistics, patents, basic registers and databases, collections of images, maps, as well as unpublished information material. The number of producers of information is huge, ranging from commercial publishers to companies, public administration, communities, organizations, and private individuals.

The principal organizations providing information are libraries, information services, archives, and, to a certain extent, museums. Education and training, research, mass media and other forms of primary communication are extensive systems for the transfer of knowledge in society. All these sectors can be information producers, transmission media, and information users. The development of electronic media, in particular, blurs the distinction between these roles. New, alternative methods are emerging for the production, transmission, and acquisition of information. The roles of the various organizations involved are changing. One example of such a new form of activity is the "Cable Knot" of the Helsinki City Library.

The use of information and communication technologies changes the ways publishers produce, process and distribute information. Functional technical solutions are essential, but information content and methods of presentation are a much more complex challenge to electronic publishing. Market conditions and competition guide the business of commercial publishers, but it is possible for society to direct commercial activities, if so desired, through different forms of support.

Characteristic of national information provision in Finland is the small size of the language and economic area. This means that the market for Finnish information products is a limited one. The special requirements of technical compatibility, the dependence on informa-

tion generated abroad, and reliance on global networks hold back the utilization and development of content products.

In Finland, information generated abroad is of particular importance in higher education, research and product development.

7.1 National information resources and information maintenance face new challenges

In information provision, technology enables links to global information networks and the use in digital form of reference data and original material. Users gain access to a virtual resource, the "Global Electronic Library". Through the use of information technology, publications can be tailored for different readers and published and produced on demand.

As information resources become increasingly accessible over networks, finding a relevant piece of information becomes increasingly problematic. Easy-to-use tools for information retrieval are needed. A few such tools already exist, such as the World Wide Web (WWW) and the Wide Area Information Service (WAIS), but these are only the first steps in the right direction. National network directories of resources on the information superhighway are needed. Different network services must be integrated so that different tasks do not require different procedures. This is also the aim of the Telematics Application Programme within the European Union's Fourth Framework Programme for Research and Technological Development.

A functional electronic library in Finland requires a rapid increase in the amount of information available over networks. This can be achieved either by increasing electronic publishing or by converting printed, paper-based information into digital form. In addition to the technical and economic problems involved, legal questions, especially copyright issues, need to be solved. Methods for ensuring the authenticity of publications accessible over networks need to be introduced, as must electronic payment systems. Information published in new forms which is important for the national cultural heritage must also be preserved for future generations.

One factor restricting the publication of scientific articles in electronic form is the lack of a referee system for digital publications. Once such a referee system has been established, universities will have an important and growing role in the production and distribution of digital scientific publications.

Secrecy of information is not a serious problem when developing content products and services within the public sector, because the resulting information is already mostly public. As technology develops, public administration can further progress towards the information society by providing network access to public information resources. In this situation, the allocation of costs becomes a central issue.

As the amount of digital information increases, the allocation of associated costs needs to be resolved. A basic principle of a citizens' society should be that basic information resources, services, and systems are developed and maintained out of public funds. Standard basic services for large user groups should be available at no cost. Information required in education and research should be available at reasonable cost. Additional costs incurred by supplying individual or specialized services should be borne by the users.

Most new information is already produced in digital form, but currently only a small amount can be utilized by end-users in the form in which it was produced. Technically, it is not difficult to make new material accessible in digital form.

The use of digital information can be promoted by converting printed, paper-based information into digital form. Digitization of material on paper is not only a matter of solving the problems relating to technology and copyright, it is above all a financial question. The magnitude of the task is shown by the estimate that digitizing all the material published in Finland so far would cost about FIM 1.7 billion (ECU 300 million). Converting the material published in Finland in a single year into digital form would cost about FIM 35 million (ECU 6 million).

The amount of archive material in digital form is growing rapidly. Central government administration alone has 150 gigabytes (billion bytes) of digital material in permanent storage, and the volume of this material grows by 10 percent each year. The preservation of digital material is still unreliable and digital records cannot yet be used to replace files on paper or microfiche.

The national system for information provision must be guaranteed the necessary technology and adequate skills to make it a seamless part of the global electronic library. National directories of network information resources need to be established. Finnish information resources should be made reciprocally accessible in electronic form for international use.

The use of national information resources by means of new technology must be promoted. Production, distribution and use of digital information products should be increased in different areas, especially in education and training, research, administration, and in the libraries, information services and archives serving these sectors.

46 The production of new information in digital form needs to be promoted in order to improve the supply of information over networks.

47 Scientific publishing over information networks should be increased. Graduate theses and doctoral dissertations, conference proceedings and reports, and publication series of scientific and professional societies are particularly suitable for network publishing. In respect of theses and dissertations the universities need to revise their degree regulations.

48 The selective digitization of collections in libraries, archives and museums should be promoted, starting with frequently used or fragile material, material with special value, and material for which no copyright problems exist. Before this work begins, however, the archives and museums need to compile databases with information on their collections and to make these accessible over information networks in the way that libraries have already done.

49 Methods for preserving material in digital form need to be developed, as the preservation of digital material requires special technology and continuously maintained conversion capacity.

50 Resources need to be guaranteed for scientific libraries, working in cooperation with each other, to obtain and transmit the information material necessary for achieving the objectives of education and research policy. Developments in public libraries, where network connections are used to both produce and distribute information, should be promoted.

51 The structuring of information needs to be given special attention. Professionals in the areas of library and information services, together with experts in information and communication technology, need to develop methods of locating relevant information in the mass of data available over networks.

7.2 Promoting information production in Finland

From a business perspective, Finland is a small market for content products of the information industry: multimedia, digital publications, teaching material and special products. Although relevant know-how concerning content is available, this type of production is often unprofitable when it is targeted solely at national distribution. On the other hand, the education and training sector as a whole is an important and exacting customer the demands of which can increase competition, thereby strengthening domestic suppliers. High-quality teaching material and educational entertainment – "edutainment" – products have market potential also outside purely educational uses: in homes, in pre-school education, and in clubs and leisure activities. In the areas where sound know-how exists, markets are not limited to Finland.

Both government and commercial companies can support the development of competitive digital information products and the creation of new markets. Production can also be increased through different financial arrangements which support the creation of know-how and business activity in the field of information products.

Information networks make possible the fast and flexible distribution of teaching materials and they also create new methods for producing material. While supporting the introduction of products which exploit new storage media, such as CD-ROM and CD-I (CD-ROM Interactive), products that are produced and distributed using networks should also be developed.

Information produced by public administration must be available to the information industry for further processing into information products. This issue is also being taken up within the European Union. The price of public information supplied for further processing is governed by the law on the pricing of government services.

The availability and competitiveness of high-quality Finnish information products serving education and research must be guaranteed.

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52 The further processing of national information resources into products of the information industry must be promoted.

53 The development of information products and services in selected areas, especially those serving the needs of education and training, needs support from public funds.

54 The creation and development of Finnish multimedia production and related business activity should be furthered through commissions and subcontracts.

55 The interactive development, production and distribution of teaching materials and other information products should be supported, and international cooperation encouraged.

56 Translation and other applications used to facilitate the use of international information products need to be developed. Technical solutions adopted in Finland must be internationally compatible.

57 Services which make it easier for people to get acquainted with and start using digital information products need to be developed.

8. NETWORKING

8.1 Towards an open information network infrastructure

The information networks serving education, training and research form a part of the national and global infrastructures of information networks. The national strategy for education, training and research in the information society needs to build on a public information network with open access and comprehensive services, where the free exchange of information and services benefits everyone. The basic network structures need to be maintained with long-term public finance, so that the information facilities and telecommunications technology paid for out of public funds are adequate and up-to-date. When building the information technology infrastructure for education, training and research, international developments need to be followed and influenced as actively as possible.

The public and commercial sectors share many common interests. Advances in switching technology make possible the seamless but controlled interconnection of open information networks and those of commercial telecommunications, such as telephone networks, the entertainment industry, media and broadcasting, and where required, the necessary billing mechanisms can be put in place. Here the comparison to the road network with bridges and ferries is appropriate. The integration of networks is a central objective that needs to be pursued with determination. This development ensures that people can connect to the open broadband network as switching technologies develop.

The Internet is a global, open information network which has spread extremely rapidly, and it continues to grow. A large number of universities and research institutes were the first to get connected, but in recent times a growing number of companies and other organizations have joined the network. The Internet is used in many ways for communication and for transferring information. It is quite natural to connect the networks serving education and research in Finland to the Internet, since the Finnish university and research network has been a part of it for a long time.

The national information infrastructure, the Finnish "Information Superhighway", must be assembled as a multi-layered but integrated system. The present Internet and the standards for emerging broadband networks and services should be the foundation of the information network for education and research in Finland, so that it becomes part of an open, global information network.

58 Connection of publicly funded activities and services, such as schools, libraries and hospitals, to the information networks needs to be accelerated.

59 The construction and use of information networks in society should be promoted by developing the interconnection of telephone and cable TV networks and the open information network. Development of technology that facilitates such interconnection and the increased use of networks needs to be accelerated. In this way the foundations for the rapid integration of households into the national information network infrastructure will be laid.

60 The compatibility and interconnectivity of the different parts of the information network need to be secured. Links between the advanced university information network, the developing school network, and the public communication network should be established as seamlessly as possible in order to guarantee that services are both accessible and available.

61 Cooperation between the education and research networks and commercial network operators should be promoted. Commercial services should be made available over the open information network. By supporting the development and implementation of interconnection technology, the public sector can make the use of the network for commercial purposes as easy as possible.

62 A network of support centres should be created to assist with both the development and use of network services designed for the public.

8.2 Information networks for science and research

The scientific community has used information networks for a long time. The FUNET project, initiated in 1984, was the beginning of the university and research network in Finland. The FUNET network in its present form was established in 1987 and since that time the required

network capacity has more than doubled each year. The latest stage in the development of FUNET is the upgrading of the network to the new broadband ATM (asynchronous transfer mode) technology. This upgrade represents a ten-fold increase over the present transmission speed to 34 megabits (million bits) per second. This increase in speed will bring with it two advantages: the capacity for traditional telecommunications will increase, and the high transmission speed will make possible new network applications such as distance learning and the transmission of multimedia.

The ATM upgrade will require a total investment of about FIM 5 million (ECU 0.9 million) in 1994–1995. The update will raise annual telecommunication costs by FIM 1 million.

The continuous development of the national and international telecommunication links necessary for research must be guaranteed.

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63 The FUNET trunk network will be upgraded to ATM technology in 1995. As use of the network increases, the FUNET network needs to be developed further so that by the end of the decade the network transmission speed will reach 155–620 megabits per second.

64 To match the development in Finland, active cooperation should be sought to upgrade Nordic network links and international links with Central Europe and the United States.

65 Adequate resources need to be provided to enable universities to upgrade their own local area networks.

66 In order to develop and utilize next-generation transmission technology, the universities need to carry out joint experiments using transmission speeds at gigabit level (billion bits per second).

8.3 All schools and libraries to be a part of the open information network

Schools and educational establishments are not islands: they need to be an integral part of the daily life of their environment, their municipality and the local business community. Increasingly, schools also have international contacts. Good telecommunication links facilitate net-

working with the local environment and provide for versatile contact with the outside world.

Effective telecommunication links should be considered as an investment in the most important resource of any educational establishment, knowledge, and thus as one of the institution's important competitive advantages. The cost structure of each network should encourage its multi-faceted and efficient use.

The whole educational system must rapidly be brought within the reach of information network services. All educational establishments should be guaranteed a certain level of service.

The links between schools and educational establishments at different levels and in different fields, to municipalities and to business need to be increased. Information network solutions should be constructed in ways which support this development. The best way of achieving this is to base technical solutions on regional networking and cooperation.

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67 All educational establishments are to be rapidly connected to information networks. Models for local telecommunications solutions need to be developed at a national level. The regional networking of educational establishments maintained by the same body or located in the same region should be given priority. The services of commercial teleoperators and system providers should be used to provide the necessary telecommunications links.

68 All educational establishments need national network links and international Internet connections which are available to every student and teacher free of charge.

69 Schools and other educational establishments need to be equipped with the information technology required for using telecommunication and network services in education. Support needs to be provided for the purchase by schools of information technology equipment.

70 The Ministry of Education should initiate an Information Network Project for Schools to coordinate the construction of the school network at national level.

71 Information services provided by the educational authorities, especially the local school administrations, need to be improved. Better connections for education and research to the information systems of the educational authorities need to be established.

72 The task of the educational authorities must be to ensure that the whole education system is within the reach of information network services. A common framework is needed for the information network services provided by the educational authorities and different educational establishments.

Libraries continue to have an important role in securing the public's right of access to information. Libraries are central in guaranteeing equality, in ensuring the availability of information, and in guiding users in handling equipment and accessing information. All citizens should have the right to use information network services in libraries at an affordable price.

The whole library system must rapidly be brought within the reach of information network services. Adequate equipment and telecommunications links as well as the existence of necessary expertise in both scientific and public libraries need to be guaranteed. Special attention should be paid to improving network services in public libraries and to the development of libraries as nodes in the open information network.

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73 **The information network links of the public libraries should be developed by providing libraries with support to procure necessary equipment and offer user assistance. Public library network services need to be developed in parallel with the Information Network Project for Schools of the Ministry of Education.**

74 **Information about the resources available in archives and museums should be made accessible over information networks.**

8.4 Digital broadcasting and cable television networks

Broadcasting and cable networks are currently the highways of electronic media, especially those reaching the homes. The broadcasting network covers over 99 percent of homes, and the cable TV network about one-third. All these networks transmit programmes that have significance for education and training. The broadcasting companies also produce separate educational programmes for radio and television.

It is also possible to transmit data over the broadcasting network. Data TV can be used, for example, to distribute software or teaching material.

Broadcasting and cable TV networks are also moving to digital technology: first radio broadcasting, satellite transmissions and cable TV networks, followed later by the terrestrial TV networks. Digital transmission will increase the number of channels available while reducing the distribution costs per channel. The advent of digital radio and television means that channels specializing in education and training may become commercially viable.

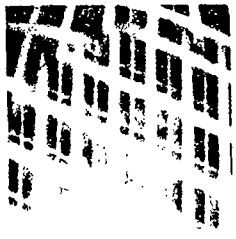
The Ministry of Education should seek to promote the supply of educational programmes and information services via broadcasting and cable networks to school pupils, students in vocational, higher and adult education, and to the general public.

75 The possibility of reserving for educational purposes some of the new broadcasting channels emerging as a result of the introduction of digital technology should be studied.

76 The possibilities for students to receive credits for open university education and other types of independent study based on electronic media needs to be guaranteed.

9. GENERAL FRAMEWORK

9.1 Standardization



There are many issues related to the functioning and security of networks that are important not only in business life and public administration but also to researchers and other users and producers of information. Verification of the origin of the information and the integrity of its content are examples of problems arising out of the introduction of new technology. From the point of view of compatibility of information systems and networks, the key question is standardization. An open information network requires standard solutions that are compatible both nationally and internationally.

77 **When developing information technology for education, training and research, the advancement of international standards need to be carefully monitored and solutions chosen so that they serve the development of information systems and networks in Finland as a whole.**

9.2 Legislation

Copyright issues

Practically all text, image and sound material is subject to copyright or related rights. Copyright protects, for example, written presentations, technical designs and drawings, catalogues containing large amounts of data and tables, photographs, video and sound recordings, and radio and TV broadcasts. Information technology makes it very easy to create, record, duplicate, transmit, distribute and display material protected by copyright.

The introduction of digital technology creates the need to develop new contract practices and to review the work of organizations which

supervise copyright. It is also likely to create the need for amendments to legislation, international contracts and international treaties.

Among the issues which must be resolved are the granting of permission to make use of existing material in multimedia productions and the question of the new use of material and other information resources in general. Licence systems need to be developed accordingly. In addition, the rights of producers and makers of material must be effectively protected both in network environments and in the distribution of recorded media so that easily copied products can be released for distribution.

In addition to legislation and contracts, technical methods of protection will probably be necessary to limit the copying of products, to secure the distribution of products through encoding, and to guarantee recognition, invoicing of charges and payment of licence fees for right of use.

78 **As a member of the European Union, Finland needs to make an active contribution to the preparation of legislation concerning digital technology and participate actively in international cooperation aimed at clarifying the needs for drafting or completing general international agreements.**

79 **The need to reform national legislation should be scrutinized. The aim must be to create solutions which are compatible with international developments. The Ministry of Education has commissioned its Copyright Committee to chart the needs for legislative amendments in 1995.**

Act on legal deposit

In section 7.1 the problems related to the preservation of electronic publications for future generations were discussed.

80 **The preservation of information material important to the national cultural heritage must be guaranteed regardless of the form in which it is published. The Act on legal deposit of publications needs to be amended to include material that is published in electronic form.**

Data protection and publicity

A directive on data privacy is currently under preparation within the European Union, together with an international set of norms. From the point of view of education and research, personal privacy and the principle of open access are closely linked to each other.

81 **In the information systems and networks serving education, training and research, the aim should be openness and flexibility, while also guaranteeing that any processing of information which affects individual rights respects personal integrity.**

82 In the information systems and networks serving education and research, information possessed by public bodies which concerns the actions of the authorities or which affects the lives of people should be as open and transparent as possible.

9.3 Taxation of digital publications and network services

As digital publications and network services for education and research become increasingly common, the manner is which they are taxed needs to be reviewed.

83 The lower value added tax rate which applies to books should be extended to also cover those digital publications which are comparable to books both as products and in the way that they are used.

84 The aim of stepwise abolishment of the current telecommunication tax should be supported. The revenue lost to the state by the ending of the tax will be made up by the increase in economic activity resulting from telecommunications and by the improved competitiveness of the service sector which exploits telecommunications services.

9.4 Tariff criteria

When fixing tariffs for publicly produced information network services the nature of the activity requiring the information must be taken into account. The objective should be to increase the degree to which information and network services are used. Full cost accountability can be used for certain services, where the user pays the costs incurred to the producer.

85 The areas in which information network services should be available free of charge according to the principles of public service need to be defined. The possibilities for flexibility in pricing should be explored in other areas, and the areas where charges should be based on actual cost need to be defined.

IMPLEMENTATION

10. IMPLEMENTATION

In its decision in principle of 18 January 1995 on the development of Finland

as an information society, the Council of State gave the different ministries the task of preparing a set of actions by the beginning of March 1995 to reach the desired goals set.

In accordance with this decision, the Ministry of Education has prepared an action programme using the general objectives set out in this strategy document for the years 1995–1999. The detailed action programme includes a list of projects with timetable, details of the parties involved, and a financial plan. The following fields are included in the action programme.

National curricula and evaluation

Actions to develop curricula at vocational institute and higher level as well as at universities following the lines defined in the national strategy. An evaluation of how the strategy objectives are met at all levels of education and training.

Networking of schools

A plan for linking schools and educational establishments to the information networks. The plan contains an estimate of the need for equipment and information network connections. The Ministry of Education is initiating a project to develop the information network for schools.

Teacher education

A plan for developing initial teacher education and for organizing continuing education, as well as for improving the information technology equipment available at teacher education units.

Initial and continuing education for the information professions

An action programme to develop initial and continuing education in

information technology, telecommunications, production of software and applications, media, and other fields related to the information industry.

Libraries and information services: networks, staff and cooperation

A development programme for public libraries. Continuing education for staff in libraries and information services. Closer cooperation between libraries, archives and museums.

Networks and applications serving the scientific community

The development and testing of applications using broadband and other networks to serve education and training,research,and industry.

Information technology in higher education and research

Development requirements for information technology in research and higher education: volume, funding.

Research areas

Definition of the areas of research which are relevant to the strategy for development of the information society.

Information resources and information production

Digitization of national information resources. Promotion of information production and the location of relevant information. Preservation of valuable national material regardless of the media of publication. Support for the content industry in Finland.

Legislation and general framework

Copyright issues, Act on legal deposit.

TERMINOLOGY

TERMINOLOGY

In this publication, the following terms have been used.

ATM, **asynchronous transfer mode** Packet switched network system, which can transmit voice, data, images and video faster and more reliably than previous technologies. The ATM network is also referred to as B-ISDN (Broadband Integrated Services Digital Network) or "cell relay".

bit (binary digit) In communication and information theory, a unit equivalent to the result of a choice between only two alternatives, as between 1 and 0 in the binary number system used in digital computers.

CD-I (CD-ROM Interactive, Computer Disk Interactive) Distribution standard for interactive multimedia developed by Sony and Philips. Separate device used with a television set.

CD-ROM (Compact Disc-Read-Only Memory) Optical storage device, which can store large amounts of data in digital form. Used for storing text and high-quality audio, images, graphics, and video and for other databases of large volume.

communication network See **information network.**

content industry See **information industry.**

data processing Operation or series of operations, such as storing, combining, selecting, sorting, or calculating, carried out on data in order to present, interpret, or obtain information.

flops, FLOP/s Floating-point operations per second, measurement used to characterize the performance capacity of micro chips.

gigabit Billion (10^9) bits.

hypermedia Multimedia with associative links. As technology develops, the boundaries between multi- and hypermedia and traditional media become diffuse.

hypertext The linking of related pieces of information by electronic connections in order to allow a user easy access between them. Hypertext is

a feature of some computer programs that allow the user of electronic media to select a word from text and receive additional information, such as a definition or related reference.

information industry The production, sale and distribution of equipment, applications, software and other products, and the associated services. The **content industry** of the information industry refers to the production and compilation of data, information, works of art, video programmes or other performances for dissemination through information networks or electronic media.

information material The entity of documents collected for a specific purpose.

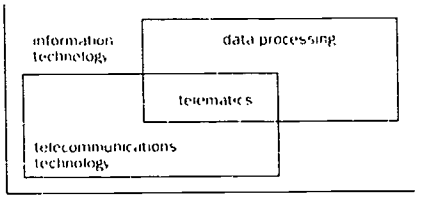
information network, communication network System consisting of hardware, software and applications of information and telecommunications technology, which offers transmission and processing services for information to users in a certain area.

information product Product related to the contents of the information industry, such as data, information, works of art, video programmes and other performances distributed through information networks or electronic media.

information provision The organized activity by which society or an organization takes care of the production, procurement, storing and bringing into use of the information it needs.

information service The area of information provision which procures and distributes information to those who need it and which assists in the use of information resources.

information technology The equipment, software and methods for the automatic processing and transmission of information and the associated know-how.



interactive television, ITV Service where the viewer issues commands or instructions which influence the course of the programme. The interactivity does not necessarily demand a two-way distribution network, because the viewer can send the control sequences or other messages to the broadcaster, for example, through the telephone network with the help of a specialized computer and modem. Interactivity as such is a part also of other systems, such as text TV.

ISDN, Integrated Services Digital Network Integrated network in which data is transmitted as digital signals.

megabit Million (10^6) bits.

multimedia Material consisting of text, sound, images, computer graphics and video material in any combination which is manipulated via a computer. Can be used interactively, for example, in open and distance learning.

open and distance learning (ODL), study, teaching A planned entity of study for a specific target group, consisting of a combination of face-to-face and distance teaching, self study combined with tutoring and counseling. Open and distance teaching can make use of electronic communication, telematic services and information technology. The teaching is often organized in cooperation with several training organizations. Arrangements for open and distance learning is often referred to as open learning environments.

telecommunication, telecommunications The technology of sending signals and messages over long distances using electronic equipment, for example telephone, radio, data communication.

telecommunications network The combination of transmission channels and nodes, which establishes teleconnections between two or more users for telecommunication.

telecommunications technology The area of information technology which deals with the equipment and methods of telecommunications and the knowledge related to their use.

telematics The area of information technology which covers both telecommunications technology and data processing.

teraflop Trillion (10^{12}) floating-point operations.