

FINNSIGHT 2015



The Outlook for Science



Technology and



Society



Academy of Finland

The Academy of Finland's mission is to provide funding for high-level scientific research, to offer science and science policy expertise, and to strengthen the position of science and research. It serves all fields of science and research.

Academy-funded basic research generates new knowledge and new experts. The main focus of the Academy's development efforts is on providing career opportunities for researchers, supporting the development of high-level research environments and taking the best possible advantage of international opportunities.

Tekes

Tekes, the Finnish Funding Agency for Technology and Innovation, is the main public funding organisation for research and development in Finland. Tekes funds industrial projects as well as projects in research organisations, and especially promotes innovative, risk-intensive projects.

Foresighting provides a sound basis for Tekes' strategic and operational planning. The strategic focus areas adopted by Tekes are based on joint foresighting work together with national and international stakeholders.

The Academy and Tekes will use the results of FinnSight 2015 for developing Strategic Centres of Excellence in Science, Technology and Innovation.

1 Learning and Learning Society: The Learning panel dealt with various activities related to individual and collective competence and its reproduction: different forms of education, learning on the job and education as a business. Competence is becoming an increasingly important resource for competitiveness and welfare. Growing emphasis is placed on the challenges of life-long, flexible learning and the need for new approaches and for multidisciplinary learning research.



2 Services and Service Innovations: New service businesses and innovations are needed in all sectors of industry and public sector. The panel set out to address the following questions: "Who are services provided for, who provides those services and in what way?" Under the pressures of population ageing, mounting competition on the global service markets, and other similar trends, the challenge now is to raise productivity and to make good use of new technologies.

3 Well-being and Health: The panel dealing with the health and well-being of people in Finland identified a number of areas on which the national research and product development effort should be focused in the future. Well-being is influenced both by people's health behaviour, advances in medicine, preventive health care as well as new health care services and innovations. The well-being of children and youths is paramount.



4 Environment and Energy: Sustainable management of the environment, availability of energy, new energy solutions and energy efficiency are intricately interwoven with one another and present a complex challenge for research and innovation. According to the Environment and Energy panel Finland has proven competence in environmental sciences and technologies. A stronger drive is needed to make new solutions and innovations commercialised.

5 Infrastructure and Security: The panel addressed a range of infrastructure and security issues that are more and more closely intertwined in today's increasingly technological and global environment. Potential new security threats in society include international crime and pandemics. Information and energy networks may be exposed to vulnerabilities, but on the other hand security of supply and operational safety are national competitive assets.



6 Bio-expertise and Bio-society: *There is an ever-growing need in today's changing world for basic research in biosciences and for bioscience applications. Expertise and competence in the biofield will have great significance in most sectors of industry and society. The panel heavily emphasised the need to ensure the performance of the whole chain from the basic knowledge to the effective commercial application of research outcomes.*



7 Information and Communications: *This panel covered the disciplines, technologies and practices that support the acquisition, processing and transfer of information between humans and systems. These include telecommunications technology, data mining, user interface research, neurosciences and linguistics. The panel believes that the convergence between information technology and communication may in the next few years lead to the emergence of completely new kinds of actors.*

8 Understanding and Human Interaction: *The panel adopted an interdisciplinary perspective on the question of "What is good for Finland?." It emphasised the importance of human interaction both between individuals and in social and economic activity as well as the importance of multicultural competence in an increasingly international environment. Rather than seeking out contrasts and differences, such as those between technology and the human sciences, the panel's main concern was to identify synergies and in this way to promote mutual understanding.*



9 Materials: *The panel explored various areas of competence on the use of and potential new applications for existing materials as well as avenues for the development and use of completely new materials and technologies with special consideration to international competition and ecologically sustainable raw material economy.*

10 Global economy: *Finland and its research and innovation system are more and more closely interconnected to the global economy, which crucially influences the needs and opportunities for development in business and industry and the various functions of society. The panel placed particular emphasis on the development of new service business concepts, management of global risks, as well as the more effective use of global knowledge in the economy, science and technology.*





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Foreword



The only way to reach the top is by joining forces

The development and strengthening of competences and innovations are the key to Finland's success in the future. Cutting-edge basic and applied research coupled with broad-ranging expertise and competence will help to reach international excellence. Finland needs a national development strategy, a vision and commitment to pursue these policies as well as an understanding of the challenges that lie ahead for business and industry and society as a whole and the means with which to promote our welfare.

At the beginning of 2005 the Academy of Finland, an expert organisation in basic long-term research funding, joined forces with Tekes, the Finnish Funding



Agency for Technology and Innovation, to launch a foresight project under the heading of FinnSight 2015. Its aim has been to identify focus areas of competence for the future in the fields of science, technology, society and business and industry, and to establish priorities among them. The project was instrumental in helping to define Finland's Strategic Centres of Excellence in Science, Technology and Innovation in line with the Government's decision-in-principle of 7 April 2005 on the development of the public research system. Not only did the project further the achievement of this goal, but it also deepened the collaboration between the Academy of Finland and Tekes and fostered a climate of multidisciplinary debate and discussion.

The foresighting work was done in panels where leading research and industry experts contributed their multidisciplinary knowledge and insights on the subjects concerned. In addition, the 120 experts who were involved in the ten panels also communicated the knowledge of their respective networks.

The FinnSight 2015 project was an intense undertaking. The chairs and members of the ten panels were jointly selected by the Academy and Tekes. They were expected to have strong expertise in all aspects of their

own field, a broad understanding of society in general and a willingness to share their expertise. The discussions were constructive and the members totally committed themselves to the task. The work to identify trends and focus areas of competence continued from autumn 2005 to spring 2006. Each of the ten panels produced their own extensive reports, which are compiled in Finnish in a separate FinnSight 2015 publication. This publication summarises the main contents of the panel reports.

Project planning and implementation was the responsibility of a core group chaired by Professor Ahti Salo from the HUT Systems Analysis Laboratory. Its other members were Paavo Löppönen, Director; Annamajja Lehvo, Senior Science Advisor; and Anu Nuutinen, Science Advisor, all from the Academy of Finland; and Pirjo Kyläkoski, Foresight Manager and Eija Ahola, Research Manager from Tekes. The core group's secretaries were Hanna Räisänen from the Academy and Sanna Ojanen from Tekes. Support for the panel's work was provided by researchers Tommi Gustafsson, Totti Könnölä and Ville Brummer from the HUT Systems Analysis Laboratory and by Johanna Korhonen and Elina Ranta (summary report) of the online newspaper Verkkotie. The summary report was compiled and edited by Eija Ahola, Pirjo Kyläkoski, Annamajja Lehvo and Paavo Löppönen.

Special thanks are due to several people who helped make the FinnSight 2015 project possible: to Professor Aatto Prihti and Pekka Ylä-Anttila, Research Director at the Research Institute of the Finnish Economy ETLA for their background support; to the panel chairs who did an excellent job in reporting the views of their respective panels; to Johanna Korhonen who assisted them in this task; to the project's core group as a whole; to Professor Salo for his constructive leadership of the project; and to the staff of his laboratory.

Thanks also to the project steering group, which consisted of Academy President Raimo Väyrynen and Veli-Pekka Saarnivaara, Director General of Tekes; Anneli Pauli, Vice President, Research (Academy of Finland) and Martti af Heurlin, Deputy Director General (Tekes); Professor Arto Mustajoki (University of Helsinki); and Pirjo Kyläkoski, Foresight Manager (Tekes).

Helsinki September 2006

Raimo Väyrynen
Academy of Finland

Veli-Pekka Saarnivaara
Tekes

Introduction

Since the 1990s, Finland has advanced to an increasingly innovation-driven stage of development. As the rate of fixed investment declined in the wake of recession, so private and public investment in research, technology and innovation began sharply to climb. That investment is crucial to economic growth.

The challenge for the future is to develop new independent science, technology and innovation policy solutions. Such is the speed of change that we now have to structurally assess our research and innovation systems. Networking, new relations of cooperation and multi- and interdisciplinarity are set to become increasingly important success factors. The impacts and effectiveness of research and innovation systems in society will also assume increasing prominence.

In advanced countries the science and technology policy response to these challenges is to step up foresighting efforts. Foresighting has developed out of the cooperation between surveys of the future (and especially drivers), strategic planning and policy analysis. The target is to identify changes and challenges in the research and innovation environment and to assess how to best respond to these changes.

Foresighting provides a structured platform for open and insightful discussion about the future among as large a number of people as possible. It can help to detect weak signals, opportunities and threats, to build up a common understanding of what really is important and to identify issues and measures on which decision-makers should concentrate their attention.

FinnSight 2015 – starting-points and targets

The results of international foresights have only limited applicability in the national solutions adopted in Finland, but much can be learned from the methods used in foresighting. Among the countries that had conducted foresight projects before FinnSight 2015 were Japan, the UK, Germany, France and Sweden. Furthermore, several research institutes in the United States produce an abundance of future-oriented analyses on different disciplines and technologies.

Finland has worked consistently over a long period of time to build up an advanced research and innovation system whose main strengths include close cooperation and networking at all levels. In international comparisons of competitiveness Finland has always performed exceptionally well in functions related to competence. Examples include the country's highly qualified workforce, public and private investment in research and innovations, world-class researcher intensity and the level of technology development and utilisation.

At the time that the initial ideas for the FinnSight 2015 project were floated in 2004, it was already obvious that Finland's public research system



was in need of structural renewal. Another factor working in the same direction is the increasingly global view taken by companies on the location not only for production but also for research and development functions.

A question that has received increasing attention in the political process is whether the investments made in knowledge and competence actually generate enough economic growth, new job opportunities and welfare in Finland. At the same time, questions are raised about the prioritisation of future development efforts and funding decisions.

The Government's decision-in-principle regarding the structural development of the country's research system served as a motivating factor for the decision by the Academy of Finland and Tekes to conduct a broad and comprehensive foresight exercise on Finnish science and technology.

Key objectives of this exercise are a) to identify and explore the drivers that are expected to im-



part Finnish business and industry and society at large; b) to identify the challenges faced by research and innovation activities; and c) to identify the areas of research and innovation competence that promote welfare in society as well as business and industry competitiveness. The results of the foresight project support the Academy's strategic work and needs to strengthen basic research and Tekes' strategic focus area planning. Furthermore, the aim is to deepen cooperation between the Academy and Tekes and in general to develop Finnish foresighting work.

Theme selection

The themes for FinnSight 2015 were selected with the support of expert groups that are most directly relevant and important to the Academy's and Tekes' operations. The overarching idea was to promote of interaction: to encourage the free flow of ideas and expertise in the foresight process.

Among the dozens of themes put forward by the Academy and Tekes, those were eventually included that met the relevant criteria of national significance, level and extent of competence as well as potential socio-economic impacts. Half of the panelists were appointed from among candidates submitted by the Academy and half among those submitted by Tekes. A full list of the panelists is attached as an appendix.



Driving forces



- *Globalisation*
- *Demographic changes*
- *Science and technology*
- *Sustainable development*
- *Changes in knowledge and competence*
- *Changes in work and people's mental resources*
- *Changes in the cultural environment*
- *Governance and safety and security*

Globalisation is redistributing roles

There are two prominent driving forces in today's global operating environment. The first is the trend of increasing mobility: the flow of goods, money, capital, people, ideas, cultures and values across national boundaries is continuing to expand. The second is the growing interdependence of different parts of the world, their increasing interaction and cooperation in the economy, production, social development, communications and human exchange.

Globalisation today is very much capital driven. Indeed, it has been suggested that national industrial economies are collapsing and giving

way to a new international, investor-driven monetary system. In old industrial countries traditional manufacturing accounts for an ever smaller proportion of economic production and employment, at the same time as the role of the service sector is expanding.

With the breakdown of economic and communications boundaries around the world, nations states and regions are having to rethink their roles. Strong economic growth in Asia is driving old industrial countries into competition where the key success factors are innovativeness and cost efficiency.

The Far East, China and India all have strong emerging economies and science and technology. India in particular is now rapidly moving into areas where advanced industrial countries used to have a competitive advantage, such as high technology. Closer to home, strong economic growth is expected in the new EU members and Russia.

In more and more sectors, businesses are no longer competing only locally but also in a global marketplace. The growing demands for efficiency that follow with competition are in turn leading to a globalisation of work and increasing pressures to lower costs.

Finland is one of these advanced economies that is losing industrial job opportunities. With the continuing development of emerging economies in science and technology, production and



the focus of growth in mature sectors are shifting outside of Europe and the United States. These changes have a major impact on employment in Finland and on the country's technological and economic competitiveness.

Market success, in the future, can no longer be achieved simply by means of technological innovation, but it will require more in-depth knowledge of consumers' wishes and choices and an ability to differentiate from other products and services. Globalisation is not only an economic process, but it is also impacting social development as well as people's everyday life. As far as the individual citizen is concerned, globalisation means an increased freedom of choice both in education, in the labour market and in consumption. At the same time, the daily life of individuals is increasingly permeated by growing complexity, the increasing vulnerability of business and the economy, instability in the work environment and growing cultural tensions between people.

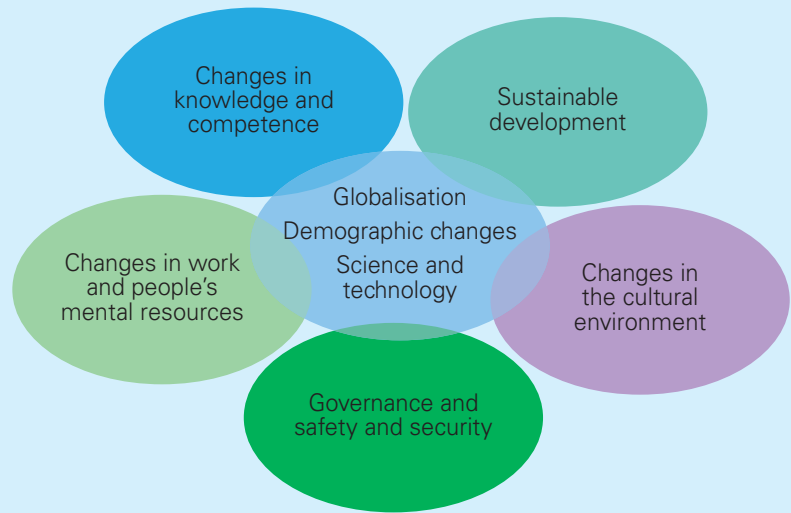
Changes in the population structure are shaping the economy

According to United Nations estimates the world population will grow from its current figure of around 6.5 billion to over 8 billion by 2030. In almost all advanced countries, including Finland, population growth is slow, and the proportion of older people is set to

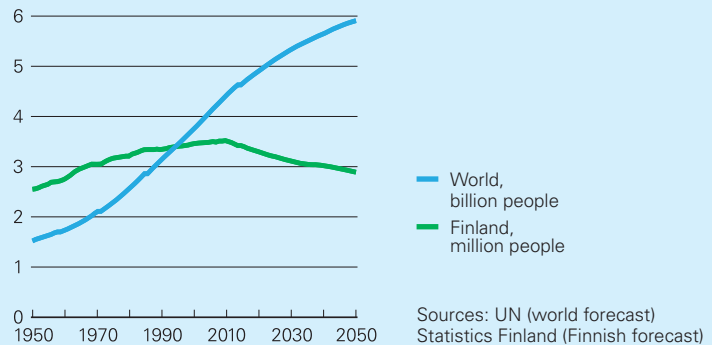
rise very rapidly in the 2010s. These countries will need more staff in the service sector as well as in jobs requiring high levels of education.

In Finland, people of working age now take greater responsibility than before for the welfare of children, older people and others who are not in active employment, and the dependency ratio is rising more sharply than in most other European countries.

Population ageing is significantly changing the structure of consumption. In particular, the demand for health and care services is soaring.



World and Finnish population of working age





Information is everywhere

The development of science and technology is opening up new opportunities for innovation, which are reflected among other things in working practices, business processes, systemic structures and social behaviour.

Digital information and networks are paving the way to ubiquitous networking. Government functions and services are increasingly moving to web-based networks, which means they are accessible to all people at all times and in all places. Information itself is increasingly ubiquitous.

There is increasing convergence of telecommunications networks and computers. Data, sound and images are now being transmitted over the same networks. Mobile technologies are more and more widely used for both content production and reception and impacting the way that work is organised.

Technological convergence also enables completely new ways in which people can link up to networks both technologically, professionally and socially. This complex web of networks offers greater scope for a new kind of creativity.

Based on the principles of openness and sharing, the open source concept is continuing to gain in popularity. For those who have the knowledge and the willingness, it offers great new opportunities for connecting things in new innovative ways.

In the future people will be living and interacting more and more closely with machines, which will have the effect of changing people themselves. The frequency of interaction will increase, but at the same time it will become more superficial. The need for human interaction will increase, as will the need for human relations that support human maturation and that provide for a sense of security.

Sustainable development: a safe option for the longer term

The requirement of sustainable development will have an ever greater impact on our future choices. As well as being ecologically sustainable, our decisions and solutions have to be economically viable, socially just and culturally valuable. Living environments can be improved by changing established ways of doing things. Investment in competence on sustainable development is a safe option in the longer term, but it is not clear how and by what means such development can be achieved, and those means are certainly not always profitable in the short term.

Climate change and the loss of biodiversity are global processes that are causing increased susceptibility to crisis. The world's ecosystems are in a state of accelerating change as a direct result of human activity, but we continue to know too little about those changes. The world water problem is getting progressively worse. The lack of clean drinking water and waste management problems call for urgent solutions in many parts of the world.

The changes that are going on in people's living environments are also having an impact on their health, well-being and quality of life. Industrial products include ever-new chemical compounds that have both positive and adverse effects on the environment



and individuals. There is also growing concern about the potential adverse effects of these compounds on a nanoscale.

Multinational corporations will take on an increasingly prominent role, and it is absolutely crucial that they display a responsible attitude. Global and local environmental issues must be managed simultaneously. International environmental agreements are gaining increasing weight. The option is now available to impose trade restrictions on environmental grounds.

In energy production, there will be an increasing drive to find more sustainable solutions. The economic competitiveness of nuclear power will increase vis-à-vis fossil fuels, but in many countries this is a major political issue.

Prices of depleting natural resources such as oil, natural gas and uranium will increase. The scarcity of energy is placing increased pressure on energy production and transportation systems. Efforts shall be continued to increase the environmental efficiency of industrial processes and to reduce their emission levels. Material reuse and recycling and the improved long-term usability of materials will gain in significance.

A competent workforce is a crucial success factor

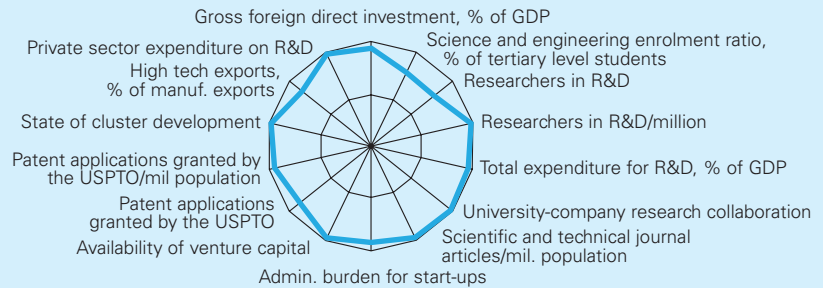
Competition for locations is a key factor in global competition: cost levels and the availability of a competent workforce are crucial

to success in this competition. Small advanced countries such as Finland have to show ever more judgement in selecting the fields where they want to try and reach the international excellence in research, technology and innovations. These countries also have to network globally and develop new ways of exploiting global knowledge and competence.

With this trend in development, the requirement is no longer simply for scientific and technological competence in innovation, but regulatory and cultural competencies are also needed. In the future, growing need will be investment in developing competencies that creatively integrate basic scientific and technological know-how with business, cultural, legal and societal competencies.

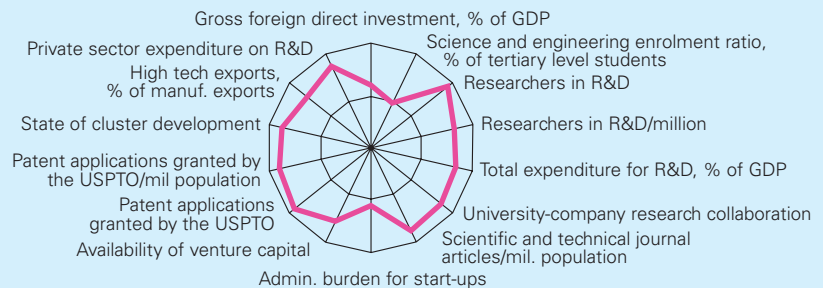
The market for competent workforce is becoming increasingly globalised. Efforts must therefore be stepped up to make working and living environments in one's own country more attractive to people coming in from the outside. At the same time, the doors must be opened to allow

Science and technology variables in Finland



Source: World Bank Knowledge Assessment Methodology, 2005

Science and technology variables in G7 countries



Source: World Bank Knowledge Assessment Methodology, 2005



people to move out in search of the best education, science and technology in their own field, wherever it is in the world.

Organisations and their management and leadership are becoming increasingly complex. People involved in network organisations are presented with growing competence challenges, most significantly with respect to the development of diversity as well as interaction, communications and social skills. People will have to adjust to changes in their job tasks at some stage of their life span, highlighting the importance and necessity of life-long learning.

People who are working full-time in production in advanced countries will be spending more time than before in training and education. Patterns of alternation between work, study and leisure during the individual's life span will also be changing. Learning will increasingly take place outside formal educational institutions. This means that greater attention needs to be paid to the development of learning environments and to ironing out emerging learning differences.

Open source concept set to expand

Work is becoming increasingly independent of time and location. Organisations working towards the same goals may be scattered around the globe, managed and administered via ICT networks.

The role of motivation and incentives is set to increase even further, as is the importance of a motivating and inspiring climate at work. More partnerships and cooperation means more communication. This open in-

novation concept will continue to grow and expand with the rapid changes in earning models. The constant changes in needs are also increasing job insecurity and short-term job contracts.

Increasing ubiquity is making the distinction between work and leisure increasingly blurred. Leisure time is increasing, but it is more unequally divided. The key workforce groups are ever more pressed for time and also have increasing purchasing power.

These creative experts are critically important to our future, but more generally Finland needs to have competent people in its workforce as well as skilled craft-people.

Care professionals and service providers are one of the biggest groups of experts. Where knowledge workers operate globally, services are needed locally. For instance, tailored and flexible home and child care services are needed. The shortage of staff in care services is worsening.

Continuous changes driven by multiple simultaneous factors can severely challenge the adaptability of both adults and children. Resources need to be invested into strengthening mental well-being and health so that the growth of marginalisation and alienation can be prevented. Amidst all the changes it is important to recognize the need for constancy in all age groups and to make sure that the things people value most remain intact.



Equality in cultural encounters

With the advance of globalisation, different sets of values are coming into contact with one another more and more often. The reactions of individuals and societies range from the denial and suppression of diversity through approval and respect to active efforts to promote cross-cultural interaction.

As the need for competent people continues to increase with population ageing, positive multiculturalism combined with the welfare state is definitely a competitive asset.

As more and more jobs today are independent of time and location and communications technology means people are readily reachable, the boundary between work and leisure is shifting. By 2015, most people in industrial countries will have access to wireless multilingual multimedia via various kinds of terminals. This will significantly change the way that work and everyday life are organised.



Young people in particular are keen to seek ever more intense experiences and to get them faster and more easily than before. One of the places they turn to in search of these experiences is the virtual world. Travelling will assume ever greater significance as a source of adventure and experiences.

For reasons of Finland's international attractiveness and competitiveness it is important that there is a sufficient range of cultural and adventure services in the country. The promotion of Finnish culture also has intrinsic value in this multicultural world.

Managing changes

Global dependence was earlier understood primarily in ecological or military security terms. Today, it is understood first and foremost from the point of view of capital and investment markets, production networks and information flows.

The problems of governance and the development of new methods of governance have changed, even though the traditional structures of economic and military power continue to exert an underlying influence. Many of the new challenges and means of governance are related to the deepening of cooperation between governments and businesses and industries in which the goal is to strengthen national competitiveness in the global competition.

On the other hand, governments and NGOs, which often operate internationally or even globally, can work together to search for new solutions to human rights problems and environmental issues, for example.

More and more often now, the globalisation of innovation and production requires joint solutions to issue and technology-specific governance issues. These may be in the form of agreements on standards, regulation and common rules. The significance of competencies in this area will continue to increase.

States continue to remain important actors, but they now have to work more closely with other, domestic and more often international actors in seeking to safeguard national interests. There are many weak and strong signals which indicate that the role of nation-states in their traditional functions is increasing again. A growing proportion of the wealth in the United States, Russia, China and other countries is being spent on military security.

Economic protectionism is gaining ground even in the world's leading economies. The battle for natural resources and energy in particular is intensifying, and more and more often the adversaries in this battle are national governments and global corporations.

Competencies related to governance and the assessment of systemic risks are set to gain increasing importance. These risks may have to do with international systems, finance, information and energy systems or ecological systems.



Continuous learning is crucial

Focus areas of competence:

- *the neurological, cognitive, motivational and social basis of learning*
- *human technologies that support learning*
- *technology-based working and operating environments, management of mobile and distributed work*
- *practices of life-long learning, the education system and informal learning*
- *civic skills and competencies, life control and social innovations*



In today's global and technological world, learning has become increasingly important to all people and all communities; it is the best way to cope and manage in a competitive and ever-changing environment. The development of learning is no longer the exclusive domain of education professionals, but a whole host of experts from different fields are needed to organise as well as to support, produce and supervise learning.

The responsibility is widely diffused in society. So great is the need for learning that the only way it can be met is by means of collaborative learning and by taking advantage of the experiences of as many people as possible. Key challenges for the global information society are to gain an understanding of virtual and actual knowledge creation processes, to steer and manage those processes and to integrate them with other activities.





The increase in knowledge work heightens the global competition for skills and competencies

The world of work is in constant flux. For reasons of cost efficiency, there is a growing tendency to relocate manufacturing in cheaper labour countries. Increasingly, jobs that remain in Finland are highly knowledge-intensive, requiring high levels of skills and competencies.

The markets for skills and competencies are global. Expertise can be exported anywhere in the world, wherever it is in demand. On the other hand, experts can be recruited from any corner of the world. Increasing numbers of knowledge workers today work in short-term assignments where their individual skills and expertise are needed as part of a broader project. This has promoted mobile work and distributed organisations. Managing distributed work is a major challenge. The communication between employees and



their managers may be based only on virtual contacts.

In short-term assignments and in mobile work it is difficult to update and upgrade one's competence. This would, however, be crucial to the future employability of knowledge workers. On the other hand, it is difficult for managers of distributed organisations to support continuous learning of individual employees and to emphasize shared learning of all employees of a team or an organisation. There is a growing need for flexible structures and practices of lifelong learning. Learning at work and new web-based social software also have an increasingly important role in competence development.

The requirements of speed and possibilities of virtual work have emphasised the emergence of new business models, such as open source. Instead of strictly protecting a development work up to the launch of a product or service, the idea or project is openly discussed and collectively developed from an early stage in Internet. Based on open source, anyone can contribute an idea or provide improvements in the project in order to benefit the total development. The development resources can thus be multiplied.

Open source could well open up new opportunities in Finnish research and development, which continues to struggle with scarce resources – provided that these kinds of processes are properly managed and that the results can be rapidly translated into new business applications.

More learning outside the domain of formal education

Information technology and information networks have made learning and knowledge independent of the constraints of time and place. Information





is created and distributed globally online via social software. Wikis, blogs and RSS services with aggregators are facilitating online learning in networks and various kinds of communities. Many young people in the IT sector now consider this social software and sharing technologies as the most important way of learning.

Extra-institutional learning should be integrated with formal education at all levels so that people are not divided into two separate worlds of education. On the other hand, given the growing requirements of efficiency in learning, the world of formal education also needs to adopt new modes of learning.

Children spend most of their time outside the school. Whether or not they learn during that time depends upon the environment, parents' resources, and the information links available. Educational equality can no

longer be guaranteed simply by a uniform system of comprehensive education. To some extent equality can be enhanced by developing living environments that support the universality of learning in all different age groups.

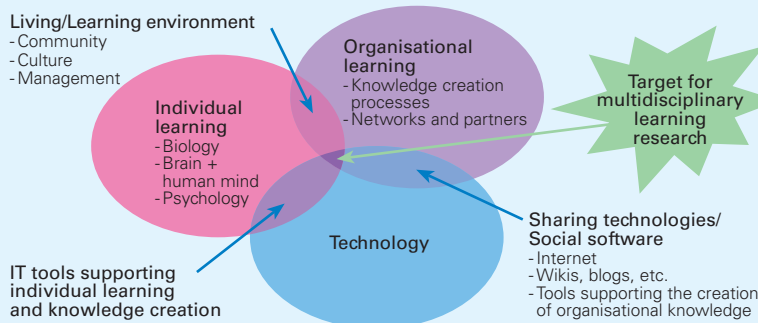
Learning technology to support learning of different kinds of people

Technology can also provide various kinds of support for learning. It can be used to support learning in different age groups, including older people, as well as in people with learning difficulties. Much of the technology development effort so far has been driven by technology itself, the thinking being that people need to be taught how to use that technology.

Given the country's high level of technological expertise, Finland is well placed to develop learning technologies that support users at different levels. This highlights the importance of a close collaborative effort in which technology joins forces with cognitive science and artificial intelligence with a view to creating a learning technology that serves its users.

The key importance of learning in society also underscores the importance of learning research. Whether we are talking about individual, team, community or network learning, this is always a multidisciplinary process. Learning research should adopt an equally multidisciplinary approach.

Multidisciplinary learning, multidisciplinary research





In order to understand individual learning we need to explore the human individual's very own processor, i.e. the brain and the human mind. Furthermore, more in-depth knowledge is needed about the social and cultural processes related to learning.

Complex technologies, the ethical dilemmas related to these



technologies, increasing multiculturalism and the social problems faced by both adults and young people all combine to put learning under much pressure. Examples of these problems include the increased emotional and neurological problems that may be caused by the continuing growth of information flows and stimuli in the environment, such as attention deficit disorders in young people. Not enough is known as yet about the problems caused by learning disorders in the technological environment.

With respect to organisational learning, the main focus needs to be on knowledge creation theories and the preconditions for a learning organisation. Technology impacts both individual and community learning by providing tools and support for the creation and distribution of knowledge.

For individual learning to turn into community learning and collective learning, it is necessary to have an environment where the search and retrieval of new knowledge, learning and the distribution of competencies are consciously steered in the right direction by a manager or "teacher" and where human interaction is supported by culture. The various fields of learning research should be integrated and the experts working in these fields brought together.

Apart from natural sciences knowledge and IT and information society competencies, steps are needed to strengthen people's practical skills as well, such as various manual skills as well as all-round general education in children, young people and adults. Culture and the arts can serve in the role of promoting and supporting learning.



Service sector offers growth potential and new jobs

Focus areas of competence:

- *the promotion of a customer and consumer approach*
- *business competence in services*
- *the development of better housing, service and work environments*
- *the promotion of service exports*
- *data security and information and communications technology in services*
- *culture and adventure services*
- *the renewal of public services*



The role of the service sector in the global economy is continuing to grow. At the same time there are mounting pressures within this sector to raise productivity, to make better use of technology and to develop new service concepts and innovations.

This development is driven by ongoing changes in the global economy: the deregulation of service markets, business internationalisation, population ageing, technology and growing demand in the wake of rising income levels as well as the development of a service culture.

In Finland it is estimated that by 2015, production in the service sector will increase by one-third and the number of jobs by one-fifth. This would mean 300,000 new jobs. Services may be facing a serious shortage of labour.

Technological development and productivity growth have been slower in the labour-intensive service sector than in manufacturing. Productivity can be increased in various different ways, including the reorganisation of labour and management and the development of business competence. This means the ability to create new products, new brands and service concepts and duplicable, automated and electronic services.

Key to the application of technology is not only strong research and development, but also the ability of the service sector to



import and adopt technologies and business models developed elsewhere. The application of these technologies and models in the service sector is crucial to the future success of Finnish service production.

Customer needs and consumer approach in innovation development

A customer and consumer approach is important in all services. No service business can be successful unless it takes into account the consumer's needs and desires. Customer-driven approaches can be developed systematically. This is important in all fields, not just in the service sector, where it is a condition for survival.

Customer and consumer-driven approaches represent a key area of competence that ties in with many different disciplines and technologies, including marketing, business management, business psychology, information and communications technology and design. This is a multidisciplinary area of expertise that integrates several social and behavioural sciences as well as disciplines that are concerned with human action, including neurosciences.

The service sector needs to have a deeper understanding of the mechanisms that lie behind consumers' choices. This can be achieved by exploring and analys-



ing the reorganisation of such aspects of people's everyday life as time use, spending, production, consumption, and leisure, and particularly the dynamics between these different aspects.

In the service sector – and today the same applies of course to industry, for instance – the concept of innovation needs to be defined in broader terms so that it also takes in social innovations, such as new strategies of action, new practices and the development of practices into routines.

Service innovations are developed as, or evolve as, user innovations and practice innovations. Another concept that relates closely to the introduction and diffusion of innovations is that of social learning or inno-fusion.

The emergence of new routines requires both new producers and new consumers (e.g. the new popular pastime of Nordic walking), and on the other hand, a conscious effort to improve material and mental raw materials and places as well as to develop competencies. As far as the reproduction of service practices is concerned, consumers and producers are in virtually the same position.

An understanding of consumers' everyday life, their desires and the dynamics between time, money, consumption and production, also paves the way to ideas that differ from the mainstream. Even quite mundane practices and dreams may provide new, unexpected targets for development.

Examples of the broad markets for service innovations are offered by household services, the impacts of immigration and regional development on the demand for services, and particularly projects for the reform of public health care services.

The customer-oriented and service-minded approach also impact the strategies, value chains and business models applied in traditional industry.



Service exports set to become a strength area

The development of business competence is recognized as an area of key importance in several different sectors in Finland. The service sector is no exception. Business competence can be understood as comprising not only the development of new business models, but also the adoption and application of models that have been developed and proven elsewhere.

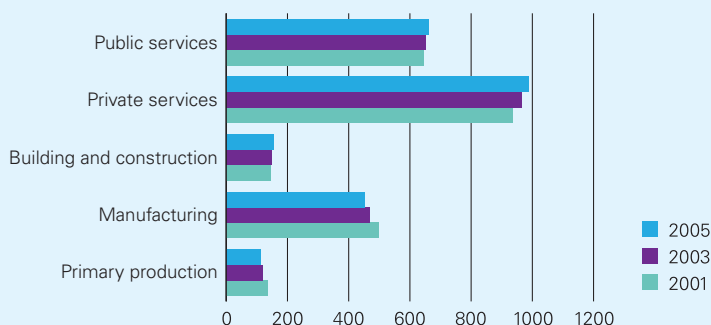
This has to do with marketing, business management, production economics, economic sociology, information technology and logistics. New services are created in all these sectors, with far-reaching benefits for Finnish business and industry. There are thus two dimensions to business competence in the service sector: on the one hand it is a prerequisite for the development of profitable, innovative service business, and on the other hand this competence provides a platform for service businesses.

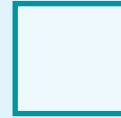
The development of business competence offers various practical applications. These include the broader use of ICTs in service businesses, the development of service marketing, as well as brand creation and brand management. In services, business competence should pay closer attention to customers' needs. At the same time, it should also work to generate value-added service products.

Finland is well placed to become a major exporter of technology services. For reasons of industrial competitiveness it is extremely important that the export of technology services becomes a growth sector. In public services, too, there are probably many functions and activities that can be rationalised with the use of information technology. Administrative back office functions are a case in point.

Areas of particular strength for Finnish exports might include social services, international general purpose services as well as environmental services and technology. Services related to information security technology and information and communication systems might also provide new export opportunities for Finland. Culture and adventure services are a growing field where technology and business competence have great importance.

Employment by main industry in Finland





Service production requires a sound operating environment

The development of better environments is a focus area that requires the contribution and input of architecture, urban and community planning and logistics. However, a number of other fields are also closely involved; these include design, consumer psychology, sociology, marketing and consumer research, culture and art history and environmental aesthetics. Technologies that can contribute include the technology of design, environmental technology as well as housing and living environment technologies.

Better environments are one way of responding to changing needs and demands and strengthening the competitiveness and appeal of Finland. There is a very clear need now to enhance people's immaterial well-being, to create more aesthetic and pleasing environments, to improve living and work environments. These changes are already visible in consumer behaviour, and there is reason to believe that they will gather further momentum in the future if income levels continue to rise as expected.

Finland has every opportunity to become a competitive model country for good housing and good living environments where all people, regardless of where they live, have access to pleasant,



well-tended everyday environments and related environmental services as well as solutions based on modern environmental technology.

It is important that the solutions adopted are in line with the close-to-nature lifestyle that people in Finland have chosen for themselves. The notion of a quiet, clean and safe Finland or Helsinki will certainly fare better than any attempt to turn this into a "swinging metropolis".



The reform of health care system

Focus areas of competence:

- *biomedical research*
- *brain and neuro research*
- *the development of ICTs that promote public health*
- *physical exercise and nutrition research*
- *mental health and substance abuse research*
- *home care and telecare technologies*
- *pharmaceuticals research*
- *research supporting the social and health care system*



Public health in Finland has continuously improved. Life expectancy has increased, and at the same time functional limitations and disabilities due to diseases have continued to decrease. Self-perceived health has improved most particularly in middle-aged groups. It is expected that these same trends will continue over the next few years, which can at least in part be attributed to an efficient health care system. However, that system is now in need of reform, for several reasons.

The population structure is ageing and changing geographically. The growth of the elderly population is evident in all advanced countries. In Finland the dependency ratio is increasing more sharply than in most other European countries. The situation is even more alarming from the point of view of economic dependency. Lifestyle diseases caused by obesity are increasing in all age groups. Alcohol consumption is rising and causing more and more alcohol-related health and social problems.

Changes in the age structure are also driving up the number of ageing-related diseases, such as osteoporosis, cancer and brain disorders. There is also growing concern about the mental health of children and youths.

The reorganisation of care provision can help to make the work of care professionals more mean-



ingful and more attractive. The number of immigrants moving into Finland may become a matter of great importance to the future of the social and health care system, for it is faced with a serious shortage of labour.

Advances in medicine and ICTs as well as the development of new health services models work as counter trends to the changes in the population age structure. These can help pave the way to the more effective provision of health care services for the population. At the same time the emphasis is increasingly shifting to the prevention of diseases.

Globalisation has not and will not have the effect of undermining Finnish welfare society. Intellectual, social and physical capital combined with a system that has a capacity for change, together constitute strong competitive factors in an integrating world.



ICTs to modernise health care services

Health and welfare policy as a whole will need to be completely rethought in the future. The health care system is headed into a crisis, facing a shortage of labour, funding problems in local government and staff overload problems. There are also problems with the availability of specialised health care and emergency care arrangements in local regions. The structures and mechanisms of the service system can be completely overhauled by means of ICTs.

Advances in health technology can help to slow the rise of costs. New pharmaceuticals alleviate symptoms and cure and prevent diseases. On the other hand, future technologies are more and more often high technologies or preventive technologies. High technology provides ways of preventing or curing diseases, but these treatments are very expensive. It is expected that the emphasis in “hard” medicine will shift increasingly from treatment to prevention.

Health technology is constantly gaining in significance. Finland has exceptionally strong expertise in this field as well as good opportunities to test innovations in real environments. In the future, there will be ample opportunities for the practical application of that expertise, as long as industry and academia continue to deepen their collaboration.

Health technology also produces crucially important home care and telecare services, for which there is growing demand with the continuing ageing of the population and rural depopulation. On the other hand, telecare systems also raise new kinds of professional and ethical questions.

New ICTs are also paving the way to improved customer management. With each patient’s consent, health care staff can easily access relevant patient information – by virtue of wireless terminals even without



time and location constraints. A national health portal is needed as a source of general information and guidance on the use of services and on how to apply for benefits.

Various kinds of secure information system services are important not only for improved health care delivery, but they are also valuable export products. Finnish businesses are exceptionally well placed to make use of the electronic health record and the national system architecture in their own product development.

From the treatment of diseases to health promotion

Advance prevention of problems will assume increasing prominence in future social and health policy. The main emphasis will shift to life-long health promotion. From a population point of view the health of children and youths is crucial because health habits and attitudes are acquired at a young age.

Very often the choices of individuals, families and communities are more important than the service system. New technologies and services now give people the chance independently to improve and promote their own well-being.

From a health promotion point of view there are significant development needs in activities aimed at preventing exclusion and marginalisation, the use of addictive and other substances as well as problems in the workplace and in families. The latest research evidence heavily underlines the importance of prenatal and child health clinics to well-being and lends support to strengthening the clinic system, which in recent years has weakened.

More research is also needed into the factors that impact the health behaviour and marginalisation of children and youths. Mental health problems in children and youths are giving cause to growing concern. The numbers retiring on grounds of mental health problems are also increasing.

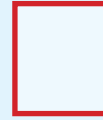
There are several different avenues to health promotion and the prevention of diseases. One of the most important of them is diet. It would be important to gain a clearer and fuller picture of the mechanisms involved in food, eating, health and well-being.

Another important way of maintaining health is by means of physical exercise. Sports services should be set up in places where they are most readily accessible. The development of new sports service concepts requires the input of experts who understand the needs and impacts of exercise for health in different target groups.

The growth of knowledge is revolutionising research and treatment. The challenge now is to make that knowledge more widely accessible. It is the responsibility of the authorities to make sure that citizens receive as accurate evidence-based information as possible.

In recent years the prevention of many public health problems has been delegated from the public health care system to public health organisations. If there is a real and serious commitment to promoting public health in the future, then central and local government will need to clearly step up their investment in this effort.





However, even knowledge is not always enough to steer and shape lifestyle choices, but motivation may be required as well. Citizens are more and more clearly divided now between those leading a healthy life and those with unhealthy living habits. The promotion of health in the latter groups ties in closely with the structural measures taken by society.

Research in biomedicine can pave the way to breakthroughs in health care

The impacts of research in biomedicine extend from basic research through to the various health care sectors. Genomics and proteomics knowledge is opening up new avenues for the prevention, diagnosis and treatment of both common and rare diseases. Practical applications are related first and foremost to the diagnosis and treatment of cancer.

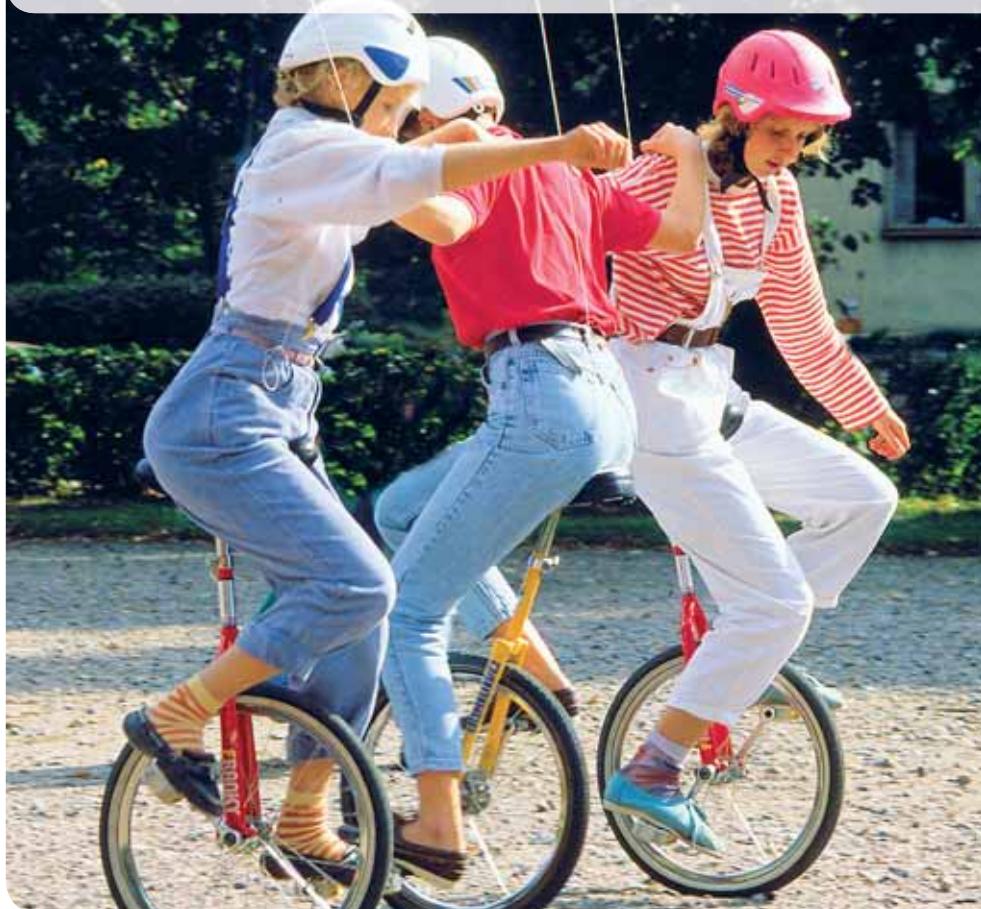
The disciplines and technologies related to research in this field and to its application are very strong in Finland, but also scattered. Our competitive advantage is based on public health care, an atmosphere that is favourable to research, well-studied and well-described population and patient datasets and strong traditions of clinical and basic research.

Finland should invest in molecular medicine, nanoscience and nanotechnology and in practical applications in these fields. Finland is also strongly placed in

the field of stem cell research, which in the near future may be bringing changes to treatment practices in many disease groups.

Brain research is also making rapid progress and producing applications for the diagnosis and treatment of brain disorders and psychiatric illnesses. Practical applications have emerged most particularly in the field of imaging, which is also continuing to make impressive progress.

In the sector of health and welfare technology there is a clear demand for cross-disciplinary experts with a strong background in both mathematics, the natural sciences, technology and biosciences. Core professional competencies will not in themselves guarantee success unless business and marketing specialists are trained at the same time. In Finland, there is certainly a significant need and demand for such specialists.





Environmental management: a new area of strength

Focus areas of competence:

- *the operation of ecosystems*
- *the management of environmental issues in Finland and globally*
- *urban environments*
- *water systems and water cleaning technologies*
- *biomass as an energy source and biomass production technologies*
- *improved energy efficiency or “negawatts”*
- *new energy production systems and their integration*
- *smart sensors and new energy conversion and storage technologies*
- *logistics, distribution*
- *mobile and distributed technologies as a platform for energy and environmental services*



In order to adapt successfully to environmental changes and to put effective measures of environmental protection into place, we will need to gain a much clearer understanding in the coming years about climate change, the operation and tolerance of ecosystems and the mechanisms of ecosystem interdependence.

Environmental management is a demanding business in which the scale of operation often ranges from the local to global. Furthermore, it is dependent on a large number of drivers. Different sectors of society need to be better prepared than they are now to manage uncertainty and to respond flexibly to changing situations.

Finland has an extremely high level of ecological expertise and competence. It is important to make sure that this expertise and competence is fostered and developed and that it is put to even better practical use. Furthermore, the development of methods of environmental management will require support for basic research, joint research programmes among different funding bodies as well as ongoing dialogue between the





research community and other stakeholders.

The natural sciences and marketing are often dealt with in separate fora, but the development of marketing is absolutely integral to the success of environmental and energy technologies. Investment should be channelled via pilot projects to areas that are most important to the global markets. In the future, territorial thinking within individual disciplines and fields of research is no longer viable in either research or research funding.

Product development and commercialisation

Finland has strong expertise in the development and commercialisation of methods of environmental management. It is also a world leader in the application of remote sensing and GPS techniques in research on the impacts of land use and forest fragmentation on biodiversity. There is strong international demand in these areas.

Advanced geoinformatics provides a solid foundation for tackling many environmental issues. Applications require expertise and know-how in such fields as geographical positioning, modelling, land use and urban planning, and hydrology – all important areas of strength for Finland. The institutional expertise – legislation, environmental impact assessment, administration and information



systems complete with laboratories – could also be packaged for export.

Growing challenges and new markets are emerging for sustainable development products, most particularly in two areas of expertise and competence: first, in urban environments and water systems, and second, in water cleaning technologies. European cities already have their own ecodistricts, and China is now working to design and develop whole ecocities.

A competitive advantage in building and construction is gained through a comprehensive overall view, i.e. through various integrated systems in community planning, energy and waste management, transportation, logistics and safe and good quality environments.



Much of the world's population lacks access to drinking water and decent sanitation. A key in resolving this problem is the integrated management of water resources and the development of proper water management systems. Finland has received international recognition for this kind of comprehensive approach to water management, but this expertise still needs to be packaged into more marketable products, and incentives must be provided for collaboration between different stakeholders.

Energy efficiency – a competitive asset

The energy sector is moving increasingly to the use of rapidly renewing raw materials. Given the country's abundant forest resources, Finland is indeed well placed to utilise biomass as an energy source. In the forest industry Finnish technology is already being used to make efficient use of biofuels. As industrial processes continue to develop, so does the energy surplus from those processes increase – and the surplus biofuel can be converted into electricity or some other fuel.

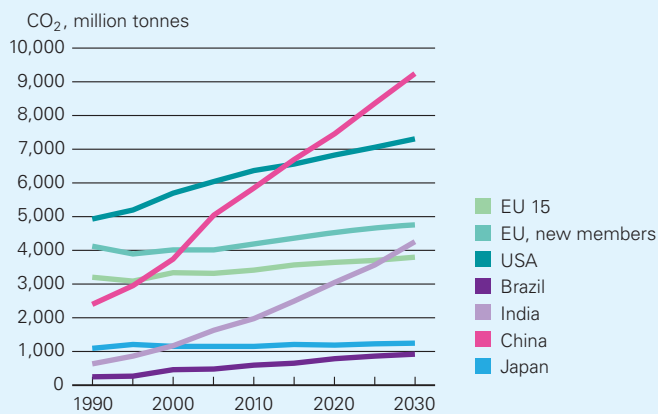
Forest industry by-products can be used in transport fuel production and technology development, an area that could make a significant contribution to employment and the national economy. The forest industry can provide the platform for these more advanced biorefinery concepts.

Energy efficiency offers huge potential. Finland should work to leverage this into a marketable feature in the global competition and the industry's profile as a whole. Energy expertise today is local and scattered and characterised by lack of competition.

The efficiency of many products and applications can easily be increased by one-fifth and even one-half. Energy efficiency should be clearly identified and promoted as a product performance. In the construction of low-rise housing, emissions and energy consumption can be reduced even from the planning stage. Ultimately the aim could be to develop a packaged house that integrates different technologies and that virtually eliminates all energy needs and waste.



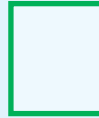
Carbon dioxide emissions from energy production in 1990–2030



Source: European Commission WETO 2003

In renewable energy production methods, there are several promising new areas of development that require adequate research and development investment. A number of new sustainable energy production methods are currently under development and even in use. One of the most direct routes to the production of biofuels is provided by oil plants. The aim is to have plants with as high a yield by hectare as possible. Botany and plant breeding as well as genetic engineering should be harnessed for the development of biofuel production.

There is also growing demand



worldwide for distributed energy. In the development of smart power products, the most important target group and actors are business companies. Pilot plants have already tested small-scale distributed technologies based on fission energy, which might gradually pave the way to generating extra electrical capacity possibly from the late 2010s onwards.

New technologies in the energy sector

Growing climate threats and the scarcity of raw materials have created a strong global trend to develop and adopt new environmental and energy solutions. All in all, technology development in the field of energy production should be aimed at new innovative, commercial solutions that can be exported to many different kinds of markets

Nanosciences and nanotechnology will have a significant impact on the energy sector in the years to come. At its fastest, nanotechnology will improve the efficiency of small batteries, although methanol fuel cells are now beginning to appear in laptop computers. Nanotechnology may also pave the way to increased efficiency in automated control. In this area the key is to locate market niches and to specialise.

It is indeed investments in various smaller, distributed energy solutions that are increasing faster than investments in major power plants; for example, appli-



cations in the 10–20 kilowatt range are attracting considerable interest. Other promising areas include fuel cells as well as solar heat and electricity, which is one of the fastest growing forms of distributed energy production. Solar energy is an export area where there would be strong demand for applications and systems specialists.

In present-day industrial installations, all low thermal energy is wasted. As development needs are increasingly dictated by considerations of energy efficiency and the scarcity of raw materials, one environmentally friendly application might be to capture waste energy from industrial processes and to put it to use in greenhouses. There might well be strong international demand for Finnish expertise in cogeneration, i.e. CHP production.

Finland is a world leader in mobile technology, which provides a solid platform for technology applications in the energy and environment sector. Mobile technology is currently searching for useful services, society in turn is looking for tools that support sustainable development – a match made in heaven.



In the energy field, mobile technology could provide a tool for creating “virtual electricity companies” for instance, in which production is controlled by means of adaptive system technology. In electricity production, a digitally controlled network could be one attractive proposition for Finnish IT expertise.



Modern society has new vulnerabilities

Focus areas of competence:

- *environmental know-how and technology*
- *logistic know-how and security of supply management*
- *multicultural know-how*
- *integration know-how*
- *methods know-how*
- *Russia know-how*



The infrastructure of society is a network of broad structures that are crucial to its operation: transport routes and systems, telecommunications networks, energy, financing and health care systems as well as various institutions and organisations that run these systems. Modern society has become increasingly vulnerable and sensitive to external influences.

For the security of citizens it is essential that society's systems operate flawlessly. Any system failures or malfunctions may completely paralyse society. Infrastructure and security issues are closely linked. Complex interactions and joint effects are involved, and these have become ever harder to predict. It is increasingly important for modern society to manage these kinds of systemic risks.

Globalisation is increasing the movement of both people and information and opening up new business opportunities. At the



same time, however, it is also presenting new potential or real threats to Finnish national security and to the country's infrastructure. Examples include terrorism, human trade, cultural tensions and health risks such as pandemics.

The infrastructure today leans more and more heavily on information and telecommunications networks. Finland's geopolitical location, climate, population size and various energy and environmental resources, for their part, determine the boundary conditions for external and internal security as well as the needs for infrastructure development and



protection. Ecological changes as well as changes in the population age structure and in economic structure and ownership all involve important security considerations.

Closely related to considerations of security, which refers to the impacts of human activities such as wars, crime or terrorism, is the question of safety. Safety, in turn, refers to various mechanisms of protection against accidents or natural catastrophes as well as systems designed to maintain the stability of society. For example, the changing population age structure underlines the need to upgrade and modernise service infrastructures.

Finland is currently under no external threat from foreign armed forces. At least to some extent, the collapse of the Soviet Union and Finland's membership of the European Union have served to strengthen Finland's security policy position.

Globalisation, on the other hand, has thrown up a whole host of potential external security threats against which state borders no longer provide any protection. These include environmental threats, the problems of energy supply, international crime and the expansion of terrorism to Finland.



Close economic dependence on the global marketplace may cause very serious problems in the event of dramatic disruptions to the US economy, for instance, or if as a result of a foreign takeover there were a sudden, significant outflow of capital to cheaper cost countries.

A sound infrastructure is a strong competition factor

Fast communications and the global nature of capital, raw materials, energy and food markets mean that environmental catastrophes, crises and technological disruptions are immediately reflected in the Finnish infrastructure and security situation as well.

Steps should be taken to identify and develop key competencies related to infrastructure and security in several focus areas. Ecological disruptions are among the most significant threats to the safety of the population. Finland has a high level of environmental expertise and technology with which to combat these threats.

Logistic know-how and security of supply are likewise crucial to maintaining internal security and to safeguarding the operation of infrastructures. It is important that the existing ICT competence is used to improve the security of information and energy networks and to resolve the relat-

ed risks and vulnerability problems. This kind of fault diagnostics and system expertise also offers great export potential.

Finland's energy supply and the operation of society also depend on knowledge and expertise about the country's neighbouring regions, particularly on research into Russia and its economic development. The export of infrastructure know-how to Russia might help to support and promote the development of this sector in Finland as well. It is crucially important to secure access to energy and to reduce dependencies on progressively less secure energy sources and increasingly expensive non-renewable natural resources.



Globalisation deepens and enriches international cultural exchange, but it has also created inequality and marginalisation. Migration may incite racism and increase social tensions as well as internal insecurity or the sense of insecurity.

Multicultural competence and support for multiculturalism help to create stability in society. The growth of multiculturalism requires new skills for the management of diversity, a knowledge of foreign cultures and the ability to support and take advantage of the existence of minorities and difference.

Finland is well-placed to develop different areas of integration and management expertise, to develop models of conflict management and resolution and to gain a profile as a country that has the know-how to resolve conflicts and crises, as an expert in diplomacy. This kind of competence also helps to build national security.

It is noteworthy that whereas infrastructures used to be relatively stable and any changes happened quite slowly, in the future changes in society's basic structure may be far more rapid and dramatic. Good examples are provided by terrorist attacks in recent years that have had a profound impact on the global security environment, or by the electrical blackouts that struck large parts of the United States in 2003.





Bio-expertise has broad application

Focus areas of competence:

- *the complete use of renewable natural resources*
- *the development of bioproduction*
- *new biotechnological product introductions*
- *the development of pharmaceuticals*
- *measurement methods and diagnostics*
- *management and modelling of biological knowledge*
- *multidisciplinary synergy and new disciplines*

Finland has made substantial investments in recent years to strengthen its expertise and competence in the biofield. This has helped to create research teams and know-how that enjoy worldwide recognition. In the future, greater effort needs to be made to turn this knowledge and expertise into practical applications.

The principles of sustainable development have an ever greater influence in today's society and industry. The efficient use of renewable natural resources lays the ground both for modernising traditional industry and for strengthening competitiveness in the forest sector and the production of biofuels, for example. In the future, plant biomass will account for a significant proportion of the raw materials used in industry. Finland's



strong basic know-how in the use of large volumes of biomass provides a solid platform for the practical application of the new bio-expertise.

Finland itself is a small market, but it may well emerge as a significant centre for biotechnology production and development. The high level of research in the country at least provides an excellent foundation. However, the business sector that works to convert this research into commercial products remains relatively weak.

Biosciences applications will be used more and more widely in different areas of society and technology. It is precisely the integration of different fields of research that will generate significant new business over the next 10–20 years. Existing research and education structures should be developed



with a view to establishing a stronger multidisciplinary foundation, and the synergies between different disciplines should be exploited more effectively.

New, distinct areas where other disciplines are integrated with biosciences are now emerging in the mathematical modelling of biological knowledge, chemical biology, bionanotechnology, bioenergetics, biophysics and other fields.

Pharmaceuticals research is one of the fields that is using and developing bio-applications. However, it is important to take a broad view on the innovation potential in the health care field rather than consider it in terms of pharmaceuticals development only. We are well placed to take advantage of Finland's unique population genetic datasets and studies of hereditary diseases.

The challenge of bio-business

Biomolecular and biotechnology products are expected to open up significant new business opportunities for the future, provided that the investments in new innovations generate sufficient returns. The conversion of research results into commercial products with greater efficiency than is currently the case will require steps to rearrange or intensify business co-operation, to establish closer contacts with international investors and to

have a clearer division of labour between academia and industry.

New noteworthy products that have grown up out of the research investment include biomaterials such as biodegradable plastics. Important areas of development for Finland also include the development of new materials or structural components out of natural polymers such as cellulose and starch. Biotechnology applications have uses not only in industry, but also in the service sector.

Enzyme technology has led to the development of new and more effective detergents. Wide-scale cultivation of transgenic plants is now starting up, the use of biofuels is increasing and new biosciences applications are being introduced in health care.

There are also examples of profitable bio-business in products that are not based on Finland's earlier strengths. These include measurement techniques and diagnostic methods in the field of molecular biology, which have seen rapid advances. The markets for research reagents are considerable, and the development of these kinds of research services and research materials would be ideally suited to Finland.

There remain bottlenecks in commercialisation. For instance, there is no significant pharmaceuticals industry in Finland that could provide support for commercialisation or training for experts in this field. Far more Finn-

ish venture capital would be needed for biotechnology innovations than is currently available; the commercialisation of new pharmaceuticals in particular requires huge resources, and the results will only make themselves felt more widely after some time lag.

One way of attracting foreign venture capital to Finland would be to strengthen the structures of centres of expertise, to take advantage of innovations originating elsewhere and to get internationally recognized experts to work for Finnish companies. It is also important that researchers are motivated for a long-term commitment and that agreements are in place to make sure that the benefits of commercialisation are equitably shared.

For biotechnology innovations to retain their significance particularly from an employment point of view, it is crucial that production remains in Finland. That will require an ongoing development effort in bio-production.

Management of biological knowledge is key

The volume of biological knowledge has grown and continues to grow phenomenally. There is virtually no limit to the number of measurement applications. Keeping up with developments in this field will require the management of efficient, reliable methods of measurement as well as information technologies, which in turn



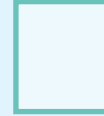
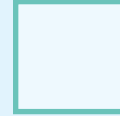
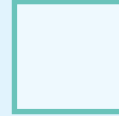
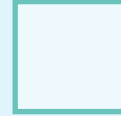
opens up new opportunities for the software and hardware business. The management and application of knowledge will be a key competitive factor in biosciences research and related business ventures.

Advances in measurement and diagnostic methods provide another example of a transdisciplinary area of application that has seen impressive development. This area of competence has broad application among others in medicine, industry and environmental research.

Pharmaceuticals development is an important area for biotechnology applications. The development of better and faster diagnostic methods may significantly contribute to the treatment and even prevention of diseases. With the continuing growth of genomic information, these methods will help to provide more accurate predictions of risk of illness, in the same way as blood biomarker analyses, for example.

Research into the population genotype is one of Finland's most outstanding areas of strength. Finnish datasets are comprehensive and highly standardised. It is expected that population genetic and molecular biology research will pave the way to the development of new tests and new medical drugs.

There is also much expertise in cancer treatment and diagnosis, which may prove invaluable in the development of new, specific cancer drugs. Similar breakthroughs may also provide useful clues for the targeted treatment of other diseases, such as brain disorders. Further areas of strength include research into infectious diseases and immunology, which offers a platform for projects in pharmaceuticals and vaccination development.



Advanced measurement methods and technologies are used both in bio-processes for purposes of producing chemicals and new materials, for quality control purposes in the food industry and in studies on the state of the environment. In the future we can expect to see the proliferation of inexpensive, easy-to-use and portable measurement devices that can be used to relay information wirelessly to a doctor or to the control centre of an industrial production process.

In industry, the new measurement technology is needed for instance in processes of bioenergy production. Biotechnology should be used in order to diversify the Finnish industrial structure and industrial products. The biorefinery concept will be a significant part of the future bio-society. Raw materials and waste will be processed into as many different basic substances as possible, such as sugar, fibres or extracts, which are then refined further into biomaterials or chemicals, for instance.

Other important bioindustry products include the basic units of a certain line of research: cells. Lactic acid bacteria, for example, are an impor-



tant product in the food industry. Finland also has sound expertise and experience in the production of valuable proteins and enzymes.

Production organisms and gene technology can pave the way to the more efficient use of raw materials in industry, such as the production of bio-ethanol. The use of cells for productive purposes requires a close understanding of how they work and function. The manufacture of production organisms often requires the transfer of external genetic material into the organism, or significant modifications to its own metabolic routes. Increasingly, this requires the tools of system biology and bioinformatics.



Ubiquitous information and communications set for a breakthrough

Focus areas of competence:

- *communications technology*
- *interaction, usability, user interfaces*
- *sensor technology applications*
- *data mining, analysis, management and retrieval*
- *telecommunications*
- *service development*
- *reforming traditional industry*
- *digital information infrastructures in society*
- *software industry*
- *bioinformation technology*
- *hardware industry*

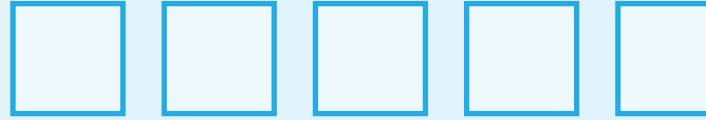


Information and communications technologies are profoundly reshaping ways of doing business and other aspects of society. For Finland, which has long been working to build up a strong technological expertise in these fields, these changes will offer significant new business potential.

The main challenge is presented by the rapid growth of expertise and competence in emerging economies and by the need to integrate citizens' information society competencies in this process of change.

One of the conditions for the success of the ICT sector in global competition is that it works to strengthen innovation in those areas and on those levels where it is possible to generate superior added value in a rapidly changing environment.

The ongoing change in communications technology involves a whole host of closely linked and mutually supportive drivers in development. Information and communications are becoming ubiquitous. By 2015, virtually all people living in industrial countries will have access to multimedia services based on mobile or other terminals. Services based on ubiquitous telecommunications and information retrieval seem to develop very rapidly over the next ten years. The key words are real-time information, multilingualism, location awareness, targeting and personalisation.



Government functions and services are increasingly moving online. Internet shopping is also increasing. Furthermore, business companies and public administration are working to develop and introduce more automated and self-service solutions.

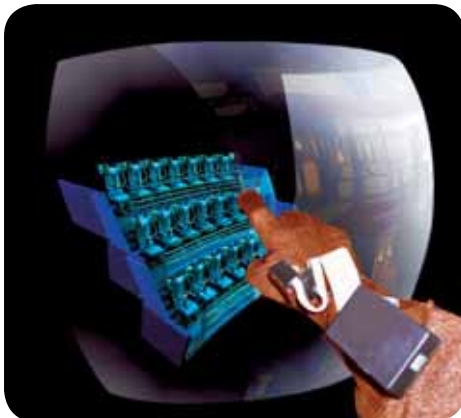
Media and technologies are rapidly converging, which means that telecommunications networks and computers will converge as well. Data, sound and images are transmitted over the same networks, and the same terminals can be used for the use of different types of contents. These changes will increase digital contents and demand for those contents, which in turn will open up new kinds of global markets.

Closer cooperation between the ICT, forest, bio and media industries

Finland has world leading expertise in three key industries: information and communications technologies, the forest sector and the communications sector. It is of great national importance how these sectors succeed in working together to develop new solutions and new products.

There are many new interesting areas of research and technologies at the intersections of different fields of expertise, and Finland is well placed to become a pioneering force in the development of these areas. For instance, printed functionality – optics and electronics – can pave the way to various combinations of fibre-based products and electronic media, i.e. hybrid media.

These kinds of innovations generate added value to consumer services, information retrieval, electronic trading, education, marketing as well as entertainment and leisure services. Hybrid media is a multidisciplinary field that requires not only technological know-how, but also research into end-users' communications needs and behaviour.



One potential area of development and even exports is ICT-based learning tools. There seems to be a lack of national will at the moment in the field of learning technology. Other interesting areas of development include the use of digital television and mobile television in learning, as well as on-demand learning, such as services related to learning while

working. In general, it is crucially important that the scattered know-how is coordinated and brought together so that it can be put to more effective use.

Standardisation, the creation of ontologies and the semantic integration of information are all part of the broader exercise of developing knowledge management. Web-based society needs to integrate its separate information systems: a current example is provided by the challenge of integrating patient information systems in health care.

In culture and entertainment, the digitalisation of contents continues apace and by 2015 the country's main cultural heritage will also be available in digital format. This effort is very much dependent on public sector funding, copyright issues and advances in display technologies.

Finland has strong expertise in telecommunications and the potential to become a pioneer in the convergence of heterogeneous networks at the gigabyte level. A seamless telecommunications system composed of different networks and technologies provides a sound platform for the development of new services and contents.

Putting digital data resources to better use

Individual citizens and businesses both have a great interest in accessing and further processing



the digital data resources that have been collectively compiled. This sharing of resources provides a sound basis for the development of a national information society, international cooperation and the emergence of new services. It also contributes to better decision-making.

The free movement of information requires the development of digital information infrastructures. Among the fields integrated with ICTs in this area of competence are remote sensing and positioning as well as cultural sciences and the media sector.

Mobile devices are an important part of digital information infrastructures because they are used to create services for such purposes as navigation as well as guidance and assistance. In general, investment in GPS expertise should be considerably stepped up.

In the development of the information infrastructure, special consideration should be given to

the potential for industry to develop services and generate added value out of different materials. It is equally important to make sure that private citizens have access to sources of information. This will probably require test environments that could be funded through various kinds of programmes.

The digitalisation of contents and services in information society will also require new service concepts and new business models. New Finnish-developed electronic service concepts have definite export potential. Indeed, it has been suggested that electronic services are emerging as a "second Nokia." However, questions of copyright present a major challenge that will require global solutions.

One particularly significant area is the intensification of traditional service production by means of information and communications technologies. As yet this has received only limited research attention. More accurate instruments are needed for measuring the true impacts of ICT introduction on productivity. This will require the development of test platforms such as the living lab as well as involving staff and customers in the development of IT-aided services.

Digital media: a new growth area

Programming and software have a key role to play in the development of information technology. Increasingly, the operation of society is controlled by means of computer software. Society, therefore, is increasingly dependent on software that works.





The size and complexity of software have grown hand in hand, and the same trend will continue in the future. There are question marks about the reliability even of existing applications, and it is very difficult and expensive to try and improve them. Unless methods can be improved, the problems with software technology may become a bottleneck in IT development.

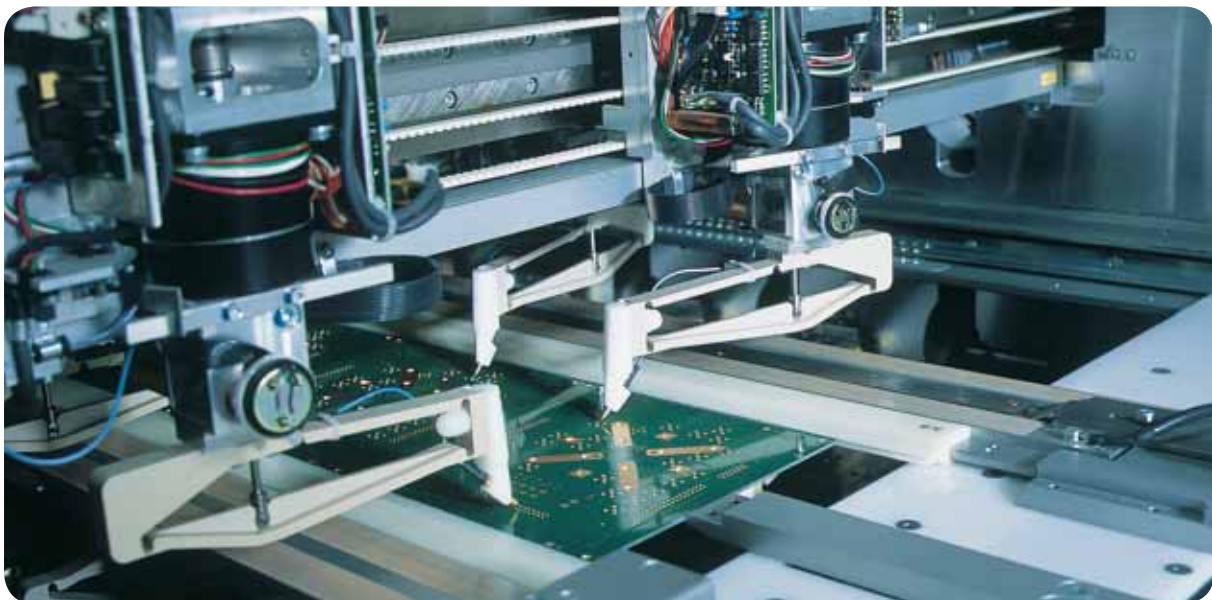
Software is worldwide being outsourced to lower cost countries. This may lead also the Finnish software industry to lose one of its most significant competitive assets: its hold over software development. If this trend continues, research and the workforce in this sector will begin to dwindle.

The role of open source code, on the other hand, may well increase in the future. It enjoys very strong support among researchers and programmers in the field. It is possible that we will see a divergence in software between publicly funded program development based on open source code and closed software development in business companies.

The digital media markets have continued and will continue to expand around the world. The market will become even more consumer-driven. Media uses will continue to diversify. The adventure and experience industry will open up new business opportunities both for technology and content production. The competencies of the experts in this field need to be integrated. A key characteristic of the Internet era is that software is becoming more service than product. Business models have to reflect the change.

The growth of digital entertainment and the electronic exchange of music and film files are increasing the capacity requirements of the communications network and memory chips. The network structure will change significantly with the proliferation of affordable gigabyte connections. Research needs to respond to these challenges that concern both hardware manufacturers and operators.

However, the need for investment in the semiconductor industry is growing faster than the expected revenue. This may even have the effect of slowing down the development of the ICT sector. With the ever shorter life-cycle of semiconductor technology (CMOS), it is imperative to search for new innovative solutions.





Human interaction and understanding lay the foundation for human welfare



Focus areas of competence:

- *human interaction, understanding and dialogue*
- *multicultural competence*
- *language and communications*
- *life-long learning and understanding*
- *people and media*
- *human technology*
- *human creativity*
- *increasingly intelligent technology*
- *deep understanding of own culture*

Human interaction and the learning that takes place through interaction provide the very foundation for the welfare and well-being of both individuals and society and indeed for all development. People's mental resources, their experiences of community and their knowledge of their own and foreign cultures are absolutely crucial to the creation of the future.

Efforts to deepen understanding and strengthen processes of interaction will also open up space for creativity, which in turn generates new social capital and innovations.

Finland's future success depends on our being able to strike a balance between stability, continuity and change. The humanities, social sciences and behavioural sciences are all working to deepen our understanding of the processes of human change and of how to achieve balance in the midst of these changes. It seems that the differentiated world-view of the natural sciences and humanities continues to hamper the achievement of comprehensive, interdisciplinary understanding.

Finland has a strong and diverse tradition of interaction research in different fields as well as strong technology expertise in these fields. In order that this technological expertise can be put into practice, we need a new understanding of language, culture and interaction. Language technology promotes human understanding, but in order to do this it needs to explore and gain deeper insights into interaction and multilingualism.

Finland has a high level of know-how and expertise in research on communication, interaction, language and language technology. However, there is still room for improvement with respect to the collaboration between information technology and language studies in other disciplines; improved cooperation here would certainly be a major asset internationally. One important way of promoting a multidisciplinary interactive perspective on communication, language, culture and social activity is to bring together existing strengths.





Mental resources stretched to the limit

Several ongoing changes in people's living environment – technologisation, the information flood, the growing demands in the workplace, and a way of life pervaded by competition – are placing a huge drain on their mental resources and capacity.

In the midst of all these changes it is important to address and look after people's emotional needs and socialisation, such as their need for constancy and community, and to make sure they have meaningful human relationships and a capacity for empathy.

This is most important of all in the case of children and youths: it is important to look after their mental well-being, for that will largely determine the success of individuals and society as a whole. Another key factor is the creativity of individuals: supporting children's imagination, creativity, independence and skills of interaction is paramount to fostering their mental resources.

Earlier, welfare and equality used to increase in the wake of material affluence, but nowadays economic growth no longer automatically brings about human well-being. On the contrary, it seems that in countries with higher standards of living, children's and youths' problems are only increasing.

A sense of insecurity may trigger processes of violence and marginalisation that are hard to predict. Indeed, the current changes present a host of new challenges to welfare society. It is essential that welfare society not only safeguards people's financial security and economic equality, but also looks after success and equality related to mental well-being.

People in Finland must learn to take good advantage of difference and

search for new perspectives: by rising to this challenge they can also create new opportunities for learning. All the various means that are available for increasing, researching and supporting understanding must be put to use.

Investment needed in human technology

Human technology refers to technology products that are suited to people, that add to people's mental, physical and social well-being and that promote human dignity.

Among other things, human technology produces intelligent information networks and various kinds of smart devices, learning and cultural services as well as health





technology and language technology applications. One of its distinctive features is that it allows for the difference of individuals, for instance that they speak different languages and are of different ages.

People today are spending more and more time interacting with different kinds of machines, which is also changing them. The proliferation of technical appliances is also making people and societies, in all their complexity, increasingly vulnerable – even though technology is at the same time contributing in many ways to increasing safety and security.

Human technology also deals with the various drawbacks and difficulties that are bound to increase in the wake of technologisation. More and more open debate is needed about the technologisation of people's living environment and its value implica-

tions – debate and discussions for which technology is at once, somewhat paradoxically, creating new forums.

Online communication is facilitating the involvement of ever greater numbers in active grassroots participation. Key areas of future research in communication studies include multimediality and technology-driven interaction.

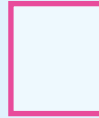
Finland has extensive expertise and know-how in the fields of information technology and electronics, but it is possible that the main export assets of technology industry today may decline in the future. New areas of growth are needed, one of which is cognitive technology. This area of expertise is created by the opportunities that are opened when competence related to the mind and the brain and on the other hand competence related to language and thinking are integrated with technological know-how.

Information networks, personal smart devices, learning and cultural services as well as health services and language technology applications are all an integral part of the future in this field.

Making multiculturalism an asset

Multicultural competence is needed both in the workplace and in different social situations. It comprises the knowledge, skills and attitudes that are needed for the effective management of a multicultural and international environment and for intercultural communication and interaction. Multicultural competence has not only social benefits, but it is also a production factor that supports the international success of Finnish business and industry.

It is important that existing competencies related to the integration of immigrants are put to more effective use. Immigrants are a resource in



the workplace. Successful integration also works to prevent tensions from rising in society. More research knowledge is needed about how multicultural workplace communities operate, how the entry of immigrants into the labour markets is facilitated or how human relations are fostered in the workplace.

No mechanisms are currently in place to measure or monitor the success of the authorities' integration activities. Furthermore, we continue to lack knowledge about how immigrants themselves experience these

activities, and about how they could be encouraged to take a more active part in these activities.

In the field of economics, there has been some research concerning multicultural management and intercultural marketing, although in Finland it still remains quite modest. In the future, it is necessary to step up transdisciplinary cooperation between economics, communications and the social sciences, for example.

Multiculturalism does not in any way threaten or undermine "Finnishness"; even in our globalising society, people will remain collectively and culturally distinct from one another. On the contrary, Finnishness is a highly-respected "brand" today: the country's past history and harsh climate have given great strength and flexibility to the Finnish people.

Finnishness is certainly worth fostering and developing as an area of new social and human innovations. Examples include international intermediation and the better exploitation of the natural environment, culture and related technologies.

Among the features that may well become weaknesses in the creation of human networks or in the international marketing of our competencies are an ethos of going it alone as well as the relative cultural and ethnic homogeneity of Finnish society. Making the best of difference and searching for new perspectives are an ever-increasing challenge for Finland and its people.





Materials development opens up new alternatives

Focus areas of competence:

- *technology transfer, innovation chains and processes*
- *printed electronics*
- *new surface techniques*
- *specialised and effective use of wood, biomass and renewable natural resources*
- *cost-effective, environmentally friendly steel products*
- *biomimetic materials*
- *new carbon materials*
- *multidisciplinary and cross-technological applications in health care*
- *photonics materials development*
- *electronics materials development*
- *biomaterials and bioactive materials*
- *controlled synthesis of polymers*



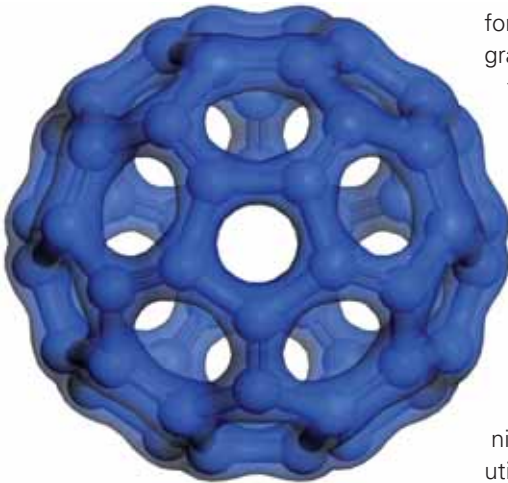
The future of materials production depends largely on Finland's success in strengthening the areas of competence where it is possible to gain the greatest competitive advantage. In the years to come, increasing investment will be required in materials production that uses renewable raw material sources, as the scarcity of oil is driving up the price of plastics.

The need for alternative energy sources and new materials and related technologies has opened up whole new opportunities for Finnish research and innovation. The development of traditional materials also continues to hold significant potential. In particular, the more efficient reuse and recycling of raw materials will be important for sustainable development in the future.

The search for new research partners in the east is also expected to open up new opportunities. The management and coordination of multicultural research teams requires considerable skill. This is an area that will require significant development effort in education.

Stronger interdisciplinary cooperation in materials development

Major scientific and technological achievements can be expected to flow from interdisciplinary cooperation between the natural sciences and technology fields in materials development. An interdisciplinary approach, in this case, requires



expertise in physics, chemistry, biomaterials, electronics, communications, programming, automatics, medicine and biology.

Interdisciplinary cooperation is also needed in a broader sense:

for instance, materials research and product development should be integrated with design and cultural competence. Nonetheless, it is important to bear in mind that much of the most important work is still done within individual disciplines – if all activities at all levels were interdisciplinary, that would effectively undermine the preconditions for interdisciplinary cooperation, i.e. the in-depth expertise in different fields.

There are numerous areas of competence in the field of materials production. Some of them are relatively well-established and support existing industries, others are still at the stage of basic research, potentially looking to generate completely new products and innovations. Many of these areas of competence are related to reinforcing and regenerating existing lines of industry.

Major focus areas in this field include surface engineering techniques and printed electronics as well as the specialised and effective utilisation of wood and biomass. Technology transfer is a separate competence area that ties in with the development of all other innovation chains. Technology transfer should be improved at least by developing funding structures, by intensifying cooperation throughout the network of actors and by providing training to technology transfer professionals.

More generally, there is a need in materials production to invest in modelling, particularly in the seamless cooperation between modelling and manufacturing, which is crucial to the fluency of production.

New materials to provide intelligence and functionality

Printed electronics combines the expertise and assets of Finland's strongest industries – electronics and paper – and can gain a significant position in different applications. Printed electronics use materials whose electronic properties can be printed onto different kinds of surfaces.

This kind of electronics is highly cost-effective and can therefore be used even in disposable applications. There is a wide range of possible applications from packagings for commodity products through product specifications to different kinds of printed products and electronic displays.

Surface techniques are of central importance to all major industries in Finland and to many emerging branches. Surface technology and surface treatments will rapidly gain in significance in the near future. Over the next ten years, major advances are expected in the development of dirt-resistant, self-lubricating, antibacterial and smart surfaces, for example.

New surface techniques will offer improved product characteristics, or they may even pave the way to entirely new product functions. High expectations are placed on nanotechnology. An example of functionality is provided by materials that respond to changes in temperature or pressure based on sensors embedded in their surfaces.





The development of self-healing surfaces is in turn expected to open up new horizons on product life-cycle thinking. Already important advances have been made with various surfacing techniques and in the nanostructures of different types of surfaces. There are a number of small businesses in Finland exploiting the existing expertise in this field. Nanostructure surfaces may be dirt-resistant, exceptionally durable or refract light in a specific manner.

Materials are expected to have ever new properties. In particular, they should be environmentally friendly, recyclable and help to save materials: people now want more with less. With soaring oil prices and falling paper prices, the use of biomass is considered a viable way for reducing emission levels.

Finland's high level of research, development and industry in the field of forest management and use provides a solid platform for the development of new materials in wood processing. Researchers both in Finland and elsewhere are looking into ways of producing biofuels out of ethanol and lignin, which are obtained from wood.

Finland has strong traditions in cellulose chemistry and in the chemical processing of cellulose. Because they are biodegradable and compostable, cellulose-based products have a new future in the packaging industry, for example. There are also new applications for lignin in the manufacture of bioplastics and glues.

New carbon materials and biomaterials are a very interesting potential new area of expertise and are receiving much research attention around

the world. One way in which Finland could benefit from the development of these fields is through the search for new market niches.

It is too late for Finland to mount a large-scale basic research programme on carbon materials, but it is nonetheless important to keep a close eye on developments in the field and to make carefully targeted research investments. In principle it is possible that in the future carbon materials will partly replace silicon-based electronics and that we will be moving on from the Silicon Age to the Carbon Age. Great expectations are placed on carbon nanotubes, offering excellent thermal and electrical conductivity, and huge advantages over steel in terms of strength.

Two key aspects in the development of biomaterials are those of multidisciplinary and biodegradability. A familiar example of biomaterials is provided by contact lenses. A biomaterial may be one that does not cause tissue rejection. A new field of research now emerging alongside biomaterials is that of biomimetic materials, in which the aim is to emulate the functional properties of biological materials. This is a particularly strong area in Japan and the United States. In Finland as well as elsewhere, the topic is still at the stage of basic research. Therefore any allocations of public funding must be carefully selected.





Global economy needs innovations



Focus areas of competence:

- *assessing and managing global risks*
- *the impacts of business globalisation on national economies*
- *exploiting global knowledge*
- *reforming the public sector, the prerequisites for taxation, and public acquisitions*
- *enhancing the production and exports of services*
- *promoting and managing the innovation process*
- *new research challenges*
- *international migration*



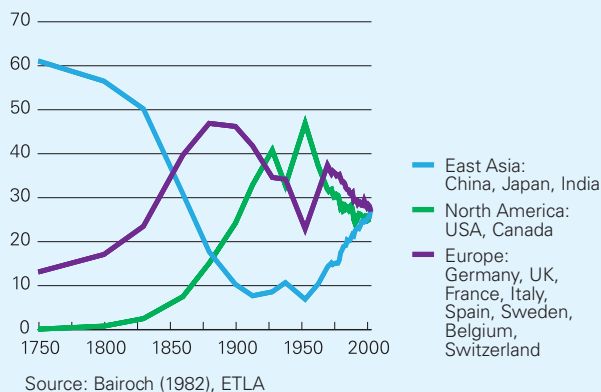
Global competition will present ever-greater challenges for Finland in the years to come. This applies to all areas of society and the economy, including business and production, research and development, and educational policy.

With the development of the global economy, three focus areas of competence are expected to become particularly important to Finland. These are the management and intensification of innovation processes; the development of services, their conversion into products and export; and the more effective use of globally produced knowledge.

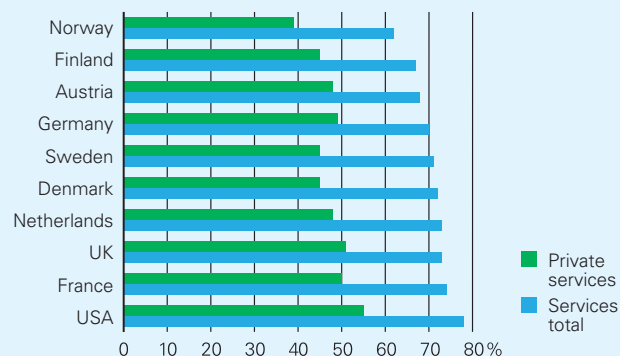
It is also important that Finland has a clear understanding of the implications of economic globalisation to business and to national economies, for more and more industries are now having



Breakdown of world industrial production by region in 1750–2003, %



Service production as a proportion of GDP in selected countries in 2004, %



to compete in what is a global marketplace. It is necessary to make sure that information about internationalisation and global business operations is readily accessible through research institutes, Statistics Finland, international organisations and business and industry organisations.

A major factor impacting the Finnish economy and its structure is the liberalisation of world trade, although that is now largely taking place through regional mechanisms as many market areas are keen to start the process of integration on a local basis. However, this trend may also lead to trade bloc formation, which may deter growth.

Environmental agreements are also having a major impact on the operating environment of national economies. All in all, compe-

titution and the globalisation of work are stepping up the demands on efficiency, which is increasing pressures to lower costs. At the same time, however, new business opportunities are opened up for manufacturers of highly specialised products, systems and technologies.

Creative research inspires innovations

The management of the innovation process is rated as the single most important area of competence in the global economy. It is important not only for research and product development, but also for management and other areas.

Competence and know-how means producing and developing new knowledge, networking and the application and integration of so-called tacit knowledge with codified research knowledge. The conditions for networking are excellent because in a small country it is easier to get key experts and decision makers to work together towards a common objective and to make decisions at short notice. It is necessary to promote and increase networking among business companies, universities and research institutes as well as decision-makers in the public sector.

In order to generate innovations it is necessary to have an adequate infrastructure – opportunities for creative research and development. Requirements of efficiency must not be allowed to undermine creative innovation and its resources.

Finland needs to be able to attract competent professionals into the country, particularly in those fields where Finnish skills and competencies



could still be improved or where a shortage of skilled labour is anticipated. The same applies to universities: one way to get competent immigrants to move into Finland is to offer more places for foreign students.

But this is not yet enough; the foreign talents must also be encouraged to remain in Finland by offering them inspiring job opportunities. It is particularly important that employers show a positive attitude to the recruitment of immigrants.

Much progress to be made in the export of services

The development of services, their conversion into products and export is another significant focus area for the future. There are several reasons for this. Service production accounts for a growing proportion of world trade, and the same goes for Finland's gross national product. Service production is important not only for general welfare, but also for industrial competitiveness, as a growing part of industrial foreign trade is related to services.

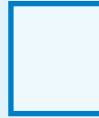
There is plenty of scope for growth in health care, welfare services for the elderly as well as in wholesale and retail trade and business services, for instance. The development of these opportunities requires interdisciplinary development programmes as well as efforts to recognize ICT opportunities and user needs and to test new concepts. Successful services are those that integrate social, commercial, organisational, technological or design expertise, among others.

Finland still has much to learn in exploiting opportunities for service exports. Finland has been described as a "self-service society" and it continues to lag behind the competition in the export of services. Traditionally, the private services sector has been relatively small in Finland and the whole service culture still needs development.

Nevertheless, Finland has one resource that is crucially important to service development, i.e. relatively highly educated human capital. The development of services also requires a favourable business climate, which can be fostered by means of economic policy.

It is absolutely crucial in the global marketplace to have a clear understanding of how demand and needs as well as markets change both in services and in other business. As has often been observed, Finns are good at developing new products and technologies, but we very much lag behind in sales and marketing skills. This does not bode well for our chances in world market competition.

Finnish export industries and other business that are active in the international marketplace will need to invest in improving and developing their marketing of services as well as the customer-driven product development efforts that are required in that marketplace.



Special expertise in risk analysis and management

Greater efficiency in the use and application of global knowledge will assume increasing importance in both business and industry and science and technology. More and more often, key knowledge is produced outside the boundaries of small countries, but at the same time that information spreads much faster and more widely than before. In order to remain at the cutting edge of research, Finland needs to be well prepared for change and to have in place the mechanisms for monitoring international developments and for using and transferring global knowledge.

International risks are set to increase in the global economy, and Finland is well placed to emerge as a major expert in the analysis and management of the vulnerabilities related to information, telecommunications and energy networks as well as in related business areas. Finland also has special expertise in risks related to forests and environmental changes. There is a need for interdisciplinary research and for the development of new evaluation and management methods.

Finland itself needs new information about global risks and their management for purposes of foreign policy, economic policy and energy policy and for ensuring the health of business and industry. Energy market risks are particularly important since they can have dramatic impacts on the economy and on politics.

Finland is a small country and needs to concentrate its high-level research in those areas and those research units that have special expertise and a competitive advantage. It is important that knowledge produced elsewhere is put to effective use both in cutting-edge research and in production.

In order to succeed in global competition, Finland must encourage internationalisation among its researchers who are working in smaller fields of expertise. One possible avenue is provided by the mobility of researchers. Businesses must also be encouraged to participate in international cooperation through publicly funded research and development projects. Research should also work to create new tools for the use of global knowledge.

In its key market areas, Finland needs to have more multilingual people who have a strong background in international business and who are familiar with the local culture. Social, communication, and interaction skills as well as cultural knowledge are increasingly important in the global economy.

As the hub of the world economy shifts to Asia and other emerging market areas, there is also growing need for research into the economy, culture and politics of these markets. More coordinated or better networked research on these areas as well as on developing countries would enable better access to knowledge.



Interfaces and synergies



The themes and focus areas of competence addressed by the foresight panels form a whole series of interfaces that are in a constant state of flux. Many of these themes and focus areas of competence are closely interwoven, and their collaboration is expected to deliver significant synergy benefits and provide opportunities for breakthroughs and innovations.

The cornerstones of a good life include good health and the opportunity to understand through rich interaction and learning throughout the life span. These are also basic measures of welfare and development in society and keys to groundbreaking, creative work.

There is an abundance of new interfaces between bio-expertise, information and communications and materials development that offer great potential for scientific breakthroughs and new technologies and innovations. New services and service innovations pave the way to new approaches



and new ways of doing things, facilitate new welfare solutions and renew businesses.

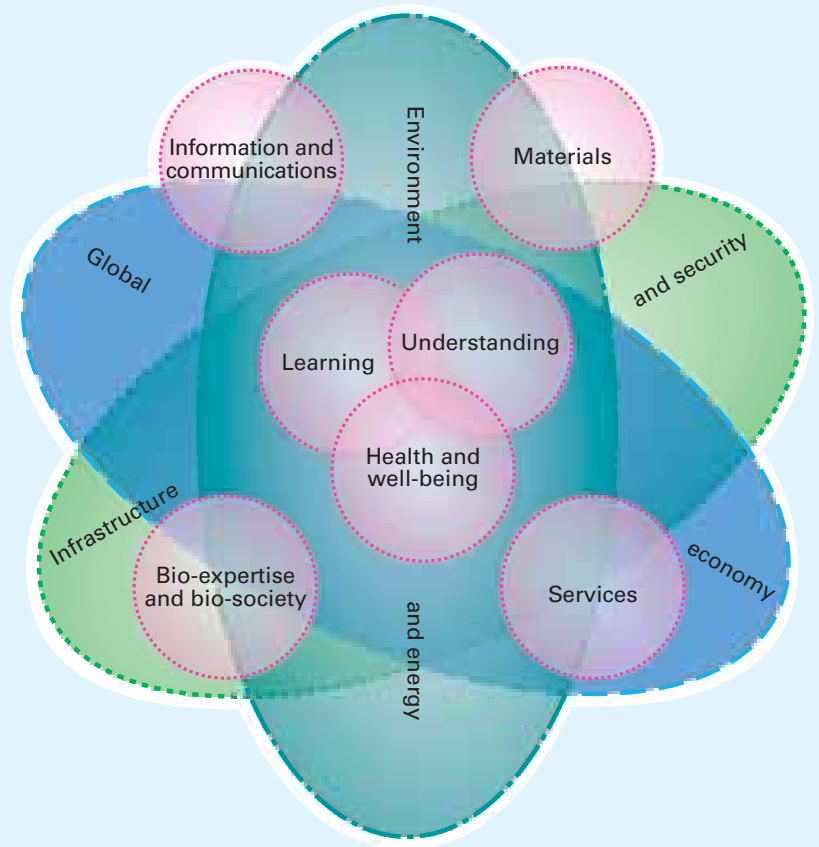
Environment and energy issues as well as the security and safety of society's infrastructure are among the most critical issues for the future of Finland and indeed the whole world. The development of the global economy and governance provides the basis for national wealth and for people's well-being.

The depth and diversity of knowledge and understanding included in the focus areas of competence covered by FinnSight 2015 cannot be reduced into simple models or formulae. What lies ahead for Finland in 2015 in the light of this foresight project? One possible way to form an overall view is presented schematically in the figure below.

All countries share the same interest of developing competencies in order to increase wealth. However, it is crucially important that this is done on people's own terms: in this way the outcome will be more satisfactory and more sustainable both from the individual and from society's point of view.

The development of research and technology creates new innovations for greater wealth and welfare. This is facilitated by those competencies that together with other competencies create new practices: information and communication technology, bio-expertise and materials know-how, service innovations and society's infrastructures.

Intersections of competencies



The development and application of competencies is taking place in an economic, political and cultural environment that is ever-changing. The challenge for both citizens, businesses and society is presented by global development: as well as inspiring and encouraging development efforts, it also involves new risks that need to be taken into account. The most critical issue for the future has to do with the sustainability of the natural environment and the availability of energy – and their global management.

I On human terms



Interaction and learning take precedence

The human mind develops in the process of cognitive and social interaction. The basic knowledge we have about the functioning of the mind and the brain and the practical competence related to the mechanisms of thinking and language are now being integrated with technology. Our understanding of the human mind and how it works is continuing to grow.

All this provides a more solid basis to explore the underlying causes of learning difficulties and to develop life-long learning and high-level, sometimes unexpected learning environments. The solutions are based on a basic understanding of human biology as well as emotional and social interaction.

Health promoting policy and citizens' choices

Finland's competitive advantages in health expertise lie in public health care, a research-friendly atmosphere, well-researched and well-described population and patient datasets and a high standard of clinical and basic research. Finland offers an ideal environment for the responsible operation of biobanks and stem cell research, for example.

People today attach ever greater importance to the promotion of health and the maintenance of functional capacity. There is a



growing understanding of the impacts of lifestyle choices on health and well-being. Health policy is geared to encouraging a healthy way of living and preventive public health care. People's own choices gain greater significance.

The goal of health and well-being also guides the planning and building of everyday living and work environments. Human interaction and activity are again the basis for well-being. As attitudes continue to change and the population is ageing, the demand will increase for functional food and for products and services that promote health and functional capacity.

The opportunities of human technology

Social interaction skills and the basic knowledge supporting those skills are recognized as crucial in education, learning, in the workplace, in international exchange, multiculturalism and the promotion of mental health. ICTs have greatly expanded opportunities for various kinds of interaction. Not all of the outcomes and consequences are known yet.

The aim of R&D is to create improved learning technologies and more human technologies. A technology is described as human when it is well adapted to the needs of their end-users, when they promote physical,



mental and social well-being and health and add to human dignity.

Technologies related to nature may well emerge as a growing and successful area of human technology in Finland. Opportunities to experience the natural environment will continue to be important quality-of-life factors. Finland has an abundance of natural riches that are ideally suited to various forms of nature tourism, ecologically sustainable leisure services and supportive technologies.

Learning for activity

Effective life-long learning is important in supporting citizens and employees maintain their activity and functional capacity in what is an increasingly technologised society. Informal learning in diverse and high-quality learning environments will be integrated as part of formal education. Individual learning, organisational learning and supportive technologies are important new assets for Finland from an educational equality point of view. In learning and interactive environments it is important to recognize the enriching power of difference.

Finnish culture offers chances for survival

The Finnish democratic welfare state and dynamic, creative information society both continue to enjoy international recognition. The country's small, well-educated population has shown great flexibility and adaptability. History has afforded Finland and its people – living in a harsh climate and in-between two distinct cultures – skills of survival than may be extremely useful in our globalising world.

The tradition of confidence and reliability strengthens all development efforts. Equality and egalitarianism continue to remain strengths that allow people to have their say, safe in the knowledge that they will be

heard. Striking the right balance between history, continuity and change is still a significant asset in this world.

Cultural competence in a multicultural world

Multiculturalism will continue to expand and increase in Finnish society as a result of increasing international exchange and cooperation. Cultural competence is an important premise for success in a globalising world; from an economic point of view it is vital. For communications culture, taking the best possible advantage of differences and the search for new perspectives presents a major challenge indeed. The role of partnerships in interorganisational cooperation is set to increase, and it is important that there is the competence to create and manage these partnership in an appropriate, win-win manner.

An attitude of going it alone and coping continues to exercise an influence both in the workplace and in service culture. This kind of thinking may well hamper the development of communal learning processes, services and work organisation. Moving towards greater interactivity remains a current challenge for all development efforts.

Multiculturalism is, on the one hand, about diversity in everything from values and attitudes to interaction; and on the other hand, about equality, where difference does not mean inequality. Multicultural competence leads to a natural life in a multicultural society. This competence does not develop all by itself, but it can be consciously developed, and people's attitudes can be influenced by means of education and research. Apart from the social good that comes out of this competence, it will also have benefits for Finnish businesses in their international operations.

The need and role of cultural competence will continue to strengthen in both design, product development and service innovations. Cross-cultural competence will improve and develop through research and applications in intercultural communication and interaction.

From marginalisation to interaction

Decrease in or even absence of interaction causes human suffering. It is therefore important that research is stepped up to monitor and analyse the processes that lead to the dwindling of interaction and eventually to marginalisation in learning, health, and work.

Processes of marginalisation have a tendency to accumulate, and they often begin in childhood and youth. The human, social and economic costs involved are unacceptably high. There is a need for broadly-based, interdisciplinary cooperation as well as new knowledge about how our society is changing to support that cooperation.

Cultural competence is one of the strengths of the Finnish economy, society and development work. Steps are needed to strengthen its position along with other competencies.

The human, social, health and economic costs of marginalisation can be reduced through the synergy of different competencies

The greater the sensitivity shown by technological development work to basic human and social needs and considerations, the higher its quality and the stronger its competitiveness.

Basic education has the task of providing civic skills and competencies. The life-long maintenance and development of these competencies is also important. Apart from general education, civic competence also includes a basic knowledge of science and technology, the use of information and communication technologies and networks, the promotion of health, dialogue and interaction skills, communication skills and social and cultural skills.

II Enablers – core competencies and new practices

Customer and user orientation and service expertise

People's lifestyles are changing and at the same time the demand for services is increasing. Key challenges in the development of the service sector in Finland are to raise the level of service expertise, to increase productivity and to converse national service concepts exportable into global markets. ICTs provide a powerful tool for the development of new business concepts and service exports. Science and technology can also help make everyday life easier.

The first requirement of successful innovations is understanding and anticipating customer needs and desires. New knowledge and understanding is needed of the human beings, consumers and end-users, different uses and functionalities, of how people's lifestyles are changing. All this must be supported by market and marketing know-how.

Customer and user-oriented thinking promotes and accelerates the adoption of new innovations. In service industries and traditional manufacturing customer and service orientation provides a sound basis for renewing business concepts, for improved productivity and for a new kind of competitive advantage.

Infrastructure functionality

ICTs are changing people's behaviour and living environments. Technology serves as a tool or



extension of people's physical and cognitive capacity. The key to making the best possible use of technology in designing and developing everyday living, working and learning environments lies in understanding human activity.

Further steps are needed to facilitate the development and better use of integrated community planning and services. Finland can offer services that integrate measurement expertise, remote sensing, governance and regulatory expertise. It is important to promote innovations that are multi-disciplinary.



People are increasingly interested to receive accurate information about their living environments and themselves; furthermore, information and its web-based availability are related to work, housing, leisure activities, life-long-learning and citizenship. Welcoming and inspiring environments add to the appeal and attraction of Finland, and their development helps to create new exportable solutions and social innovations.

The built environment will become increasingly vulnerable. Energy, information and communications systems as well as logistics network are among society's most important infrastructures. It is paramount that the security and reliability of digital information systems are maintained. Finland has a very well-functioning infrastructure, the maintenance and undisturbed operation of which requires constant investment. This also ties in with questions of safety and appeal.

Risk, reliability and vulnerability assessments as well as simulation and process control are further examples of competencies that are used in the development of the built environment. It is important to secure the vital

functions of society, and at the same time the lifespan of systems must be taken into account. Service innovations support the design and planning of good living, working and learning environments.

System competence as a strength

A major short-term challenge for Finland is to improve the efficiency effectiveness and impact of its social and health care system. The ultimate aim is to secure people's all-round well-being. The productivity of the system can be improved by the sensible use of new technology. In renewing the service system it is also possible to plan new ways to facilitate the mobility of people, materials and information.

Systems research is by nature an interdisciplinary exercise. Its results are often dependent on time and on the social and cultural context, and they can never be totally exported to other cultures. Finnish systems research can therefore be efficiently applied in the development of the social and health care sector.

Country differences in infrastructure and other systems hamper international and global operations and prevent the diffusion of innovations. Building and construction, energy, logistics and transportation are some of the areas where country differences cause unnecessary investment as well as development and operating costs. In the first stage coopera-



tion in system development will be focused on a European level.

The development of global business operations and system management depend upon the effective integration and use of information and communications technologies, systems and networks. Finland has sound expertise in this field. The more effective the application of systems, the faster and more flexible the business operation and the easier the task of streamlining business chains.

Finland's total productivity and competitiveness can be significantly improved by raising productivity levels in different sectors. Information and communications technologies can provide invaluable support in upgrading industrial functions, products and services as well as in developing the service sector and increasing its productivity.

Human intelligent technology

One of the key requirements in the development of useful and



usable, "intelligent" technology that learns as it is used, is to understand the interaction between human beings and technology. It is also necessary to have an understanding of the interaction between people and groups of people as well as knowledge of the needs of special groups, such as elderly people. The goals of human intelligent technology can only be achieved through multidisciplinary cooperation.

Finland is well placed to maintain its position as one of the world's leading ICT producers and users. The challenge now is to move forward with a balanced development effort in high-level research and basic competencies as well as in the application and commercialisation of technologies in different fields. In the long term the focus of this development effort will be on wireless, broadband and seamless communication, knowledge and content management, and methods and system expertise.


ICT is an enabling technology for many other fields and their innovation activities. Methods and system competence will become a major competitive asset for Finland as it merges with the high-level expertise in other fields. The digital convergence of communication media, the ubiquity of communication and its independence of time and place are changing ways of doing things throughout society. The changes in modes of communication are seen in all industries.

Materials development and biotechnology: towards multidisciplinary cooperation and diversity

In materials development and biotechnology, investment to boost the synergies between different fields can help to generate new production and new applications that make use of nanotechnology. It is important to have a clear picture of current strengths in basic research and applications. Finland has a high level of research expertise in biomaterials, bioenergy, bio-ICT and bioinformatics, and the integration of these different fields will open up new opportunities.

The various players in Finland know and trust one another, which is an important asset, providing an opportunity to create and strengthen broader cooperation. However, even greater effort is needed to boost interdisciplinary cooperation that combines the expertise and competencies of basic sciences and technology.

Among the fields that should be integrated with materials development and biotechnology are information technology and its systems as well as the processing and modelling of large data masses. Bioinformatics can open up new opportunities for significant new breakthroughs in Finnish biomedicine. Multidisciplinary and interdisciplinary approaches are needed in other fields as well, including materials production where cultural and design competencies are needed.



At the same time it is crucial to retain the strong basis of in-depth expertise within individual disciplines, for it is only strong basic research that can pave the way to new innovations and regeneration of business and industry. Innovations that depart radically from earlier technologies often come about quite unexpectedly, and it may be difficult to predict their economic significance and value even after the idea has been developed. It is not uncommon for the inventors themselves to underestimate their importance. Radical innovations require opportunities for creative work and unfettered basic research, the outcomes of which do not necessarily have any immediate, economically significant applications.

Intersectoral synergy and competence transfer open up new business opportunities

Materials research and biosciences applications will spread more and more widely in business and industry and throughout society. Potential new applications and business opportunities are created most particularly on the interface of and in interaction with different fields. The integration of ICTs and materials and biotechnology in the forest and communications industries may pave the way to exciting new business potential.

Health biotechnology is creating new innovation potential in health care and pharmaceuticals, for example. The development of new biomaterials integrates stem cell research with materials development. Functional foods are another example of an area of application where Finland has strong competitiveness potential.

The principles of sustainable development continue to have growing influence, increasing the potential of bioproduction. Increased attention is paid to the complete use of biomass, and its various components are utilised as carefully as possible in the manufacture of competitive and sustainable products. This may generate greater industrial diversity in Finland. Global competition for biomass resources is set to accelerate at the same time as the paradigm change in energy production gathers momentum and the need for new renewable energy resources increases.

Need for industrial and commercial development

In technology-driven fields such as materials technology, nanotechnology and biotechnology where the development effort is geared to the creation of enabling technologies, there is also a need for end-user driven development towards specific future applications and opportunities. We must both renew existing industries and create new business areas. Business developers should be closely integrated into the development process from the very outset, providing their views and assessments of the opportunities and the time span of innovations.

Research in these fields needs a stronger input by industrial developers. Together we can facilitate the development of new, regenerating technologies for new and existing businesses. Customer and end-user orientation must be applied in technology development.

It is paramount to foster competencies that facilitate scientific breakthroughs and technological trajectories.

It is necessary to have strong basic research that does not necessarily have direct economically significant applications.

Multidisciplinary approaches and the integration of competencies in different fields shall be encouraged. The development of applications requires an in-depth understanding of the human needs, culture, nature and society and of how they change with time.

A focused, long-term research and development effort requires a common understanding and a strong target orientation from the very outset.

Networked environments are needed where researchers, industrial developers as well as entrepreneurs and business developers work closely with one another at all stages of the innovation process.

III Challengers – global development



Meeting the challenges of the global economy

Finland is closely involved in the growth of the global economy and in utilising the opportunities for growth. Finland has a clear vision and commitment to make the best use of science and technology. To implement this national vision as well as the positive impacts of scientific and technological development, we will need actively to search for European and global partners.

Global competition of business environments and the lower cost levels in many emerging economies make productivity an increasingly critical factor for Finnish competitiveness. Productivity can be improved by means of business renewal, new ICT applications and new service concepts, for instance.

The Finnish innovation environment needs constant access to up-to-date and forward-looking information about the challenges of the global economy and the changes in business, operating and innovation environments. This makes it easier for a small country to find its own niches by specialising in areas where it is possible to achieve an internationally strong position. At the same time Finland should seek to optimise its resource allocation with a view to boosting welfare in the country, the growth and renewal of business and industry.





The management of global knowledge and multiculturalism

In the current flood of information it is necessary to concentrate on finding, analysing and creatively linking together the most relevant information, which ultimately will help to gain a clearer view of the bigger picture. In order to step up the effectiveness of innovation, it is important that the opportunities offered by global competencies and researcher exchange are interactively better utilised.

In the context of EU cooperation the target is to promote more effective interaction, to exchange views and opinions on foresights and to set joint goals and objectives so that R&D cooperation can be as effective as

possible. Multiculturalism and difference must be seen as a richness and an opportunity for creativity. The growth of multiculturalism will require new leadership practices, a knowledge of foreign cultures as well as an ability to understand and take advantage of difference.

Assessing and managing global risks

Finland has strong expertise and competencies in risk management, including system know-how, methods know-how, project management and control, crisis management and integration know-how. Demand for the building and management of global operational systems will increase. This will require, and at the same time develop, competencies in conflict management, which in turn will provide an invaluable tool for improving safety and security and the functionality of infrastructure.

Global risk management in economy and in the energy and environment sectors is increasingly important. The assessment of global risks and the production of related knowledge can be improved and stepped up through interdisciplinary cooperation. Finland has special competence in various sectors of the economy and in risks related to forests and environmental change. Other areas of strength include know-how in international regulation,



the management of global ecosystems and the environment, remote sensing and ecology.

With the continuing advance of economic and social integration, products, services and production are increasingly regulated by means of international agreements. The harmonisation of regulation in different market areas increases overall productivity, which is in the interests of all concerned. It is essential that there is a broad and collaborative involvement in developing global and EU-level regulation.

The driving force and the network for this development effort are created on a needs basis according to existing expertises. Involvement in regulation will guarantee a sufficient awareness of the direction of the market development, as well as giving an opportunity to actively influence its direction. This improves the prospects for forward-looking R&D and also supports the timely introduction of innovations in the marketplace.



Sustainable environmental management

One of the key challenges with respect to environmental management is the simultaneous management of environmental issues at the global and local level, which are closely linked with each other. Globalisation and the liberalisation of world trade are fundamentally changing the framework of environmental management.

The trend so far has been towards increasing environmental regulation at the same time as the public sector has assumed a stronger role. Globalisation will increase the role of multinational companies. Clean water, forests, and pristine nature are other precious resources are increasingly turning into critical natural resources.

Policy innovations for sustainable development will be in growing demand. There is a need for basic research into ecosystems, for analysis of alternative ecosystem scenarios and for new decision-making methods. Improvements are also needed to methods of forecasting environmental crises and methods of environmental management so that the short-term target of economic effectiveness does unduly increase risk-taking or overload infrastructures.

Finland has strong expertise and competence in all these fields. The integration of environmental know-how in these fields with other areas of expertise offers real potential to create significant innovations at the product, process, solutions and service level.



The challenges of energy production and use

The global and national challenges related to the environment and energy and the responses to those challenges in the near future will have impact on the economy, welfare, the quality of life and safety and security. As energy prices continue to rise and climate change continues to gather momentum with increasing energy consumption, new forms of energy production will be developed and introduced.

The transition from fossil fuels to renewable energy will globally change the role of different actors. Increased efficiency in energy use will require new solutions in materials production and use as well as new energy solutions in living environments and transportation.

The development of the energy sector is very much shaped by the interaction between the international economy, politics and living environments. Finland must as soon as possible take advantage of the competence potential it has created in the energy sector. There is intense political pressure to introduce renewable forms of energy production, and new energy solutions are needed quickly. It is particularly important to expand the energy production base. Biomass is used extensively in Finnish industries and there is therefore extensive expertise of biomass utilisation in the country. The use of integrated biomasses could complement energy solutions that rely on fossil coal.

Finland also has outstanding competence in services related to energy technology, but there is a need now for new commercially innovative solutions, and particularly for environmentally sound energy solutions. The demand for services that can help to boost energy and material efficiency is also set to increase, and the development and offering of those services is a potential success factor for Finland. The decentralisation of en-

ergy production allows for more diverse technological solutions and new services concepts.

The management of innovation networks

More and more often, innovations are created in global networks. The management of innovation networks supports the development of the innovation process and facilitates new innovations. The knowledge and know-how





related to the management of innovation networks is needed in all R&D sectors – in companies, at universities and at research institutes.

Finland's networked and open environment allows for relatively quick and smooth decision-making. Cooperation between basic and applied research and an effective innovation environment have a particularly important role in this respect.

A key aspect in the management of the innovation process is understanding how people's demands and needs as well as their behaviour change. The assessment of profitability and business opportunities and competence related to marketing, logistics and brand development are important areas of expertise and crucial to success in global competition. However, this is an area where there is need for much improvement in the Finnish innovation field. Test environments for new concepts are also needed with a view to ensuring global replicability.

From a national economic point of view it is vitally important to try and optimise the impacts of public authorities' operations. Better management, control and incentive systems are needed so that productivity can be increased in the public sector as well. Public-private partnerships can provide new solutions in many service concepts, for example, as well as increasing productivity.

It is absolutely essential constantly to monitor the factors that determine and influence Finland's appeal to business and entrepreneurship, to investors, experts and researchers and to promptly take the decisions required by any changes observed.

Foresighting

Foresighting is a key and integral part of strategy work and organisational development. It is important to strengthen the opportunities of the Finnish innovation environment to well utilise foresighting and to support the development of insight from opportunities and threats opened up by the changes. Furthermore, it is important to ensure that Finland has sufficient knowledge of global driving forces and their impacts.

The processes and networks of foresighting must be constantly updated and improved so that they can support the renewal of business and industry and the public sector. To this end, constructive discussion and debate across established boundaries on the needs for changes in the innovation environment and in innovation activities is of paramount importance.

Increasing productivity is crucial for Finnish competitiveness. In this regard the development of services and service innovations as well as ICT applications have key significance.

Steps are needed to strengthen the use of global knowledge and cultural know-how in research and innovation.

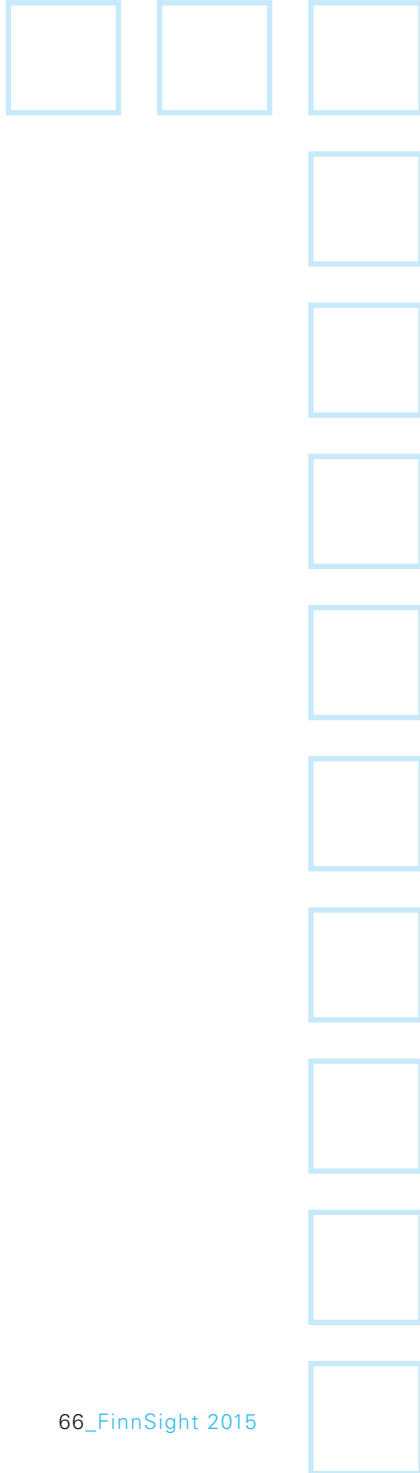
Global risk management has assumed ever greater importance. In particular, there is a growing need for competencies in foresight and risk management related to the economy, environment, energy, infrastructure and health.

Energy and environment issues are of critical importance globally. More investment is needed in developing new forms of energy generation, in the sustainable management of the environment and in environmental technology innovations.

The management of effective innovation processes is a critical factor that must be further strengthened

Appendix

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*The numbers in brackets refer to the
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Foresighting is an increasingly important tool for decision-making by political and business leaders, public sector authorities and research organisations.

This publication summarises the results of FinnSight 2015, a science and technology foresight project jointly undertaken by the Academy of Finland and the Finnish Funding Agency for Technology and Innovation (Tekes). The country's leading science, business and social policy experts from both industry and academia got together to exchange views on how Finland can remain a well-being society and a world-leading innovator. The foresight project was organised around a core of ten expert panels: their discussions on current and projected changes in science, technology and society provided the foundation for the common future and focus areas of competence outlined in this summary report. www.finnsight2015.fi



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