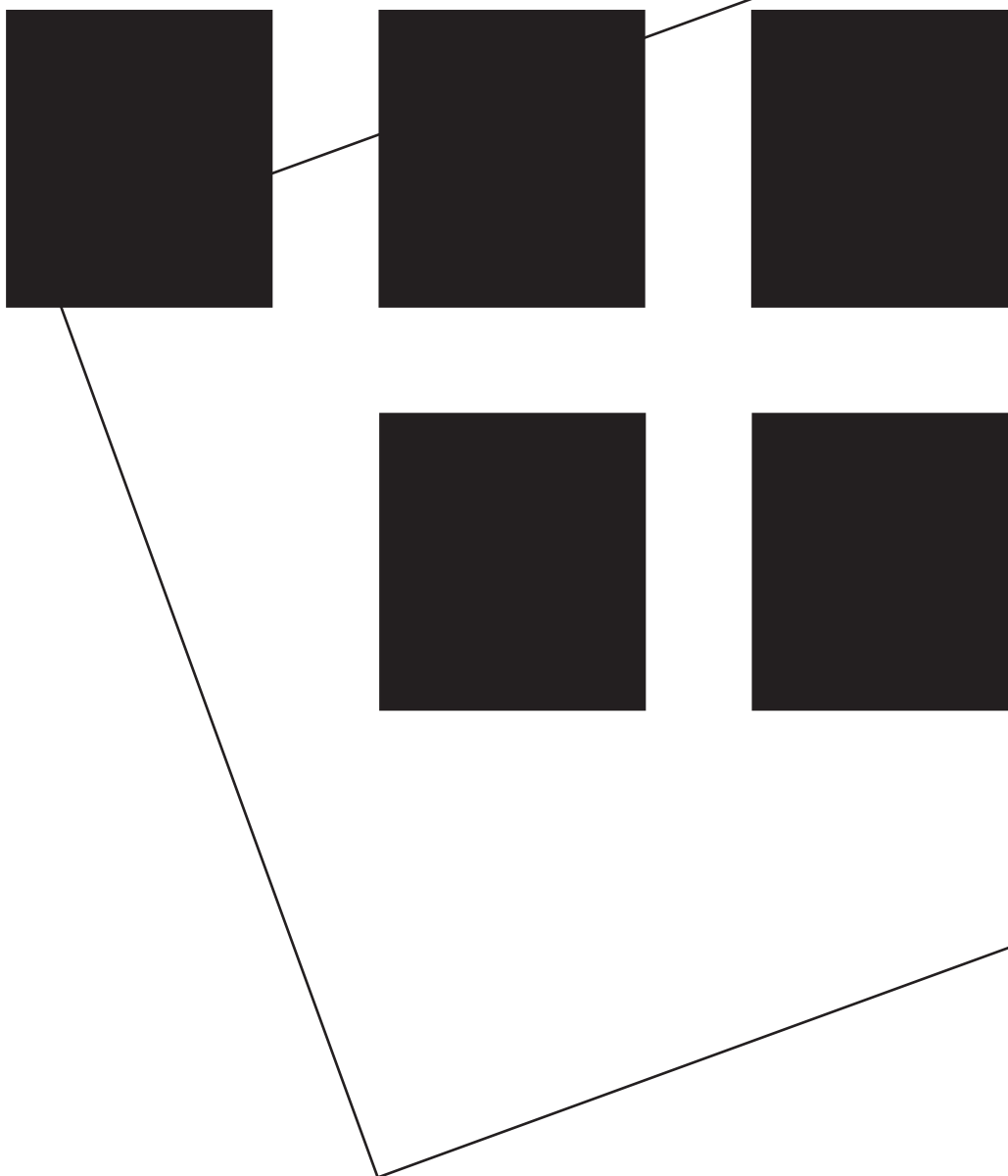


VTT's Annual Report

1996



TECHNICAL RESEARCH CENTRE OF FINLAND



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VTT's Annual Report 1996



Mission

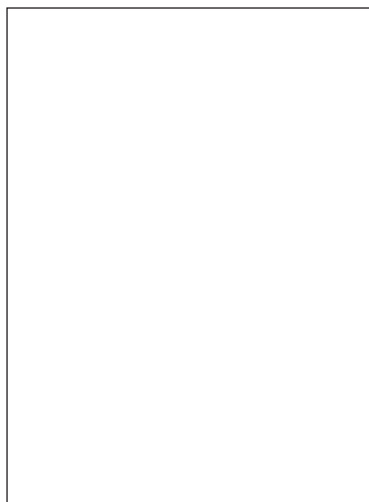
VTT is an impartial expert organisation that carries out technical and technoeconomic research and development work. VTT develops technologies both to improve the competitiveness of companies and the basic structure of society, and to foster the creation of new businesses. VTT thereby promotes growth of the Finnish economy in accordance with the national industrial strategy.

Core Values

Our core values are:

- Responsiveness to the views and needs of customers
- Cooperation
- Successful performance
- Continuous development

Review by the Director General



VTT's economic operating environment developed favourably on the whole in 1996. Even though industrial output and gross domestic product rose more slowly than in the previous year, the R&D input of the enterprise sector continued its strong growth. This was reflected in the demand for our services. We were also quite successful in the process of competitive tendering for EU projects. When planning our 1996 operations we made provision for a substantial reduction in income from the domestic public sector due to an expected decline in non-committed research funding by the state. In fact, this income remained almost at the level of the previous year.

The end of the year brought good news indeed: The government had decided to make a substantial increase in the level of research-spending by the state in 1997-99. The government is thereby aiming to benefit the economy, the enterprise sector and employment by enhancing our national innovation system. The primary instrument

chosen to achieve this aim is the selective allocation of additional funds. In particular, the resources distributed on a competitive basis by the Technology Development Centre and the Academy of Finland will be increased. This decision is in harmony with VTT's strategy. We have confidence in the chosen instrument of research policy, and in our own ability to compete and co-operate.

The plan drawn up by the Science and Technology Policy Council of Finland in order to implement the government's decision guarantees that VTT's budget funding will be preserved at its present level. The plan also offers opportunities for research activities funded jointly by different partners and for faster than previously planned growth in contract services for paying customers. The additional funding will raise the demand for research services. The Council's view that VTT has a special role to play in strengthening the national knowledge base for basic technologies is also worthy of note.

The Ministry of Trade and Industry sets annual performance targets for VTT. The general framework for these targets is that VTT's overall finances must be in balance and that costs must be covered by income from contract activities. Our primary goals are to help companies develop new and more competitive products, and to develop safer, more efficient and more environment-friendly production processes for industry. We also seek to improve the exploitation of information technology, the efficient management, use and production of energy, the reduction of emissions, the creation of new enterprises and the technical development of SME activity.

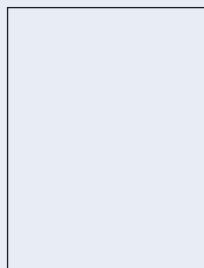
Within this framework the Ministry and the Board of VTT agreed upon more detailed goals for the review year. For instance, VTT had to cover a full 60 per cent of its expenditure on research activities with funds obtained from commercial activities and jointly funded contract research. In actual fact, 66 per cent of the expenditure was covered in the prescribed manner. Joint projects and commercial assignments accounted for 84 per cent of VTT's total volume, which is indicative of the progress made towards the important goal of better orientation toward customers and their needs. In an objective survey of customer satisfaction VTT improved its scores in expertise, willingness to serve, diversity of services, and credibility.

I believe that VTT has achieved the functional and economic targets set for it in 1996, and that the outlook for the future is promising.

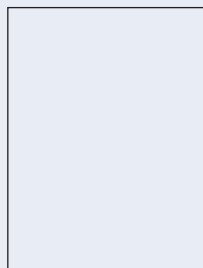
I would like to express my thanks to the staff of the research centre for their successful efforts in 1996, and to the representatives of our interest groups for their manifold and valuable contribution to our success.

Markku Mannerkoski

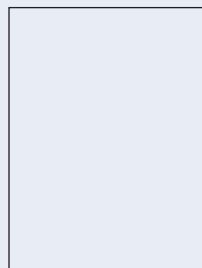
Review by the Board



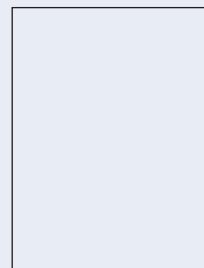
*Chairman
Jukka Viinanen
Managing Director
Neste Corporation*



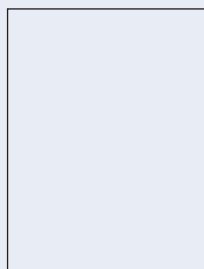
*Vice Chairman
Alpo Kuparinen
Special Advisor
Ministry of Trade and Industry*



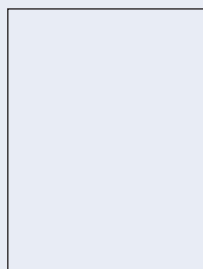
*Matti Ilmari
President
ABB Oy*



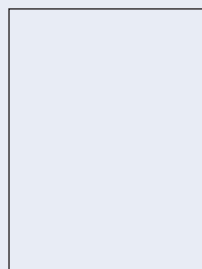
*Pertti Koskinen
Senior Research Scientist
VTT Building Technology*



*Markku Mannerkoski
Director General
VTT*



*Martti Mäenpää
Director General
Technology Development
Centre (Tekes)*



*Seppo Säynäjäkangas
Professor
University of Oulu
Polar Electro Oy*

The favourable development of the Finnish economy continued and the volume of VTT's contract assignments from industry increased. Membership of the European Union was accompanied by improved opportunities for international co-operation and financing. These environmental changes facilitated an expansion of VTT's activities and an increase in external financing. The trend in commercial activities and international research collaboration was positive. The profitability target for commercial activities was achieved.

VTT's strategy was reviewed during the course of the year. In the goals set for the period up to the year 2000, special emphasis was given to the following:

- the effectiveness of VTT's activities with regard to the technological development of industry, the support of the services sector, the promotion of business competitiveness and employment,
- the development of VTT's competitiveness by qualitative improvement of all activities,
- operational flexibility and the effective exploitation of VTT's interdisciplinary capabilities and its close relationship with Finnish universities,
- knowledgeable and motivated personnel, whose labour productivity and work satisfaction are high, and
- development of the financing structure by increasing contract and international activities so that external income accounts for about 70 per cent of turnover.

Industry's influence on VTT's activities has increased in many different ways. The advisory committees play a key role in promoting co-operation between the research institutes and the research centre's main interest groups. The advisory committees were given a greater role and their tasks were more clearly defined. Contacts between the committees and the Board were improved.

VTT regularly orders external evaluations of the research institutes and their research programmes. During the review year international experts evaluated the activities of VTT Automation and VTT Biotechnology and Food Research. The research work of VTT Building Technology's Fire Technology group was also evaluated. The level of expertise was considered to be high. However, challenges remain to be met in some areas: customer orientation and collaboration with companies on a strategic level and in the implementation of research projects, the enhancement of internal processes and co-operation, and the development of performance measuring and reward systems. The recommendations made by the evaluators were acted upon without delay.

VTT's operations were also the subject of evaluations made by the Academy of Finland: An evaluation of Finnish biotechnology and molecular biology research covered also research groups from VTT Biotechnology and Food Research. Similarly, research groups

from VTT Electronics were assessed in an evaluation of the standard of Finnish electronics research. Moreover, NORDINFO commissioned an evaluation of VTT Information Service in its capacity as a Nordic Centre of Excellence for Electronic Publishing. The standard of work was found to be high in all these evaluations, although some points in need of improvement were also spotted.

VTT is making provision for future challenges by continuously improving the performance and competitiveness of the organisation. For this reason much emphasis has been placed on the use of total quality management and operational evaluations. In addition, processes were benchmarked in order to develop optimal practices.

Research and development

VTT's activities consist of R&D work in projects started on VTT's own initiative, joint projects and contract assignments, as well as work in the field of conformity assessment.

Technology-push type strategic research is mainly carried out as budget-funded activities on VTT's own initiative. Jointly funded projects are based on the expected market pull. They are mainly strategic in nature and often financed from external public sources. Contract activities are performed according to the direct demand from paying customers.

Strategic research activities were expanded in rapidly developing areas of technology. The budget funding of electronics, information technology and biotechnology research was increased. As the total volume of budget funding fell compared with the previous year, appropriate funding reductions were made in the areas of manufacturing technology, building technology, and communities and infrastructure. The funding was primarily used for VTT's long-term basic technology, industry-specific and SME research programmes, 35 long-term national technology programmes, EU projects and other strategic projects.

Fifty-four per cent of VTT's budget funding was used for joint projects that had funding also from external partners, primarily the Technology Development Centre (Tekes) and the EU, but also private sector organisations. Tekes provided less funding than in the previous year. The external partners accounted for 56 per cent of the total funding of joint projects.

The volume and quality of VTT's commercial activities gives a good indication of how important the research centre is as a practical instrument of technology policy. Income from commercial activities has grown rapidly in recent years, accounting for as much as 40 per

cent of VTT's turnover in 1996. The assessment and improvement of customer satisfaction were emphasised in all VTT units, and new services were conceived, developed and marketed.

The aim of technical evaluation is to ensure the quality and safety of products and to support the acceptance of Finnish products on the international export market. The work mainly involves testing, certification and calibration as well as the tasks of Notified Bodies and national metrology laboratories. The income from technical evaluation work was FIM 52 million.

Technical evaluation services were developed selectively for the international certification of industrial products. Several hundred test methods in over 20 fields have now been accredited. VTT has the capabilities to perform tasks according to about 60 EU Directives, and can act in the capacity of as a Notified Body with regard to 6 Directives.

The number of research and tests reports was about 14,000, and the number of publications was over 1,800. Of the publications, about a half dealt with practical technology transfer and were written mainly in Finnish, about a third were conference papers, and about a sixth were peer-reviewed scientific publications.

Emphasis on EU projects in international activities

VTT has been successful in the project proposal rounds of the EU's Fourth Framework Programme. The number of international projects rose in the review year to almost 500, of which some 260 were EU projects. There was a slight increase in the number of industrial partners taking part in international projects.

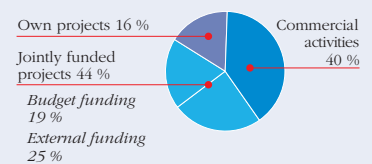
Income from abroad was FIM 82 million. Just over a half of this consisted of funding for joint projects and the remainder was obtained from contract assignments. The biggest customer countries were Germany and Sweden. EU incomes were FIM 43 million, which was almost three times greater than in the previous year. Joint Nordic funding fell slightly.

VTT-level agreements were made with the EU's Joint Research Centre (JRC) and the Japan's New Energy Development Organisation (NEDO).

Wider co-operation with universities

Co-operation with Finnish and foreign universities has traditionally been extensive. In recent years it has been extended especially in EU projects. In addition to joint projects, the

RESEARCH AND DEVELOPMENT



INTERNATIONAL RESEARCH PROJECTS

EU research programmes	264
Nordic co-operation	63
COST	37
Bilateral co-operation	34
ESA	20
IEA	18
EUREKA	7
IAEA	6
OECD	6
IMS	3
Other co-operation	36
Total number	494

VTT'S RESEARCH PROGRAMMES

Basic technology programmes:

- Microsensor Systems
- Optoelectronics
- Silicon Technologies
- Design on Embedded Systems
- Intelligent Production Systems and Control Architectures
- Nano-phase Particles
- Metabolic Engineering
- Parallel Computing and Open Simulation Environments

Industry-specific research programmes

- Closed Loop Operations in the Pulp and Paper Industry - Materials and Manufacturing Technology
- Systematised Building Construction
- Measurements and Control in the Pulp and Paper Industry
- Chemical Cycles in the Forest Industry
- Minimal Processing of Food
- Engine Technology
- Reducing the Water Use in Paper Production
- Multi-fuel Systems
- VTT Steel

SME programmes

- New Synthetic Materials and Systems for Industrial SMEs
- Technology as a Part of Business Development in SMEs

NATIONAL TECHNOLOGY PROGRAMMES IN WHICH VTT PARTICIPATES

- Bioenergy
- Electric Distribution Automation
- Electronic Printing and Publishing
- Fusion Energy
- Nuclear Waste Research
- Finnish Multimedia
- Machine Vision
- Combustion and Gasification Technology
- Advanced Heavy Machinery
- Industrial Applications of Engineering Material
- Adaptive and Intelligent Systems Applications
- Wood Construction
- Energy Use in Buildings
- Reactor Safety
- Energy and Environmental Technology
- Energy and the Environment in Transportation

forms of co-operation with universities have included joint professorships, joint technology clinics selling services to SMEs, teaching, guidance of further academic studies, checking of doctoral theses, and the shared use of equipment and sub-contracting.

VTT Chemical Technology and Helsinki University Central Hospital made an important, long-term co-operation agreement on the development of the boron neutron capture technique for use in the treatment of brain tumours. VTT Building Technology collaborated with universities in the development of research networks, the most advanced of which is Otawood, a co-operation group specialising in wood technology and wood construction. Developed in collaboration with Helsinki University of Technology, Otawood aims to create a leading international centre of excellence at Otaniemi. Preparations were made to widen co-operation within the framework of the microelectronics centre that will be opening in 1997.

Rapid growth in income from the domestic private sector

Supporting the technological development of companies and especially industry is one of the research centre's key roles. One indication of its success in that respect has been the strong growth in income from the private sector over recent years. Incomes rose to FIM 323 million, 60 per cent of which was obtained from industry and research work directly serving it.

The electricity and electronics, and basic metals and engineering industries are among the biggest and fastest growing as VTT's customers. The other important branches are the chemical, forest and food industries. The competitiveness of not only industry but also the energy and construction sectors is decisively dependent on technological development. VTT also has a number of important customers in the services sector. Including branches such as trade, transportation and telecommunications, this group accounted for 25 per cent of VTT's income from the private sector.

A significant proportion of VTT's activities are oriented towards SMEs employing less than 500 people and companies in their start-up or early growth stages. Expert services were developed for SMEs in close collaboration with the Technology Development Centre and other organisations participating in technology transfer. The services proved to be popular and the importance of the SME sector as a customer group has grown. Invoicing amounted to FIM 168 million, which was half the income from the private sector.

The SME sector accounted for about 2,700 of VTT's 6,000 customers. Of these, enterprises employing less than 10 people numbered about 800, accounting for almost 15 per cent of private-sector invoicing. Of the new service forms developed at the research centre, VTT Automation's Protechno is a notable example. Protechno covers all the stages of support for customers' product development, including equipment building and testing services. Significant investments were made in order to develop EMC testing capabilities in particular.

VTT has been actively involved in Tekes's technology clinics, which enable the knowledge and expertise amassed by research institutes and universities to be transferred to SMEs. The clinics have proved to be a fast and flexible way to solve to the acute problems faced by SMEs.

The research institutes served SMEs via domestic networks in various fields, and played their part in the development of these networks. Co-operation agreements aimed at serving the needs of SMEs were made with regional development centres acting in conjunction with universities.

The exploitation of patents and entrepreneurship

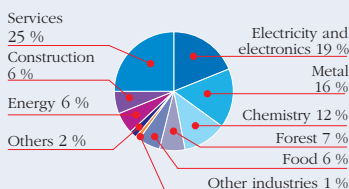
VTT was awarded 54 new patents, of which 26 were Finnish and 28 foreign. The number of Finnish patents has remained fairly constant in recent years, but the number of foreign patents has increased. Forty-nine patent applications were made. The number of invention notices was 77.

VTT's portfolio of patents contains 410 current Finnish and foreign patents and patent applications. Exploitation of the patent portfolio in the form of VTT businesses has so far been minor. Several products developed by the research institutes have been commercialised through licensing agreements. Inventions arising from contract research belong to the customer concerned.

Spin-off companies set up by research scientists is one channel by which VTT's expertise is transferred to the enterprise sector. Over the past ten years the research centre has spun off as many as 60 such enterprises. A few new companies have been set up every year in recent times. Two companies were spun off in 1996: one by VTT Information Technology and the other from an idea jointly developed by VTT Energy and Jyväskylä University.

The Spinno project originally launched by VTT to promote the entrepreneurial spirit of its own research scientists has been extended to cover the scientific community of the entire Helsinki Metropolitan Area. VTT also partici-

INCOME FROM THE PRIVATE SECTOR FIM 323 million



TECHNOLOGY CLINICS IN WHICH VTT PARTICIPATES

- Welding
- Hygiene
- Machine Vision
- Operational Reliability
- Reinforced Plastic Structures
- Recycled Materials for Land Construction
- Noise and Vibration
- Coating Systems
- Certification of Building Products
- Drying of Sawm Timber
- Casting

pates in similar enterprise incubator projects in other Finnish cities where it has a presence.

Personnel

VTT's volume in terms of labour input was 2,586 man-years, an increase of 34 man-years compared with 1995. The number of personnel returned to the level prior to the organisational reform and its associated rationalisation in 1993. The personnel structure was such that the proportions of research scientists and university graduates rose slightly over the same period. Thirty VTT employees completed doctoral or licentiate degrees in the review year. The number of VTT employees holding such degrees at the end of the year was 514. There were 29 VTT research scientists working abroad. Fifty-five visiting researchers from other countries worked at VTT for a period of at least two months.

The focus within personnel development was on the training of research scientists and the adoption of a customer-oriented way of working. The customer services, sales, marketing and internationalisation were the main training themes. Management training focused on personnel management, quality and business management training.

The personnel turnover rate was 7 per cent, which was lower than in the previous year. The focus in recruitment was on young research scientists: most of those joining VTT were either students or new university graduates. Fifty-five per cent of those who switched jobs to join VTT were previously employed in the private sector. About eighty per cent of those leaving VTT took up positions in the private sector. The average age of VTT's staff was the same as in the previous year, i.e. 40.5 years.

Finances

Turnover rose by 5 per cent in the review year and was FIM 996 million. The income from contract activities rose 13 per cent to FIM 397 million. Its share of total turnover grew slightly and was 40 per cent. The volume of jointly funded activities was FIM 435 million, of which FIM 243 million was obtained from external partners and FIM 192 million from VTT's budget funding. A further FIM 164 million of budget funding was used on VTT's own research initiatives, so the total value of budget funding was FIM 356 million - slightly less than in the previous year.

The total external income was FIM 642 million, which was 9 per cent higher than in the previous year. The development of income by customer sector was mainly in accordance with the set targets. Income from the domestic private sector rose 10 per cent to FIM 323

million. Income from abroad also developed favourably, rising 52 per cent to FIM 82 million. Income from the domestic public sector, on the other hand, fell 1 per cent to FIM 237 million.

VTT's operating expenses were FIM 1,000 million. The increase of FIM 66 million over the level of the previous year was mainly due to the higher volume and an extraordinary depreciation charge of FIM 17 million on the equipment stock.

Investments in fixed assets totalled FIM 63 million, a reduction of 11 per cent compared with the previous year.

The construction of new premises in Espoo in order to improve the facilities for microelectronics research continued. The building will be completed at the beginning of 1997, and will house an advanced multipurpose clean space for research into electronic materials and component technologies. The facilities will require considerable investments in equipment in 1997.

As was the case in the previous year, the financial result was of a good standard. Because of an unscheduled depreciation charge of FIM 17 million on the equipment stock, the result according to business accounting practice was a deficit of FIM 4 million. The corresponding result in 1995 was a surplus of FIM 15.7 million.

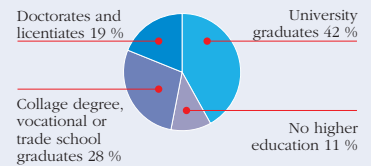
The budget was implemented according to plan. The surplus on contract activities was FIM 2.4 million, which exceeded the profitability target set in the state budget.

Outlook for the future

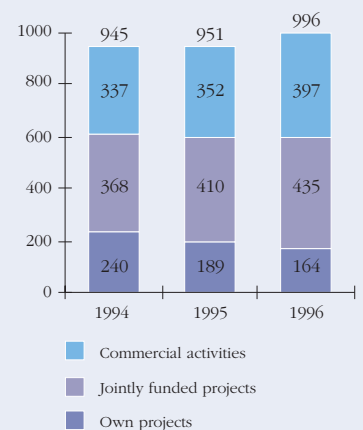
Corporate R&D inputs as well as public national research funding will grow significantly in the years ahead. This trend will provide VTT with good opportunities to sell its R&D services to industry and other sectors of the economy. However, problems with the availability of trained and competent personnel may restrict growth, especially in rapidly developing and competitive fields such as information technology and electronics.

International R&D activity is essential for the success of Finnish companies and thus ranks highly on their list of priorities. In the future the emphasis when developing customer orientation and VTT's competitiveness will be on improving the total quality management.

EDUCATION OF VTT PERSONNEL
1996



TURNOVER



EXTERNAL INCOME

	1994	1995	1996
	FIM	FIM	FIM
	mill.	mill.	mill.
PRIVATE SECTOR			
DOMESTIC	261	294	323
Percentage change	15	12	10
Percentage of total income	46	50	50
Companies	244	274	303
Other customers	18	20	20
PUBLIC SECTOR			
DOMESTIC	257	240	237
Percentage change	1	-7	-1
Percentage of total income	46	41	37
Ministry of Trade and Industry, and Tekes	173	156	138
Other state sector	77	77	89
Municipalities and municipal federations	8	7	10
INCOME FROM ABROAD			
DOMESTIC	46	54	82
Percentage change	35	17	52
Percentage of total income	8	9	13
EU	5	16	43
ESA	3	4	5
Joint Nordic public funding	5	8	6
Other public sector	10	8	8
Private sector	23	19	20
TOTAL	565	587	642
Percentage change	9	4	9

Income Statement

FIM 1,000	1.1.-31.12. 1996	1.1.-31.12. 1995
Turnover 1)		
Income from commercial activities	396,644	352,082
Budget and jointly funded activities		
- income from jointly funded contract research	243,322	234,347
- budget-funded activities	356,466	364,094
	996,432	950,523
Expenses		
Personnel expenses 2)	562,473	534,200
Travelling expenses	43,359	42,796
Materials, supplies and goods	77,415	77,158
Rents	80,271	78,762
External research services	64,224	62,294
Other expenses	86,623	75,334
Increase in projects in progress	-10,143	-17,761
	904,222	852,783
Operating margin		
	92,210	97,740
Depreciation of fixed assets and other long-term expenditure 3)	84,646	71,814
Operating result		
	7 564	25,926
Financial income (+) and expenses (-) 4)	-14,720	-12,771
Result before extraordinary items		
	-7,156	13,155
Extraordinary income (+) and expenses (-)	3,119	2,516
Result for the financial period		
	-4,037	15,671

Balance Sheet

FIM 1,000	31.12.1996	31.12.1995
ASSETS		
Fixed assets and other long-term investments		
Intangible assets 5)	12,903	12,475
Tangible assets 5)	190,817	213,008
Securities held as fixed assets and other long-term investments 6)	4,396	4,290
	208,116	229,773
Current and financial assets		
Current assets	29,254	18,241
Receivables		
Accounts receivable	176,210	176,957
Accrued income	114	144
Other receivables	59	56
Cash, bank receivables and securities held as financial assets	1,650	3,805
Receivable from the State 7)	16,171	7,780
	223,458	206,983
Total assets		
	431,574	436,756
LIABILITIES		
Own funds		
Own funds 8)	225,469	225,469
Donations 9)	1,464	1,500
Budget funds 10)	15,239	20,906
Result for previous financial period (+/-)	15,671	
Result for the financial period (+/-)	-4,037	15,671
	253,806	263,546
Liabilities		
Advances received	20,565	15,296
Accounts payable	45,663	43,352
Accrued liabilities and deferred income 11)	101,042	99,767
Other current liabilities	10,498	14,795
	177,768	173,210
Total liabilities		
	431,574	436,756

Budget Statement

FIM 1,000 mk	Appropriation or revenue estimate		Available	Used or accumulated	Deferred to 1997 (transferable allocation)
Budget account	1996	Previous years			
32.42.21. Operating expenses					
Gross expenses	942,200			980,853	
- gross income	-621,000			-648,918	
= net expenses	321,200	58,459	379,659	331,935	47,724
32.42.74 Buildings		4,766	4,766	4,766	0
32.42.89 Acquisition of shares	1,000		1,000	0	1,000
Use of appropriations from other government bureaus		15		4,097	4,514
Donations	85	1,314	1,399	127	1,272

Notes to the Financial Statements

GENERAL PRINCIPLES

VTT's 1996 financial statements have been prepared in accordance with the State's official administrative bookkeeping practice and business bookkeeping practice. The financial statements include an income statement and balance sheet derived from business bookkeeping and a budget statement derived from the State's official administrative bookkeeping. Internal transactions between profit centres have been eliminated from the financial statements.

Fixed assets and depreciation

Fixed assets have been valued according to the residual values calculated on a capital cost basis. Scheduled depreciation has been calculated from the net replacement cost of assets acquired prior to the beginning of the year, and from the acquisition cost of assets acquired during the financial year.

Scheduled depreciation changes have been calculated using the straight-line method over the expected economic lifetime of the assets concerned. The expected economic lifetimes and corresponding depreciation percentages are as follows:

	Years	Depreciation
Intangible assets		
• Software	5	20 %
Tangible assets		
• Machines and equipment	4 - 7	14,3 - 25 %

The depreciation charges for certain major investments have been calculated individually.

Current assets

VTT's current assets are costs already incurred in long-term projects in progress but not yet billed to customers. Work in progress is valued at cost. Moreover, stocks of materials and supplies as well as advance payments made in respect of project equipment are included in current assets.

Items denominated in foreign currencies

Receivables and debts denominated in foreign currencies have been converted into Finnish markka at the exchange rates ruling on the accounting date.

INCOME STATEMENT

1 Turnover

VTT's turnover primarily comprises external income which is obtained from contract activities or as contributions from partners involved in jointly funded projects. In addition, funds appropriated out of the state budget that are used for VTT's own research initiatives or to cover VTT's share of the costs of jointly funded projects are entered into the accounts as turnover in accordance with actually incurred costs.

2 Personnel expenses

FIM 1,000 mk	1996	1995
Salaries	463,899	438,994
Pension expenses	65,740	63,694
Other personnel expenses	32,834	31,512
Total	562,473	534,200

FIM 1.7 million (FIM 2.1 million in 1995) provided by the Ministry of Labour, the Ministry of Education and the Ministry of Finance to finance salary expenses has been deducted from the personnel expenses.

3 Depreciation

The depreciation item includes, in addition to scheduled depreciation, non-recurrent additional depreciation charges of FIM 17 million. The most significant additional depreciation charges related to NMR equipment, various minerals technology research equipment, and a wave machine for ship and marine technology research.

4 Financial income and expenses

Financial expenses are mainly imputed interest on capital tied up in fixed assets. This is calculated by applying a 7.2 % interest rate to the value of fixed assets in accordance with instructions issued by the State Treasury Office.

BALANCE SHEET

5 Changes in fixed assets

FIM 1,000 mk	1996	1995
Intangible assets		
Value of fixed assets 1.1	12,712*	9,409
Increases	3,233	6,012
Depreciation	3,353	2,880
Other increase/decrease	311	66
Value of fixed assets 31.12.	12,903	12,475*
Tangible assets		
Value of fixed assets 1.1.	212,771*	217,356
Increases	59,650	64,518
Depreciation	81,293	67,202
Other increase/decrease	311	1,664
Value of fixed assets 31.12.	190,817	213,008*

* transfers between asset classes

6 Securities held as fixed assets and other long-term investments

Shares and other holdings	No.	Ownership %	Nominal value FIM 1,000	Book value FIM 1,000
Finntech Oy	60	60	600	2,700
Helsingin Puhelin Oy	219	-	-	723
Other shares				303
Total				3,726

Loan receivables and other investments totalled FIM 670,000.

7 Receivable from the State

This is an imputed figure representing the amount receivable from the State Treasury.

8 Own funds

Own funds represent the difference between total balance sheet assets and other capital items, and thus describes VTT's basic capital. It is an imputed item because VTT is a permanent part of the government economy.

9 Donations

FIM 1,000 mk	1996	1995
Value at 1.1.	1,500	1,554
Increases:		
- Donations received	30	-
- Interest income	55	46
Use of donations:		
- Scholarships	116	32
- Other expenses	5	69
Value at 31.12.	1,464	1,500

10 Budget funds

This item describes the amount of 1996 budget funding valued at cost that remained unused at the end of the financial period. The funding as a whole is presented in the Budget Statement.

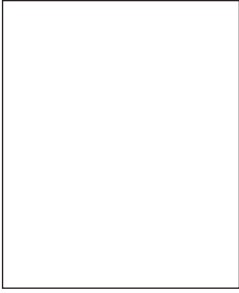
11 Accrued liabilities and deferred income

Accrued liabilities and deferred income are mainly employers' pay-related payments and the imputed holiday pay liability recorded for the financial period.

BUDGET STATEMENT

The state budget appropriations and their use are presented in accordance with the State's official administrative bookkeeping practice.

Appropriations intended for the purchase of buildings and offices that were previously included in VTT's appropriations have been transferred to the State Property Office, with the exception of the funds allocated for VTT's use in respect of the previous year.



Research Director
Jorma Lammasniemi

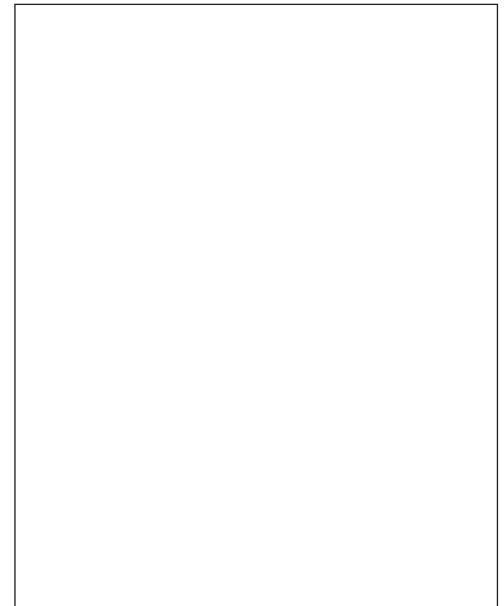
The Finnish electronics industry has expanded rapidly in the 1990s. There was no let-up in the intensity of this growth in 1996 - nor in the related demand for VTT Electronics' research services. The most-sought-after services were the design of electronic circuits and products, where the use of embedded computer and software technologies has been growing. The R&D activity of the component industry has also been on the increase.

A central factor in the growth of the electronics industry has been the global digital telecommunications breakthrough, which has strengthened the industrial infrastructure of the sector in Finland. The field is very research intensive and accounts for more than one third of the total R&D expenditure of Finnish industry. The number of VTT Electronics' R&D assignments received from industry has risen rapidly. Moreover, VTT Electronics achieved the rather exacting goals set for it in all other respects as well.

The total volume of operations was 255 man-years, an increase of 12 compared with the previous year. There was an increase in international co-operation, especially in the number of EU projects. Participation in national research projects funded by the Technology Development Centre was reduced. To some extent the work was hampered by the turnover of staff and by the general shortage of trained personnel in the electronics sector.

Most of the contract assignments involved the transfer of electronic technologies developed in strategic research work and joint projects to industrial customers. Results included the first 150 mm silicon crystals grown in a continuous process, and the preparation of low-oxygen silicon material within a magnetic field. Signal processing methods, circuit technologies and embedded software products were developed for new telecommunications products. Development environments for electronics and software design were transferred to industry. Several instruments and sensors applying optoelectronics and micromechanics were developed. The prototype of a modulator matrix and a switch matrix ordered by ESA were completed.

Technologies essential for the development and future opportunities of the Finnish electronics industry were developed in the three main research fields of the Institute: silicon technologies, embedded systems and optoelectronics. The work was carried out within the Institute's strategic research programmes, which were valued at FIM 25 million in 1996. The results included a virtual



Virtual reality techniques can be utilised in the development of future electronics and telecommunications products.

prototyping environment for product development work, technology for fully digital rapid receivers, methods improving the productivity of software development, and a miniaturised infra-red analyser. VTT's microcircuit processes can now be used to manufacture RF circuits with a 17 GHz cut-off frequency.

The Institute's EU projects involved the transfer of new methods of electronics design to Finnish industry, the introduction of a very fast wireless data transfer system, and the development of industrially applicable micro-electronic. Optoelectronic technologies were developed in ESA projects. Thanks to good preparatory work carried out in previous years, a significant percentage of the Institute's new joint research projects are now related to EU programmes.

Research fields:

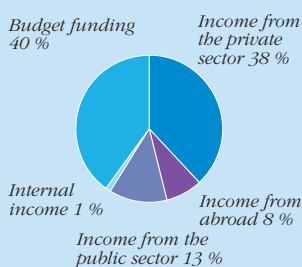
Microelectronics
Electronic Circuits and Systems
Embedded Software
Optoelectronics

Man-years: 260

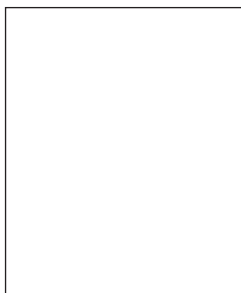
Staff by location:

Oulu 202
Espoo 75

Turnover: FIM 115 million



VTT Information Technology



Research Director
Pekka Silvennoinen

The focus of VTT Information Technology's research efforts in 1996 was on the development of information systems for decision support, applications of wireless telecommunications and distributed multimedia, and communications based on integrated electronic and digital printed media.

The demand for VTT Information Technology's services continued its favourable trend in 1996, as technology push and market pull both acted in the same direction.

The aim of the Information Systems research field is to develop innovative systems supporting and facilitating demanding operations involving large amounts of data. Knowledge-based and object-oriented technologies, multicriteria optimisation and a heavy reliance on visualisation characterise these applications. In 1996 the database software development project RAPID was completed, and the development of a new database software product with fuzzy logic was started. A neural-network based appraisal method for timber loads applying the decision criteria of dispatch managers was incorporated into the wood procurement management system. Additional features were developed for the pagination software for classified advertisements.

Important development goals of telecommunications and information network research include the broadband wireless access to fixed networks, wireless ATM, support for mobility, distributed platforms as well as the combination and grouping of services for intelligent access. A gigabit rate switch developed at VTT Information Technology to meet the needs of broadband telecommunications was licensed to the first commercial customer.

The aim of the multimedia communications research is to develop value-added services as well as service platforms for wireless and broadband communications. During the past year the research focus was influenced especially by the commercialisation of Internet and WWW solutions facilitated by new security solutions. A digital video communicator developed at the Institute received an honourable mention at the national Oiva '96 software competition. The software-based system enables the wireless transfer of files and digital video via the GSM system.

The strategic goal of graphic arts research is to respond to the needs of the printing industry as it becomes more networked and is transformed into a communications industry with integrated contents products. Research carried out on press control systems included the development of automated colour con-



Owing to the digitalisation the technology bases of information processing and transfer are converging. VTT Information Technology is meeting the research needs of the IT and communications industries with regard to this process integration.

trol, colour imaging, and the transfer of colour originals in standardised digital form.

Important long-term research projects in which VTT Information Technology participated were the national technology programmes on multimedia, electronic printing and publishing as well as new generation paper technology.

VTT Information Technology was actively involved in several EU projects that supported its core competencies in the fields of telecommunications research and in the development of a training environment for printing technology. Finnish companies participated in most of the EU projects concerned, thereby ensuring the utilisation of research results.

Research fields:

Information Systems
Telecommunications
Multimedia Systems
Printed Communications

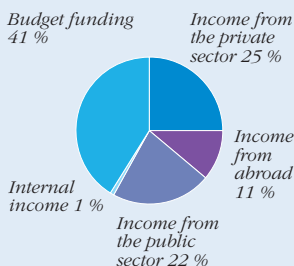
Graphic Arts Technology
Health Care Technology

Man-years: 195

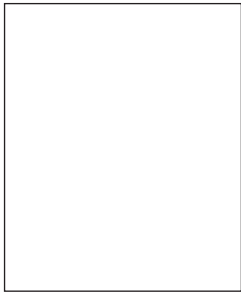
Staff by location:

Espoo 181
Tampere 30

Turnover: FIM 83 million



VTT Automation



Research Director
Esa Jutila

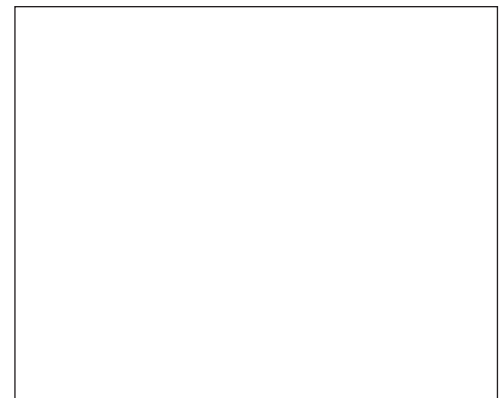
The importance of automation in manufacturing, the services sector and public administration has grown tremendously over the past two decades. Typically the production capacities of industrial plants have been doubled, while the number of personnel directly involved in production has been halved. These developments set growing demands on research and product development in the various areas of automation technology. Ensuring that these are integrated to yield even more reliable automated systems is one of the main challenges and opportunities for VTT Automation.

As a result of structural changes in Finnish industry, many companies have rid themselves of operations outside their core business processes. This has increased the need for outsourcing in services such as product design, manufacturing and testing. Responding to this demand, VTT Automation has developed the ProTechno service concept, making a wide range of expertise available to the customer at all stages of product development: product design, analyses, product engineering, prototype construction and testing. As the concept has become better known, the demand for these services has grown rapidly. The service is supplemented by the new Electromagnetic Compatibility (EMC) testing laboratory, which will be officially inaugurated in the spring of 1997.

Research programmes concerned with signal and image processing, intelligent production systems, and measurements and controls in the pulp and paper industry were started by VTT Automation in 1995. During the past year these efforts progressed well, and five related research commissions were initiated. It was decided that all of the programmes will be continued in 1997.

For VTT Automation the internationalisation process has progressed as a natural part of the development of activities and expertise. Projects carried out for the EU, ESA and CERN relate directly to the Institute's core fields of expertise. The projects will strengthen the knowledge base for future research and development. In 1996 the Institute participated in ten EU projects, almost all of which included a Finnish enterprise partner as well. A proposal on remote sensing won an EU approval for a direct research commission.

In 1996 an evaluation report on VTT Automation was completed by outside experts. The report noted that the activities of VTT Automation provide strong support for the main goals of VTT. The expertise and knowl-



A permanent magnet undulator in the measuring bench for verification of the magnetic field.

edge base of the Institute are solid and enable continuous improvement of R&D activities. The needs of customers in the services sector, both as individuals and as groups, are typically difficult to understand. In this regard the Institute's ability and practical working arrangements are still in need of improvement.

The personnel is, of course, the key success factor in an expert organisation. The development of technological expertise is one of the main tasks of the organisation, but teamwork and continuously improving working and collaborative skills are also required. VTT Automation has taken steps to develop the organisation and its staff on a broad front.

Research fields:

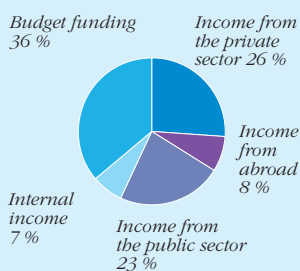
Industrial Automation
Machine Automation
Measurement Technology
ProTechno

Man-years: 232

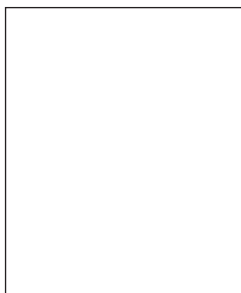
Staff by location:

Tampere 39
Espoo 192
Oulu 15

Turnover: FIM 90 million



VTT Chemical Technology



Research Director
Markku Auer

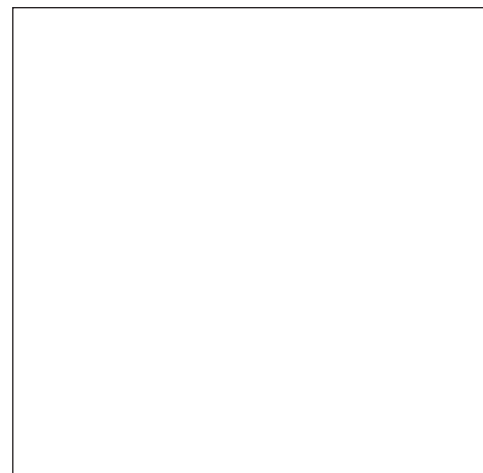
The economic conditions of VTT Chemical Technology's customers have been improving, and the demand for research assignments has continued to develop favourably. As the share of funding received from the state budget has diminished, there has been a shift of emphasis towards external sources of research funding.

Funding from the domestic private sector rose by about a third during the review year. At the same time income from abroad has risen quickly. In future the focus of growth generation will be on international assignments.

The number of contract assignments received by VTT Chemical Technology rose in 1996. A notable example of these commissions involved research into the use of sulphur-containing waste and fly ash from coal-fired power stations in land fills. A solution developed during the research prevents environmental problems and almost completely disposes of the waste material in land construction works.

Measured in terms of the number of patents and inventions, VTT Chemical Technology has improved its productivity. The Institute received 7 patents and announced 26 inventions. In addition, VTT Chemical Technology played an active role in the chemical industry's re-industrialisation programme, in which the aims were to create new enterprises and to strengthen the competitiveness of existing companies through product development efforts. A project, in which the thermal insulation and grip properties of everyday winter footwear were improved, provides a good example of the Institute's product development work for industry. Eight Finnish shoe companies were involved in the joint project.

New products and services of the Institute include structural analyses of biomolecules for the pharmaceutical industry, electron microscopy research services, chemical syntheses for the industry, measurement and calculation of material properties from real mixtures, analyses of smelter ores for the determination of diamond concentration and the analysis of gold grains, a facility for diamond pre-separation, the application of FTIR microscopy in mineralogy, a de-inking test facility for recycled paper processing, a compression press, spooler and hardening oven for the development of composite materials, a blown film production line for the fabrication of three-ply plastic films for the packaging industry, indoor air quality laboratory, and a mobile laboratory for emission measurements.



Modelling of solvents for electrically conducting polyaniline.

In 1996 four research programmes were underway at VTT Chemical Technology. Their volume totalled about FIM 21 million, and funding from the state budget was FIM 12 million. The beneficiaries of research results included Enso-Gutzeit Oy, UPM Kymmene Oy, Oy Ahlström Ab, Valmet Paperikoneet Oy, Nokia Telecommunications Oy, Wärtsilä Diesel, Cubes & Tubes and many SMEs. The installation of a safety floor at a home for the elderly in Tuusula is an excellent example of society benefiting from research results.

For the SME sector, the most notable results were achieved in the synthetic materials research programme, which concentrated on the study of electret materials and EMF films.

Research fields:

Industrial Physics
Materials Technology
Environmental Technology
Processing Technology
Mineral Processing

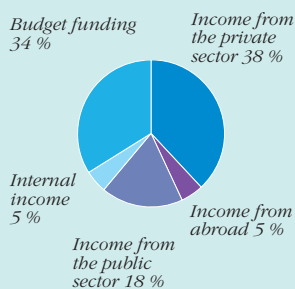
Low-impact technologies

Man-years: 266

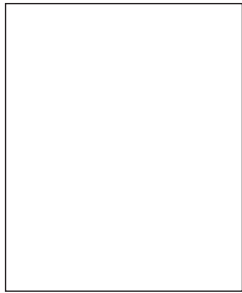
Staff by location:

Espoo 195
Outokumpu 27
Tampere 56

Turnover: FIM 117 million



VTT Biotechnology and Food Research



Research Director
Juba Abvenainen

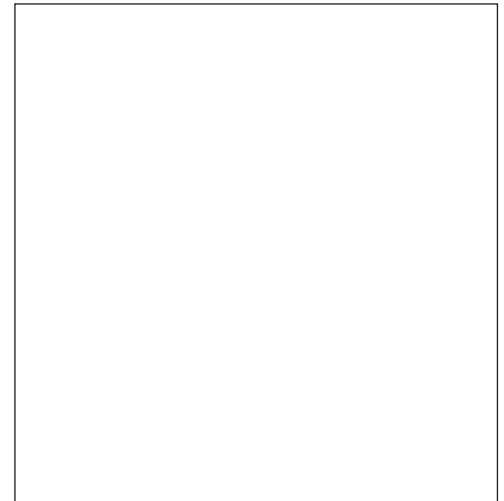
The focal points of research at VTT Biotechnology and Food Research were industrial proteins, foodstuffs and packaging, new applications of microbes, and brewing and malting processes.

In 1996 the Institute was scrutinised by two evaluation studies. An overall evaluation had been initiated by VTT and the Academy of Finland carried out a national evaluation of molecular and biotechnical research. The results of both confirmed that the scientific and technical level of the Institute is good and that its strategic plan is appropriately oriented. The recommendations contained in the evaluation reports will be analysed and acted upon during the course of 1997.

There was a significant expansion of international co-operation. By the end of 1996 some 60 international projects were underway. The Institute was very successful in the proposal rounds of the EU research programme on biotechnology (BIOTECH 2) and of the research programme on agriculture and fisheries (FAIR). Product development projects concerned with enzyme technology were targeted at the forest, textile and chemical industries. Research on the applications of enzyme technology in the textile industry is being carried out in projects launched by the EU and the Technology Development Centre. Another undertaking funded by the Technology Development Centre is a study on the enzymatic breakdown of harmful biofilms in the forest and process industries. The utilisation of hydrolytic and oxidising enzymes is being studied in joint projects funded by the EU and the industry. A method of reducing energy consumption by using cellulase enzymes in mechanical pulping was developed in the Technology Development Centre's Sustainable Paper technology programme.

Research Professor Liisa Viikari received the Walter Ahlström award in recognition of her pioneering work in the field of forest industry biotechnology.

New processing and packaging solutions were developed for the food industry. Particular attention was given to research on minimal processing technologies, rye and baking, starch processing, control of the structural properties of foodstuffs, and packaging technologies. A research programme on the minimal processing of foodstuffs was started at the beginning of the year 1996. Research on brewing and malting processes was continued



Beer fermentation using immobilised yeast is being developed in the pilot brewery.

within the framework of the industry's technology programme.

Research into industrial proteins focused on the development of hydrolytic enzymes, antibodies and receptors. An increase in the production rate of proteins excreted by yeast and mould species was achieved by using genetically modified strains.

Antibody technologies were developed in projects funded by the industry. Substantial progress was made, for instance, in the production efficiency of the important antibodies of steroid hormones. The VTT research programme on metabolic engineering concentrated on the modification of baking yeast for the production of organic fine chemicals.

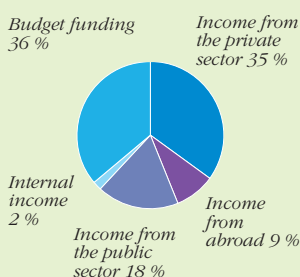
New industrial applications for lactic acid bacteria were developed. A malting process based on the starter method was tested on an industrial scale. The Institute co-ordinates an EU project tackling the nutritional effects of probiotic preparations, which is the most important research effort among several concerning the applications of probiotic bacteria.

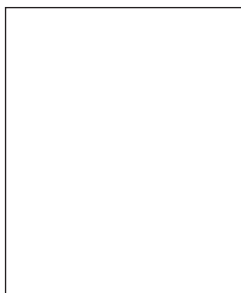
Research fields:
Biotechnology
Food Technology
Gene Technology
Microbiology and Safety

Man-years: 250

Staff by location:
Espoo 272

Turnover: FIM 90 million





Research Director
Mikko Kara

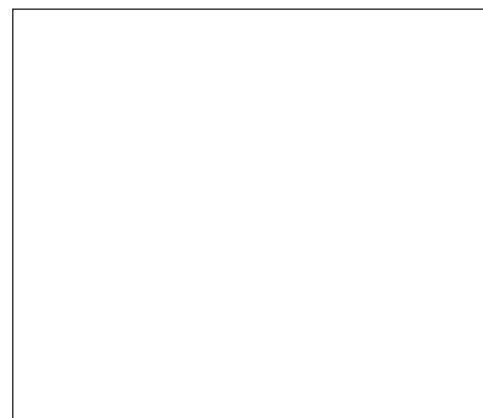
Restructuring of the forest industry resulted in new co-operation projects for VTT Energy in 1996. There were fewer contract assignments from the boiler-making industry, but other commissions related to energy production rose, with the emphasis on specialist services supporting exports. The value of R&D work concerning energy use and energy systems is being increasingly appreciated.

In 1996 VTT Energy succeeded in achieving its R&D objectives and excelled in terms of its economic performance. Budget funding was instrumental in financing the preparation, start-up and running of the Institute's research programmes and strategic work in other fields of core competence. In addition, the Institute co-ordinated several national energy technology programmes (EDISON, FFUSION, JYT2, MOBILE and RETU), and was active in several others. Internal co-operation was enhanced by the Institute's research programmes and by developing the ways in which the managers of different research fields interact and collaborate.

The main focus of nuclear safety research work was on the extensive modernisation and power upgrading projects at the Loviisa and Olkiluoto nuclear power plants. VTT Energy also carried out studies on the safety, technical solutions, and siting of a spent nuclear fuel repository for the joint nuclear waste management company Posiva Oy set up by the responsible power utilities.

Gasification and pyrolysis technologies for coal and biomass were developed for IGCC, diesel and traditional steam power plants. Increases in the costs of waste disposal brought new assignments from companies involved in waste treatment. An extensive related research programme on the processing techniques of mixed fuels (MF-SYSTEM) is being continued by the Institute. The results of research on wood fuels include integrated skidding of trees without trimming in spruce dominated forests. In peat technology a prototype series of dust-free vacuum collecting wagons was fabricated and a method for the utilisation of shallow peatlands was developed. In the field of motor fuels, studies on vehicles powered by natural gas and development work on reformulated fuels continued. Studies concerned with the drying and quality control of paper were extended by clarifying the use of superheated steam and developing new paper measurement methods.

New legislation on competition in the electricity market has spurred VTT Energy's cus-



Full-scale pumping line for research on fibre suspension flow.

tomers to issue a number of contract research assignments. VTT Energy was one of the organisations invited to give expert advice when the new legislation was being formulated. The Institute has performed a similar role in other issues of energy policy as well. Expectations concerning renewable energy sources continue within the public sector, related especially to the use of wood.

International co-operation has flourished especially as a result of the EU research programme projects. VTT signed a co-operation agreement with the New Energy Development Organisation (NEDO) of Japan, extending our activities into Southeast Asia. A general co-operation agreement was concluded with the French Institut de Protection et de Sûreté Nucléaire (IPSN), and two joint projects were immediately started.

Research fields:

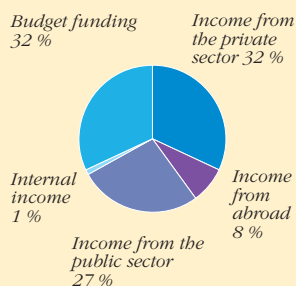
- Fuel Production
- Energy Production Technologies
- Nuclear Energy
- Energy Use
- Energy Systems

Man-years: 290

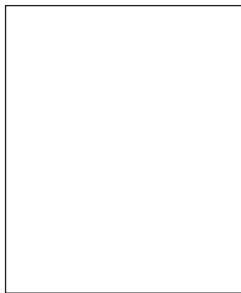
Staff by location:

- Jyväskylä 111
- Espoo 193
- Lappeenranta 5

Turnover: FIM 145 million



VTT Manufacturing Technology



Research Director
Heikki Kleemola

The two most important changes in the operating environment of VTT Manufacturing Technology were industry's recovery from recession and the improvement in international funding opportunities due to Finland's membership of the European Union.

The volume of contract activities grew by almost 40 per cent and income from the private sector by about 13 per cent. Sales of research services to the defence equipment sector, the pulp and paper industry, the electronics industry, the energy sector and the basic metals industry all rose. Domestic and especially international co-operation was increased in strategic research. Domestic public funding rose by about 10 per cent and income from abroad by 70 per cent.

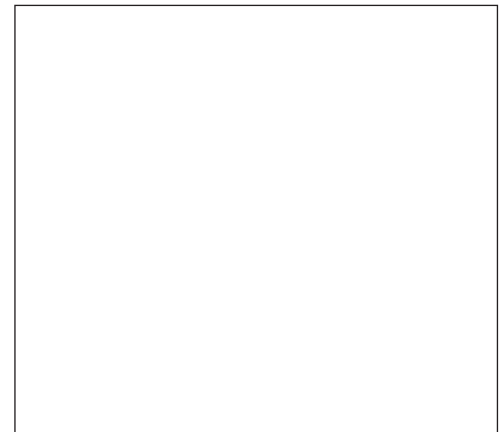
Budget and jointly funded activities were mainly implemented as projects of the Technology Development Centre, the Ministry of Trade and Industry, the Industrial Safety Fund, the Scientific Board for National Defence, and the European Union. The projects yielded good and highly beneficial results. For example, research results concerning the structural integrity of nuclear power plants were used to improve the operational safety of nuclear power plants in Finland, Germany, Sweden and Russia.

The operational reliability and risk management of industrial machines, equipment and processes were improved, for instance, by developing a model for the spread of chemicals in the soil, by providing process engineers with a safety design tool, and by making safety analyses.

Advanced materials technology was transferred to the enterprise sector, for instance, via the Technology Development Centre's Industrial Applications of Engineering Material technology programme, in which advanced manufacturing techniques such as powder metallurgy, new bonding methods and thermic spraying methods were used in the manufacture of demanding components.

The prefabrication and on-site installation of steel structures was developed in VTT's own research programme. A monitoring and diagnostics system for the machining centres of flexible manufacturing systems was developed and tested in a EUREKA project. VTT Manufacturing Technology has also played a key role in a EUREKA project in which a flexible and easily adaptable assembly system composed of independent intelligent modules was developed.

The operational reliability and safety engi-



TrendChem equipment is developed by VTT Manufacturing Technology for in-line monitoring of water chemistry in power plants.

neering of maritime traffic were developed mainly in European joint projects. The results of these were the basis for an extensive research project on the safety of Finland's maritime traffic, which was commissioned by the Finnish Maritime Administration.

A project concerned with closed loop operations in the pulp and paper industry involved the development of new equipment and methods for research into the durability of materials, as well as performance studies on materials used in the critical components of bleaching plants and the splash zone of paper machines.

Research fields:

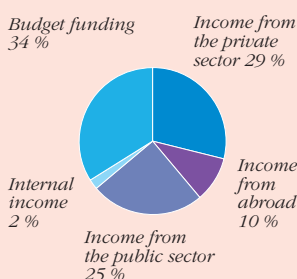
Safety Engineering
Production Technology
Materials Technology
Operational Reliability
Materials and Structural Integrity
Maritime and Mechanical Engineering

Man-years: 385

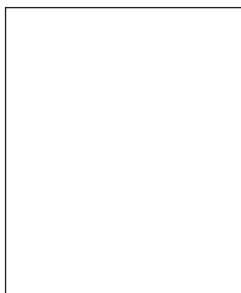
Staff by location:

Espoo 296
Tampere 83
Lappeenranta 12

Turnover: FIM 163 million



VTT Building Technology



Research Director
Erkki K.M. Leppävuori

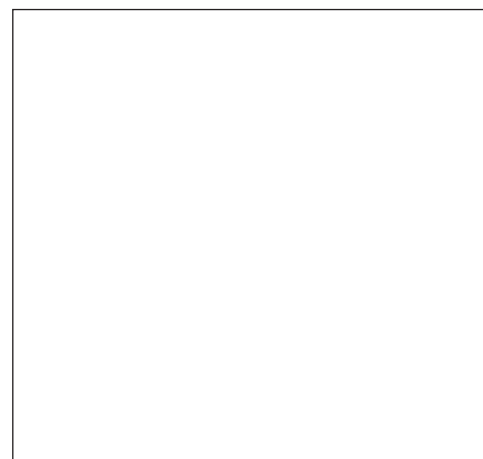
The research activity of VTT Building Technology's customers increased in response to the onset of recovery in the construction sector during the summer of 1996. The Institute's research results were applied in building materials and products, building production, design and facility maintenance, as well as mechanical forest industry products and their manufacture.

In addition to its contribution to certain international co-operation projects, the Building Physics, Building Services and Fire Technology research field performed much valuable work in national programmes such as the RAKET research programme, the Wood Construction technology programme, the INVENT programme, the VTT Steel research programme, and also in horizontal projects of the Institute. Work on active fire prevention and risk management, the fire behaviour of materials, the fire resistance of structures, and computational methods for materials and heat transfer was performed in budget-funded research projects.

The Construction and Facility Management research field acted as a provider of information and expert advice in an attempt to address employment issues in the construction industry, to improve building condition surveying and to solve the problems associated with dampness and mould growth in buildings. The STAR research programme led to the creation of new and improved methods of modelling and developing construction processes, controlling the process of customer-originated design and its technical feasibility, integrating design and construction, and managing product information. The main research themes in the field of building production were masonry techniques, construction safety, ergonomics and industrial safety regulations, waste problems and waste sorting, and automation on construction sites.

The costs of jointly funded projects in building materials research were FIM 4.6 million. The funds were allocated mainly to projects in the FAIR, Brite-EuRam, SMT and ECSC programmes of the EU, other international programmes, the Academy of Finland's research programmes concerning materials and ecological construction, and the industrial technology programmes of the Technology Development Centre, e.g. Mechanical Wood Processing, Wood-based Panels, Wood Construction, Environmental Technology in Construction and FINNSTEEL.

The value-added chain from logs to final products was studied in a project concerning the use of wood as building material. In the



VTT Building Technology carries out research for the development of living environment, construction methods and building products in accordance with the principles of sustainable development.

field of concrete and minerals technology, practical tools for packing, granulation, heat production, strength development and drying were developed and tested. Steel and composite structures were developed in the VTT Steel programme.

The Strategic Technology Development unit served the Institute's various research groups by procuring and managing wide-ranging projects of an interdisciplinary nature, thus ensuring efficient utilisation of the Institute's resources.

The number of accredited methods was increased, product certification was expanded, and environmental impact assessment was incorporated into the VTT Certificate. The German Ü certification rights were obtained for six product groups. Thirty projects were started within the Technology Development Centre's product certification clinic.

Research fields:

Building Physics, Building Services and Fire Technology
Construction and Facility Management
Building Materials and Products, Wood Technology

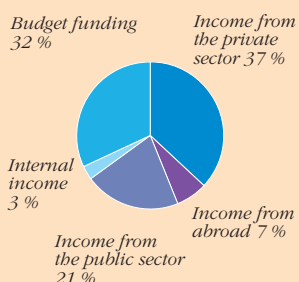
Strategic Technology Development
Service Centre

Man-years: 383

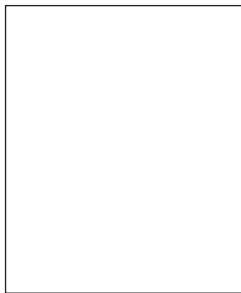
Staff by location:

Espoo 334
Tampere 36
Oulu 24

Turnover: FIM 150 million



VTT Communities and Infrastructure



Research Director
Markku Salusjärvi

The main factors and changes influencing the work of VTT Communities and Infrastructure in 1996 were the heightened impact of logistics on the profitability of export industries, the introduction of free competition to the public sector, the principle of guaranteed-quality construction, the European Union, north-western Russia and the Baltic states, and the development of ecological competitiveness in industry.

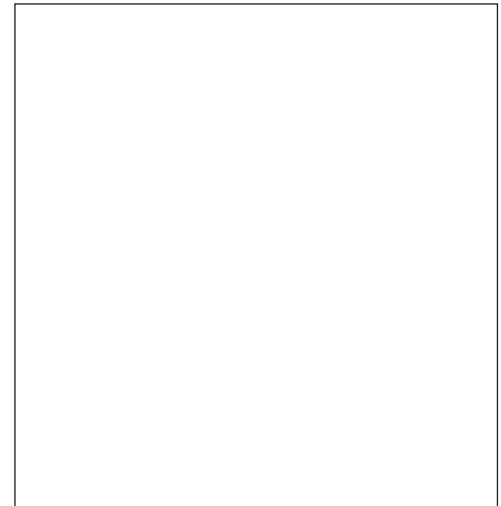
Despite a fall in funding from the state budget, the turnover of the Institute grew in 1996. There were more research assignments from the domestic public sector, but the targeted growth in orders from the private sector was not achieved.

The Institute sought to improve the competitiveness of trade and industry by developing transport logistics. These improvements include methods based on locational databases of customers and operations and, in the Paper Handling and Transport 2000 programme, logistical procedures for exports of the forest industry.

Issues related to the environment and ecological competitiveness have gained increasing prominence in the field of communities and infrastructure. In order to clarify and reduce the environmental effects of civil and municipal engineering projects, the Institute tested, verified and commercialised environmental impact assessment methods, and developed methods of estimating emissions and energy consumption. The use of by-products, previously unusable materials and wastes was promoted as a result of the Institute's work. In a joint project with government ministries, application of the principles of sustainable development in traffic was studied.

Research aimed at improving the durability and economy of physical infrastructure included studies of road base and pavement structures. The aims are to double the service life of roads, cut annual maintenance costs by 5-10 %, and halve the costs of frost damage by the year 2000. Analytical services based on urban planning and building information management methods were provided for municipalities, real estate owners and building companies. The consequences of property development decisions on the economy, the environment and business conditions can be analysed by using a traffic system simulation model developed at the Institute. The effects of new technology on driver safety and behaviour were studied using a specially instrumented research vehicle.

Budget funding was allocated according to



The measurement system of a PTM car produces comprehensive data to facilitate road and street maintenance and planning.

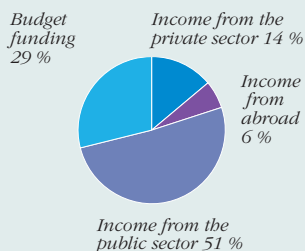
the strategic needs of the Institute's customers, with the emphasis on EU projects, other international networking, and co-operation with the north-western region of Russia and the Baltic states. The aim was to increase the effectiveness, usefulness and efficiency of the work done at VTT Communities and Infrastructure. The Institute focused especially on projects of the EU's Fourth Framework Programme and on linking their results with domestic research work on the strategic development of the traffic system. Services were targeted at the north-western region of Russia and the Baltic states. Exports of Finnish consulting and design services were promoted in the TACIS and PHARE programmes. VTT Communities and Infrastructure also participated in projects addressing the state and development of infrastructure in Russia and Estonia. This work had a direct and positive impact on sectoral employment, which was hit hard by the last recession.

Research fields:
Urban Planning
Transport Research
Road Engineering and
Geotechnology
Rock and Environmental
Engineering

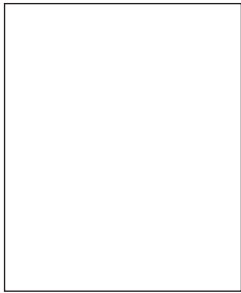
Man-years: 140

Staff by location:
Espoo 152
Oulu 6

Turnover: FIM 56 million



VTT Information Service, Supporting Services, and the Group for Technology Studies



*Head of VTT Information Service
Sauli Laitinen*

VTT Information Service

VTT Information Service provides information services for the research centre and also acts as a national information centre. It supports VTT research institutes at all stages of information acquisition and technology transfer.

Electronic information systems are developing rapidly and changing the work practices of information professionals as well as researchers. The acquisition of information is becoming easier, and researchers are starting to perform information searches by themselves. At the same time, however, the supply of information is becoming more fragmented, making it more difficult for the users to find and distinguish the best information providers from the many services now available.

VTT Information Service also supports the dissemination of research results in Finland and abroad. Publication activities are currently in a phase of intensive development. Many journals and research reports are made available in full in printed and parallel electronic versions, while others are only available as multimedia presentations. A start was made

on the electronic publishing of VTT's own publication series.

VTT Information Service's own VINTTI information retrieval system offers access to public databases on VTT research activities and results, and to other text-based databases useful for researchers. The ease of use of the system was enhanced by the incorporation of a WWW interface. VTT Information Service acts as a Nordic Centre of Excellence for Electronic Publishing nominated by NORDINFO, the Nordic Council for Scientific Information. The work involves the provision training, consulting and advisory services in the field of electronic publishing.

VTT Information Service acted as a national unit of the EU IMPACT 2 programme. The aim of the programme is to promote the use of electronic information services.

VTT Information Service and the Library of the Helsinki University of Technology have access to a shared computer and information retrieval system. This allows the use of both organisations' databases in a system known as the Otaniemi database network.

The Group for Technology Studies

The basic task of the Group is to support decision making by producing information about technology development needs and the influence of technology policy.

The Technology Development Centre enhanced its position as a leading provider of research funding for the Group. The research evaluation activities of the Technology Development Centre are expanding, and its demand for subcontracting is increasing. The most notable of the Group's new domestic customers were the Ministry of Internal Affairs and Sitra.

In 1996 the Group carried out its first research assignments for the EU Commission. The Group also took part in the preparatory work for the European Science and Technology Observatory (ESTO), which will start up at the beginning of 1997. A significant project for the Group was a study called "The effects of the EU research programmes".

The Group for Technology Studies also participated actively in preparations for the Ministry of Trade and Industry's programme on technology studies.

Supporting Services

The unit is responsible for producing administrative and other centrally supplied services for VTT's research institutes and management. Tighter funding of the research institutes and the internationalisation of activities have had their impact on the work of the unit, highlighting the need for customer orientation and cost effectiveness.

Changes in the unit's operating environment were taken into account in a strategy formulation process. As a result supporting services were reorganised as Internal Services with effect from 1st January 1997. However, the new approach was put into practice as early as the autumn of 1996. Interaction with the research institutes was increased at all levels in order to supply activities more effectively according to the needs of the research institutes.

The need to support co-operation, the diversification of the information network and systems, and expanding internal and external electronic information distribution will require continuous development of Internal Services in the future.

Examples of research results

New methods and competitive products

VTT develops technologies to improve the competitiveness of companies, contribute to the creation of new businesses, and thereby promote economic growth in accordance with the national industrial strategy.



The application of electronics is bringing new product features to taps, enhancing both the convenience and safety in use.

Smart cards less than one millimetre thick are fabricated utilising micro-joining techniques. The memory module is connected to the coil with a silver filled conductive adhesive.

Micro-joining techniques in electronics

VTT Electronics has developed micro-joining techniques to mount bare silicon chips on densely wired substrates. The chips are connected on the surface face down using the flip-chip technique. The method yields a high packaging density, which reduces the dimensions of electronic devices. Micro-joining techniques are increasingly necessary in portable devices.

The development of micro-joining techniques was part of a national research programme on electronics design and manufacturing. The four-year programme included electronics packaging development projects of Finnish electronics companies. The total funding of the programme was FIM 175 million.

The results of the programme were evaluated by a group of international experts. Research on packaging technologies received the highest grades since the work was considered to be correctly focused and the results easily accessible to companies. Micro-joining applications included a smart card less than one millimetre thick and test circuits for cellular phones.

Another achievement of the EDM programme was the development of a process for growing flip chip solder bumps on silicon wafers. The programme improved the ability of Finnish electronics companies to use new, competitive electronics packaging techniques.

The EDM programme was financed by Finnish electronics companies, the Technology Development Centre and VTT.

Electronics for taps

VTT Electronics is involved in the development of a new product family of electronic taps for Oras Oy. The aim is to improve upon the product's features and reduce manufacturing costs. Oras will benefit from VTT's expertise and experience in low power consumption devices, optoelectronic sensors, embedded software as well as component technologies and manufacturing techniques.

The application of electronics in taps adds to the ease, convenience and safety of use. As a result, demand for electronic taps has been increasing rapidly over the past few years.

Touchless operation of taps, usually implemented by using light cells, is the most significant convenience feature brought about by electronics. It also improves hygiene, which is of great importance in public buildings and in special environments such as hospitals and the food industry.

In order to arrive at the best solutions, several factors have to be considered. If rewiring of the mains supply needs to be avoided, taps have to rely on batteries and power consumption must be minimised. The small size of electronic parts is essential when they have to fit in the taps. The need to keep overall costs to a minimum means that the taps have to be very reliable and yet economical to manufacture.

Remote support for process operators

A remote support system developed in collaboration between VTT Automation and Ahlstrom Machinery can be used by experts at Ahlstrom Machinery for guidance of process operators anywhere in the world. The system also supports fault diagnostics as well as planning and realisation of maintenance operations. The first application is in the provision of remote customer support for operators of a DD-washer in a new pulp plant in Tasmania. The remote support comes from Savonlinna, Finland.

The efficient operation and management of complex installations such as processing plants requires the personnel to understand the system's features in all situations. Suppliers of process plants usually participate in the start-up phase, giving training and advice. Operators subsequently have to deal with the process alone, although the plant may be complex and very valuable in economic terms.

The new remote support system enables training on the construction and function of the washer as well as its dynamic behaviour at all times. A multimedia information package provided by Ahlstrom Machinery illustrates the realisation and operating principles of the plant. For the training in the understanding of the dynamic behaviour, VTT Automation has developed a simulator which can also be used to train the operator in identifying and managing abnormal situations. Both the multimedia system and the training simulator can be run remotely by using an information network.

Diagnostic and maintenance operations are facilitated by a measurement data acquisition system developed jointly by Ahlstrom and VTT. Real time operational data is continuously transferred to Savonlinna, enabling monitoring and analysis of the plant behaviour by process experts. Remote real-time information is also a prerequisite for advising operators running the processes.

The remote support system has been developed in an international project belonging to the Intelligent Manufacturing Systems (IMS) research programme. The Australian CSIRO participates by taking care of local operations such as testing communications.

A fast switching device

New high-speed information networks are bringing broadband services that require increasingly high processing capacities from the network components and terminals. The FSR ATM switch developed by VTT Information Technology is a new broadband telecommunication solution based on ring topology.

The throughput of the FSR switch is about 1 Gbit/s and its patented architecture provides efficient support for multipoint addressing. The device is controlled through an application independent programming interface. Its efficiency is based on a medium distribution control of high capacity. The access control is decentralised and implemented in hardware, guaranteeing real-time flow control even at high clock speeds.

The most promising applications include distribution of interactive media. The first licensing and supply contracts were concluded in 1996.

Wireless video communications

VTT Information Technology has developed a software-based system for transferring live digital video via narrow-band networks, especially GSM and low-throughput fixed line networks.

The aim of the project was to develop a multipurpose software platform for implementing video image transfer in a wireless network as well as an end-user application for video surveillance. The solution is a modular system compatible with various modes of telecommunication. The system is implemented in PC/Windows environment. The video compression algorithm has been optimised especially for low-bit-rate channels.

The system offers new business opportunities e.g. in remote surveillance and remote maintenance.

The development work was carried out in co-operation with Satel Oy, Telecom Finland, and VistaCom Oy.

1. With the help of an information network a new remote support system enables experts in Finland to give advice on the operation and maintenance of a DD-washer in a pulp plant in Tasmania.

2. The FSR ATM switch has been developed for broadband applications.

3. Wireless transfer of video via the GSM network can be implemented by applying a new software-based solution.

New services are being actively developed for SMEs as well.

Multi-layered soles for winter shoes

A multi-layered sole design for winter shoes has been developed by VTT Chemical Technology in co-operation with the Finnish footwear industry. The design was used in the manufacture of shoes for the 1996/97 winter season.

The thermal and frictional properties of commercial materials and structures were measured using purpose-built apparatus. It was possible to improve the warmth of footwear by means of an insulation layer conceived on the basis of the measurements. A patent application was submitted for this new invention. Sole tread patterns suitable for icy conditions were selected on the basis of the friction measurements. Promising results for future product development were achieved in tests performed on compound materials.

The companies participating in the Tekes-funded project included Lenkki Oy, Pohjaexpert Oy, Oy Avec Shoe Ltd, Kenkätehdas Leo Pajuniemi Ky, Pomarfinn Oy, Urho Viljamaa Oy and Tuomi-Kenkä Oy. The companies registered a trademark, FENOMEX, for commercialisation of the new product.

Active and smart food packages

Active and smart food packages are the most recent accomplishments in packaging technology. Active packages continue functioning throughout the distribution chain. Not only can they expel harmful compounds such as oxygen from the the package, but they can also add beneficial substances. Smart packages, on the other hand, can indicate condition

or quality of the package or its contents. VTT Food and Biotechnology has developed a package that is both active and smart.

The new technology is suitable for foods packaged in a modified atmosphere. The new package removes residual oxygen and indicates an invisible leakage, which otherwise would cause product deterioration and health risks. The new package offers several advantages. It improves the quality of products and lengthens their shelf-life. As a result of leak indication, damaged packages can be easily spotted and removed from the shelf, preventing consumer disappointment and health risks.

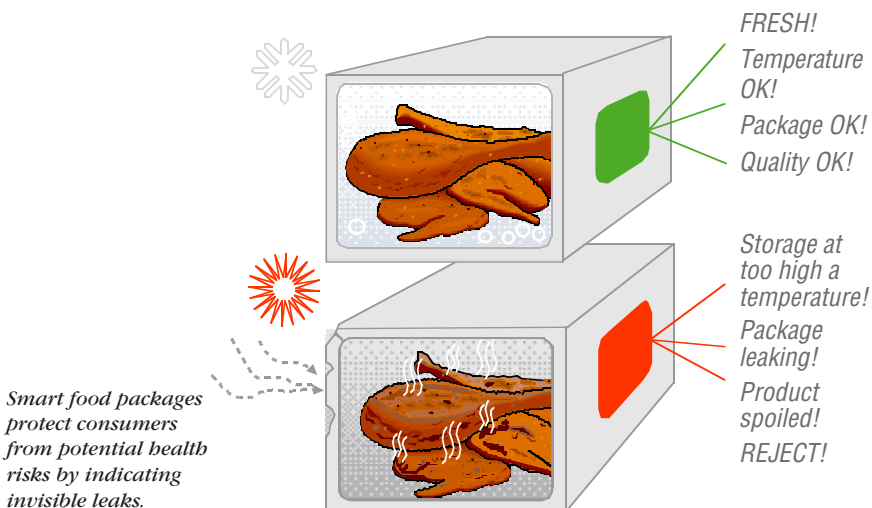
The new packaging technology has attracted a great deal of interest. Dozens of inquiries have been received from both Finland and abroad. The food industry sees many benefits in the new technology, including new opportunities in export markets, improved productivity of packaging lines, and competitive advantage associated with the concept of intelligent packaging. VTT Food and Biotechnology aims to transfer the new smart packaging technology to commercial use in collaboration with the industry.

Geographic information system and GPS in refuse collection

The Waste Management of the Helsinki Metropolitan Area Council plans the refuse collection routes for private contractors visiting more than 50 000 sites. For route planning VTT Communities and Infrastructure has developed a PC-based geographic information system which exploits satellite positioning information. Route optimisation reduces costs, energy use, and emissions.

The system uses municipal raster maps of 1:10 000 scale that show buildings and property boundaries over an area of 1,400 square kilometres as well as a vector map showing 1,400 km of streets. The basic information for route planning is generated from refuse collection contracts between site owners and the Council. The locations of the properties to be served are obtained from building register and are marked on the map. This is supplemented with information on the quantity and type of refuse bins and on the required frequency of collection visits.

Refuse collection areas can be defined by estimating the accumulating amounts of waste. Collection routes can be planned on the screen by judgement or automatically. The



quickest route is found by using the street map and route optimisation software.

Route planning also needs accurate information on the location of refuse bins, which is obtained by a mobile system. It consists of a satellite positioning and rectification receiver and a PC. Site identification information



The costs, energy consumption and emissions of refuse collection are reduced by using the satellite positioning system.

input by the user as well as the GPS information are entered directly into the geographic dataset. An accuracy of 2 to 3 metres is achieved.

Automatic location of power grid faults

VTT Energy, ABB Transmit Oy, and Pohjois-Karjalan Sähkö Oy have together developed a system that determines automatically the location of faults in the mains supply, disconnects the section of grid affected by the fault, and engages back-up power supplies.

The system uses several techniques to pinpoint the location of the grid failure. The distance from the supply generator is traced on the basis of substation current measurements. To get a more accurate estimate, the calculation is compared with signals from fault detectors placed in network nodes. If there is insufficient reliable data available, probabilistic methods are applied, and various indications are combined by using fuzzy logic techniques.

After the location of the fault has been found, the faulty section is isolated and power is restored to the unaffected parts of the grid. Before turning on the back-up supply, the condition of the network has to be checked. If there are several ways of restoring the supply, the optimal one is selected automatically.

The system is intended for use in ABB's remote control system, and it is being tested by a regional power company, Pohjois-Karjalan Sähkö Oy. The new system reduces the duration and the number of power outages

affecting customers. The reliability of electricity supply is improved as the risk of mains failure is reduced. The configuration being tested also enables the development of brand new automated functions for electricity distributors.

The system has been developed as part of the Edison research programme on automation of electric distribution.

Vehicle axles for the export market

In recent years Sisu Axles Oy has intensified its co-operation with VTT in optimising structures of vehicles and trucks and in solving the problems involved. In order to offer a full service that meets the needs of its customers, VTT Manufacturing Technology has formed a research group specialising in truck and vehicle technology.

Examples of co-operation between VTT and Sisu Axles Oy include the development of axle systems for military vehicle specifications, further development of the axles for the North American market, development of a tandem axle to replace an imported alternative, and development of a new family of axles for the European market.

Three main stages were involved in the above-mentioned projects, as is usual in comprehensive product development. First, field trials were staged in order to reveal the stresses actually encountered in service and the external loads causing them, and to confirm the design values. Designs enhancing the competitiveness of the product concept were arrived at by using analyses tailored for each individual case. The results of experimental analyses were verified by testing prototypes in laboratory conditions before mass production was started.

Many of the enterprises involved in vehicle production in Finland are too small to engage in R&D on a scale that would be effective against foreign competition. The competitiveness of Finnish vehicle exports can be enhanced by co-operation and concentration of resources. This operating model will help VTT to provide its customers with adequate access to advanced know-how over a wide range of technologies.



VTT's product development co-operation with Sisu Axles Oy has included studies on the stresses that vehicle axles are subjected to.

An advanced sensor for brain imaging

VTT Automation and VTT Electronics have developed a new miniaturised SQUID sensor for the detection of magnetic fields. The device has been designed especially for research into magnetic fields generated by brain activity. Both the SQUID design and the structure of the pick-up loops differ significantly from previous solutions, making the sensor the most advanced of its type in the world.



Research based on magnetic fields of the brain benefits from the new SQUID sensor.

Magnetic field and two of its gradients are detected by an antenna chip consisting of three pick-up loops. Currents generated by the loops are measured using SQUID circuits connected to the antenna by the flip-chip technique. One chip consists of eight SQUIDs, six of which are used to detect three channels. Each channel consists of two SQUIDs connected in series. An un SQUID patented by VTT is used as a first amplifier stage, as its noise level is smaller than that of a conventional dc SQUID.

The size of the antenna chip is 20 mm x 20 mm and that of the SQUID chip 2 mm x 2 mm. The sensor is a key component in 300 channel magnetometer intended for magnetoencephalography. The new design offers a more compact device while maintaining measurement sensitivity.

Efficient, safe and environmentally friendly equipment and production processes

Industrial processes are an important area of application for VTT's expertise. Increasing attention is being paid to the safety and serviceability of processes and equipment.

Silicon wafer fabrication technologies

In 1996 the company Okmetic Oy received an export prize awarded by the President of Finland. Co-operation between VTT Electronics and the company began in the early 1990s and continues to the present day.

Okmetic Oy manufactures high-quality silicon wafers, the basic material used by the semiconductor industry in the fabrication of integrated circuits and, increasingly, in the manufacture of components based on micro-mechanical structures. Okmetic Oy holds a very strong market position in application-specific wafers.

The joint projects of Okmetic Oy and VTT have been extensive, often involving tests of innovative processes. Co-operative development work has included improvement of the continuous growing process of silicon crystals, hot charging, the study of the effects of magnetic fields on the crystal growth, and epitaxy techniques.

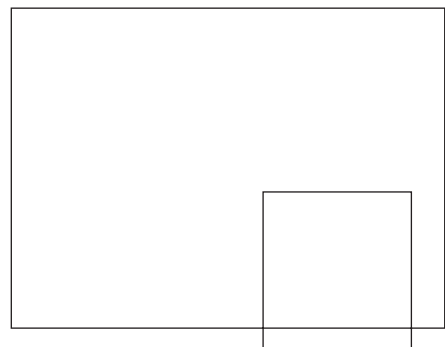
VTT has made determined efforts to improve the competitive position of the Finnish electronics industry. The opening of new facilities will enable the research centre to take up increasingly demanding assignments.

HIPS modular assembly system

An international computer manufacturer has selected a Finnish assembly system for its factory. The order, which was valued at FIM 25 million, encompassed full factory automation together with equipment, design and software. The core of the system is the Human Integrated Production System (HIPS) concept developed in a Eureka project. VTT Manufacturing Technology has played a key role in the



The HIPS assembly system combines efficiency and flexibility in production with ergonomic solutions for operator comfort.



Using the new method it has been proven that lactic acid bacteria do bind to the lining of human colon.

development of the HIPS concept and simulation model.

The HIPS assembly system combines efficiency and flexibility with ergonomic solutions for operator comfort. It includes the automated conveying of components, workstations equipped with automatic materials handling, the testing of final products under automatic control, buffer storage and a packaging system.

The assembly lines consist of modules, each employing two operators. The modularity of the system facilitates full automation of some assembly stages, enabling the replacement of manned units with robots.

Graphic 3D factory simulation software was used as a design tool during the development stage. Models of assembly modules have been stored in libraries, which can be used to speed up model building and visualisation. In order to verify the productivity of the new computer assembly plant, it was modelled, analysed and tested during the design process.

The other participants in this Eureka project were GWS Systems Oy, Nokia Research Centre, ACTEC Engineering Oy, Helsinki University of Technology, Festo Oy (Finland) and Festo KG (Germany), ALMET Ltd (Turkey), Bang & Olufsen (Denmark) and Kongsberg Automotive AS (Norway).

Probiotics enhance health

VTT Biotechnology and Food Research together with Valio Oy and the Harjula Hospital in Kuopio have proven that health-enhancing lactic acid bacteria or probiotics do bind with the lining of the human colon. The observation was one of the first on record in the world. The technique used opens up new opportunities for R&D on foods containing probiotics.

Until recently, health claims related to lactic acid bacteria have been based mainly on personal statements of consumers. The situation is rapidly changing. Properly performed clinical tests have produced indisputable evidence of the positive effects of certain probiotics on various intestinal disorders.

It has been difficult to select the most beneficial probiotic species, because there are no quick and easy tests available. It has been especially difficult to prove longevity of probiotics in the human intestine. VTT Biotechnology and Food Research used samples of intestine obtained by endoscopy to deve-

lop a method that can verify the binding of lactic acid bacteria with the mucous membrane of the colon.

The new method is generally applicable to probiotics research and is based on a combination of traditional cultivation techniques and molecular biology.

Hygiene Clinic for the food industry

The Hygiene Clinic was launched by the Technology Development Centre (Tekes) in 1996. Co-ordinated by VTT Biotechnology and Food Research, the clinic provides especially SMEs with access to the hygiene knowledge and expertise of research centres, universities and consulting organisations.

The main aim of the project is to put research results to work in solving quality and process hygiene problems in the food industry. Among the most popular services have been hygiene evaluations, optimisation of cleaning processes and studies on factors causing quality problems. In the background lies the knowledge and expertise amassed by VTT Biotechnology and Food Research in domestic and international research projects on process microbiology and the formation of biofilms on equipment surfaces. The Institute has a long tradition of hygiene research.

Access to the services of the clinic has been made as easy as possible for customers. Tekes normally subsidises one half of the cost of the assignments performed by the clinic. During the first year of operation, about 30 assignments were carried out. Customers included bakeries, dairies as well as companies specialising in fish products, berries, fruit and vegetables, malting and brewing, pulp and paper, and the technochemical industry. The activities of the Hygiene Clinic will be significantly expanded in 1997.

VTT enables companies to add value to their products by developing new, modern and more competitive equipment and processes.

At the Hygiene Clinic the results of research are applied to solve the problems of the food industry in process hygiene and product quality.

Efficiency in energy use and production, and reduction of emissions

Adherence to the principle of sustainable development is setting growing demands on the development of the environment, industrial production and products. Many energy production projects have a bearing on environmental issues. VTT is playing a leading role in developing the ecological competitiveness of Finnish companies and in raising the efficiency of energy use.

New technology is being applied to improve the recycling of liquid board packages.

The calculated salinity distribution in groundwater in the Olkiluoto island, when the fresh rainwater has during gradual land uplift infiltrated into the bedrock and displaced the more saline original groundwater.

Vital support for nuclear waste management in Finland

The results of nuclear waste studies form a reliable basis for the management of nuclear waste from Finland's nuclear power plants. The Finnish nuclear waste management company, Posiva Oy, reached a significant milestone in its long-term research and development efforts when the results of safety evaluations and other research projects were presented to the authorities at the end of 1996.

VTT's research institutes participated extensively in long-term studies concerning the techniques, safety and suitable location of a repository for spent nuclear fuel. VTT contributed not only to the technical and scientific studies, but also to research related to social and environmental impacts.

Factors affecting the safety of nuclear repositories were studied extensively by analysing the feasibility of using multiple technical and natural barriers to isolate the nuclear waste completely or at least to delay sufficiently the migration of nuclides into the environment. Radioactive substances could dissolve in

groundwater only after copper canisters, strengthened by cast iron inserts, have been corroded or damaged by mechanical stresses. In addition, the nuclides would have to be released from the uranium dioxide fuel and then be transported through a watertight layer of bentonite clay.

VTT has contributed to the evaluation of candidate repository site by carrying out experimental and theoretical studies on the geotechnical, hydrogeological and geochemical properties of the bedrock, and by investigating physical and chemical phenomena affecting groundwater flow and the transport of dissolved substances.

This challenging research work continues as a broad multidisciplinary co-operation. The next milestone will be reached by the end of the year 2000, when the most suitable repository site chosen on the basis of safety and feasibility studies performed will advance to the next stage of more comprehensive site investigations.

Recycling of liquid board packages

Corenso United Oy Ltd is jointly owned by Enso Oy and UPM Kymmene Oy and manufactures coreboard from recycled liquid board packages. Most of the liquid board packages collected for recycling in Europe, i.e. about 2.5 billion a year, are reprocessed at Corenso's new plant in Varkaus, Finland. VTT Energy has been involved in the development of the plant since 1995. Enso Oy is the global market leader in liquid board packages production, which emphasises the economic importance of recycling.

The recycling plant separates reusable fibres from reject matter consisting mainly of

Emulsion technology reduces the emissions of road pavement construction and improves the ecological competitiveness of Finnish road builders.

plastic and aluminium. The reject matter is burned in Enso's 150 MW Pyroflow boiler to recover 18 000 oil-equivalent tonnes of energy.

The first phase of the research project dealt with the initial crushing and washing stages, hygiene issues, conversion of reject matter into fuel, combustion, and homogeneity of the boiler feed. Later, new processing techniques will be developed so that the aluminium as well as the energy contained in the reject matter can be recovered.

The project is also playing its part in promoting the development of recycling technologies for packaging waste, building waste, rubber waste and scrapped cars.

Emulsion technology for road pavements

Working together with the Finnish National Road Administration and asphalt contractors VTT Communities and Infrastructure has studied and developed road surfaces produced using the emulsion technology. The environmental friendliness, economy and safety of road pavement construction can be improved by using emulsion technology, which enables asphalt mixing at temperatures lower than 100 °C without the addition of any solvents to the binder.

In recent decades oil gravel has been the most widely used road surfacing material in Finland. Solvents are used in the binder for oil gravel pavements, and each year they release 2,400 tonnes of hydrocarbons into the environment, representing about 2 % of Finland's total hydrocarbon emissions. In bitumen emulsion the use of solvents can be avoided without compromising the most important properties of the pavement.

Emulsion technology is also of use in the recycling of old asphalt. Problems related to dust and smoke have limited the use of crushed asphalt in resurfacing, but when bitumen emulsion is used, the recycled material can be mixed at less than 100 °C without emissions. In addition, the method saves energy because the mixing temperature is low.

Bitumen emulsions are not yet widely used in the production of pavements in other countries. However, the development work has produced new knowledge, which has improved the ecological competitiveness of Finnish road builders and been of benefit in promoting technology exports of the industry.

More effective use of information technology

The more effective use of information technology is one of VTT's key objectives.

Software for food production and biotechnical processes

Mashing, the first step of the brewing process, is very important for the quality and character of beer. Working together with Finnish malting and brewing industry, VTT has developed an information system that can be used to plan the temperature profile of the mashing process. The software suggests the process adjustments necessary to maintain product quality and prevent processing problems.

The raw materials used in biotechnical processes are often agricultural products, and their properties vary significantly according to, for instance, weather conditions. The variation can be compensated for by adjusting the recipe, that is, by changing the ingredients or processing conditions. Management of such changes is a demanding task, because the properties of the raw materials are not known precisely and because the processes are highly complex.

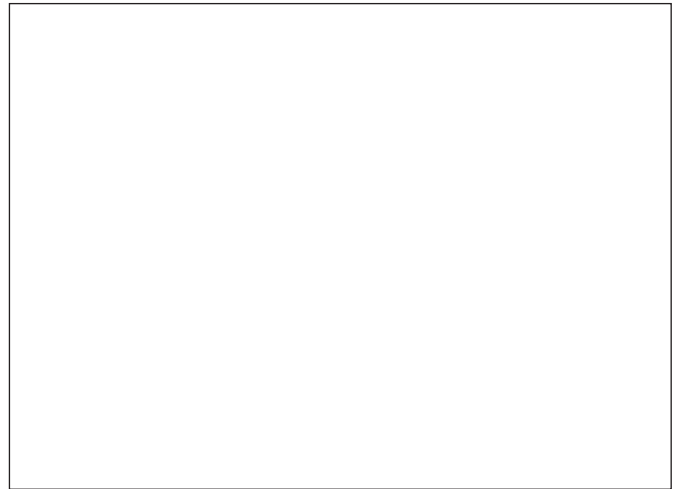
The recipe adjustment software is based on the principles of case-based reasoning and qualitative process modelling that enable the system to learn from experience and adjust to the processing equipment in use. The system also supports optimisation of purchases and the use of existing stocks by selecting raw materials appropriately.

The software will be extended to cover the general planning of biotechnical processes, and it will have generalised modules for case-based reasoning and process modelling. It will be possible to modify the system easily to accommodate different processes.

Software designed to meet the needs of the malting and brewing industry assists in the management of the mashing process and safeguards the quality of products.

VTT supports the competitiveness of the IT industry and Finnish industry as a whole by creating innovative software and systems, furthering the use of embedded computer systems, and promoting development of the national data network.

The creation of a virtual prototype enables the developer to see, feel, hear and try out the product while it is still at the design stage.



Virtual prototypes speed up product development

VTT Electronics has studied the use of computerised product models or virtual prototypes as a tool in product development work. Virtual prototyping not only increases the speed and efficiency of product development but also reduces costs and improves quality.

A virtual prototype is a simulated digital model of a new product concept. The aim is to create a realistic impression of the product's appearance, sound characteristics, user-interface and functional features to the extent that is feasible in simulation. New electronic and telecommunications products can be designed, tested and presented as virtual prototypes even before physical prototypes have been manufactured.

Virtual prototypes are based on the integrated application of virtual reality techniques, digital simulation and user-interface techniques. The realistic appearance of virtual prototypes is based on three-dimensional stereoscopic visualisation, auditory rendering, and tactile interface feedback. The latter helps the user to touch and feel the surface and materials and to operate a simulated user-interface.

Applications of virtual prototypes include the efficient collection of customer requirements and demands, the early visualisation and validation of product features, and the reduced need for expensive and time-consuming physical prototypes. In addition, simulation models of various kinds and levels, such as hardware and software simulation models, can be combined.

Virtual prototyping can also be used to develop product concepts which require technologies that are not yet available but

which are expected to mature in the near future. An example would be a cellular phone incorporated in a wrist watch.

VTT Electronics is currently working on two virtual prototype projects. One of them is funded by VTT and the other is the VIRPI co-operation project, which is a part of a national technology programme funded by the Technology Development Centre and the metals and engineering industry. The main aim of VIRPI is to transfer virtual prototyping technologies to Finnish industry. The other research partners include the University of Oulu, Helsinki School of Industrial Art and Design, Nokia Mobile Phones, CCC Software Professionals Oy, Metsävainio Design Oy, C3 Suunnittelu Oy, Elektrobit Oy and Polar Electro Oy.

Development of industrialised construction and improvement of the built environment

Construction in accordance with the principles of sustainable development, the broad-based exploitation of information technology as a competitive factor, and functional, efficient, economical, and safe communities, infrastructure and logistics are the main goals directing VTT's building technology and infrastructural research.

Real-time fault diagnostics for building automation

The inclusion of real-time fault diagnostics in the automation systems for buildings means that faults in HVAC processes can be detected much earlier than at present. The early detection and localisation of faults brings savings in energy and water consumption, equipment servicing and building maintenance.

Real-time fault diagnostic methods have been developed by VTT Building Technology in several co-operation projects with domestic industry and in an International Energy Agency's Annex 25 project. Ten OECD countries took part in the project and VTT Building Technology acted as the project co-ordinator.

The inclusion of fault diagnostic functions in automation systems should not increase the costs of equipment or instrumentation. This is a requirement that adds to the challenge of the development work. In practice, fault diagnostic methods have to be integrated into the software of the automation system. They take advantage of the measurement and control interfaces of the automation system, and communicate with the user in order to obtain sufficient information on the processes that are to be monitored.

Fault diagnostics brings new features to building automation systems and add a new dimension to their marketing. The development of fault diagnostic systems will improve the competitive position of domestic companies in the Finnish building automation market, which is presently dominated by foreign competitors.

Steel frames for small residential buildings

In Finland and elsewhere the use of steel frames is increasing in the construction of small residential buildings. Two such buildings were developed under the leadership of Rautaruukki Oy for the Ylöjärvi housing exhibition in 1996. One of the houses is a low-energy building. VTT Building Technology has actively contributed to the project by developing the functional performance of the building structures. The task was part of a multinational project called "The use of steel in urban habitats".

The load bearing external wall is fabricated using so-called thermoprofiles. These components can be used to build external walls with a thermal performance as good as or better than well-insulated timber-framed walls. The light gauge steel frame based on the thermoprofile construction saves heating costs significantly compared to ordinary residential buildings. The structural and physical performance of the product was first studied by computer calculations and then in laboratory tests using full-scale prototypes. The strength of roof trusses made of thin steel profiles was ascertained by loading tests and theoretical calculations. The results show that steel-frame houses are very suitable for the Finnish climate and that the steel plate structure can be developed into a competitive, simple-to-install alternative to traditional construction methods.

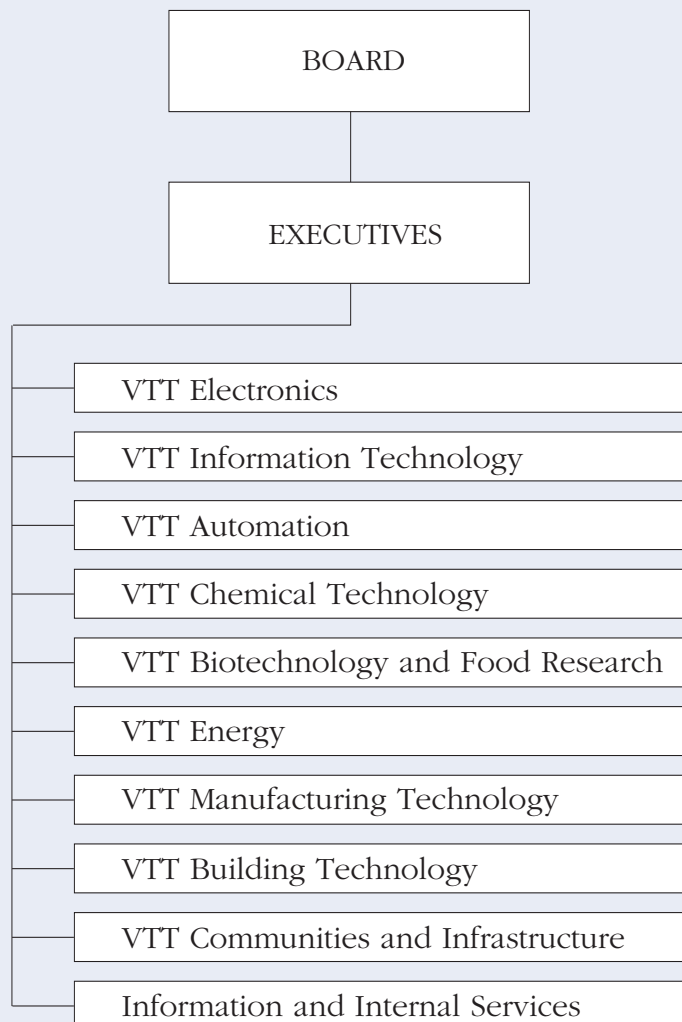
Analyses performed by VTT Building Technology suggest that the environmental impacts of steel-frame houses will not differ from those of wooden or brick houses.

An external building envelope made of insulated thermoprofiles significantly reduces the need for heating compared with more traditional structures.

VTT carries out its research assignments confidentially, impartially and in accordance with agreements. VTT does not release or publish any information without the consent of its customers. The projects described in this annual report have been included by agreement with companies concerned.

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January 1, 1997



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This annual report is printed on Galerie Art Silk
printing paper, which has been granted the
environmental emblem of the Nordic countries.

ISBN 951-38-4587-7
Libris Oy 1997



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