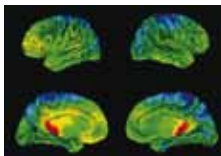
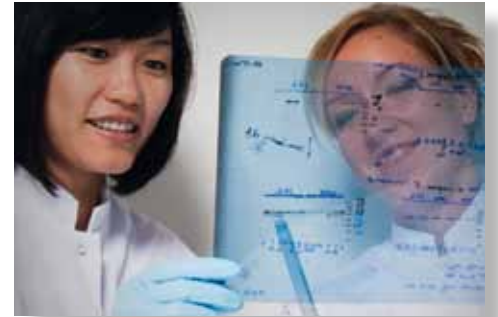




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VTT Review

2011

2012 2013 2014 2015 2016



Web version of
VTT Review 2011:
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President & CEO's review

The vortex of the European public economy has concentrated minds on the solving of debt problems, pushing long-term investment in developing competitiveness into the background. There must be greater public investment in support of business competitiveness and the well-being of society at large. Research and innovation activity must be boosted, with the emphasis on the reallocation of scarce resources.

Europe has traditionally placed significant investment in basic scientific research. Both exploitation by industry of the new information generated and the development of new jobs have nevertheless remained modest. The publications and patents that are produced fail to lead to the birth of an export industry or to employment. In fact, much of domestic industrial production has shifted elsewhere. Now is the time for a new direction, and the targeting of a major increase in public investment in more relevant, multidisciplinary research and technological development, and the generation of new innovations.

European development is also manifest in Finland, albeit on a small scale. Here scientific research is carried out by several bodies, with research coordination spread thin, and widespread duplication of research. All information generated in small countries such as Finland, whether of theoretical or practical application, needs to be channelled for the betterment of overall society, business life, national competitiveness and social well-being.

The starting point must be response to the grand challenges of society and the generation of sustainable competitiveness in the business sector. Important themes in this respect include bioeconomy, resource-efficient industry, low-carbon energy, digitalisation, clean environment and the well-being of the people.

Effective input is also required in the structural reform of industry. The prevailing financial turmoil has brought with it a considerable reduction in risk funding. While new growth enterprises in particular have suffered as a consequence, the situation has also affected successful small and medium-sized companies. Small enterprises are part of an ecosystem in which large anchor tenants play a notable role. In order to ensure the employment, care must be taken also to prevent the fall of the large companies. As well as measures targeted at individual small enterprises, efforts must be made to strengthen sustainable value chains and value networks.

VTT Technical Research Centre of Finland is an internationally networked organisation. Such is demonstrated by the facilities opened in 2011 at Berkeley, California (molecular biotechnology) and at São Paulo, Brazil (water technology and biomass exploitation). VTT occupies a strong scientific and recognised position within the global research field, and can provide a wealth of evidence of how information can be transformed into results and well-being. VTT, in its role as pacesetter, promotes all this through its everyday operations.

Our success in research and business in 2011 would not have been possible without our personnel, our partners and, above all, our customers. To you all, a heartfelt thank you!

Erkki KM Leppävuori
President & CEO

Mission

VTT produces research services that enhance the international competitiveness of companies, society and other customers at the most important stages of their innovation process, and thereby creates the prerequisites for growth, employment and well-being.

Core values



VTT Group organisation

Erkki KM Leppävuori, President & CEO

Business Solutions

Jouko Suokas, Executive Vice President

Vice Presidents:

- Biotechnology, pharmaceutical and food industries: Hannu Lampola
- Chemical industry and environment: Tuomas Mustonen
- Electronics: Juha Palve
- Energy: Rauno Rintamaa
- Forest industry: Timo Pekkarinen
- ICT: Seija Sihvonen
- Machine, vehicle and metal industries: Tuomo Niskanen
- Real estate and construction: Harri Airaksinen
- Services and logistics: Harri Airaksinen

Research and Development

Kari Larjava, Executive Vice President

Vice Presidents:

- Bio and Process technology: Anu Kaukovirta-Norja
- Energy and Pulp&Paper: Satu Helynen
- ICT: Jussi Paakkari
- Industrial Systems: Risto Kuivanen
- Materials and Built Environment: Eva Häkkä-Rönholm
- Microtechnologies and Sensors: Arto Maaninen

Strategic Research

Anne-Christine Ritschkoff, Executive Vice President

Vice Presidents:

- Applied Materials: Erja Turunen
- Bio- and Chemical Processes: Johanna Buchert
- Energy: Kai Sipilä
- Industrial Systems Management: Rauno Heinonen
- Information and Communication Technologies: Tatu Koljonen
- Microtechnologies and Electronics: Harri Kopola
- Services and the Built Environment: Matti Kokkala

Business Development

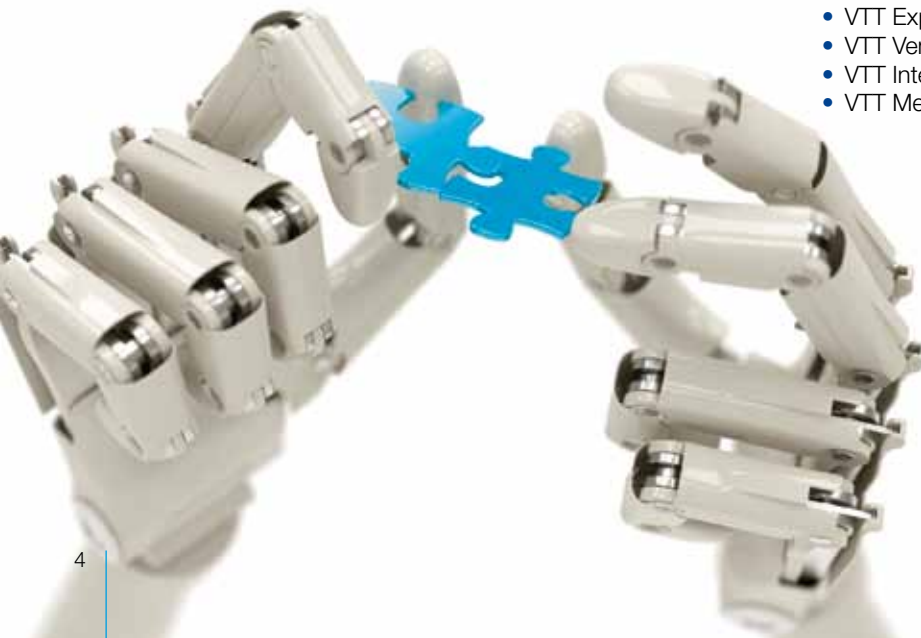
Petri Kalliokoski, Executive Vice President, Strategy and Business Development

Group Services

- Olli Ernvall, Senior VP, Communications
- Timo Nurminiemi, Senior VP, Finance
- Seppo Viinikainen, Executive VP, Group Services
- Riitta Tolvanen, Senior VP, Human Resources
- Markus Ekman, Senior VP, Information Management
- Jukka Forsström, Senior VP, Internal Audit
- Matti Karhunen, Senior VP, Legal and Governance

VTT companies

- VTT Expert Services Ltd, Laura Apilo, CEO
- VTT Ventures Ltd, Antti Sinisalo, CEO
- VTT International Ltd, Petri Kalliokoski, CEO
- VTT Memsfab Ltd, Hannu Kattelus, CEO



Business from technology

VTT Technical Research Centre of Finland is a technological pioneer providing high-end technology solutions and innovations. VTT's activities are guided by two megatrends: sustainable development and the digitalisation of information. Grand global challenges, such as climate change and an ageing population, push VTT's research towards areas in which research-based solutions have the potential for substantial impact. Bioeconomy and services related to wellbeing are examples of focus areas in which we are creating new competencies and – on the basis of these – new improved products, services and business models. With the help of the new solutions we enhance our customers' competitiveness and foster society's sustainable development, employment, and wellbeing.

VTT's services range from forecasting future technological and business developments through strategic technology development, solutions development and testing to the commercialisation of solutions and concepts. By taking advantage of extensive collaboration networks, participating actively in EU projects and including customers in development work from the early stages we ensure transfer of new technologies into practical solutions.

We help to identify emerging technologies and find new solutions and business opportunities by exploiting our multidisciplinary expertise. According to our customer survey 2011, 74% of all respondents had already utilised the results of their VTT project commercially, or expect to do so within the next three years. As a result of a VTT project, 28% of respondents had introduced a totally new technology.

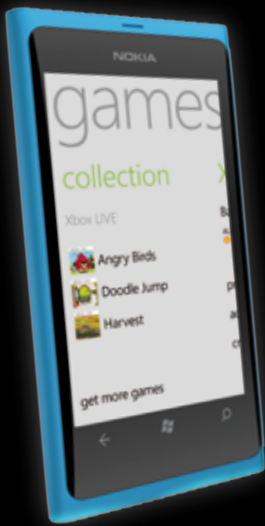


VTT is the biggest multitechnological contract research organisation in Northern Europe. VTT provides high-end technology solutions and innovation services.

From its wide knowledge base, VTT can combine different technologies, create new innovations and a wide range of world class technologies and applied research services, thus improving its clients' competitiveness and competence.

Through its international scientific and technology networks, VTT can produce information, upgrade technology knowledge, and create business intelligence and value added for its stakeholders.

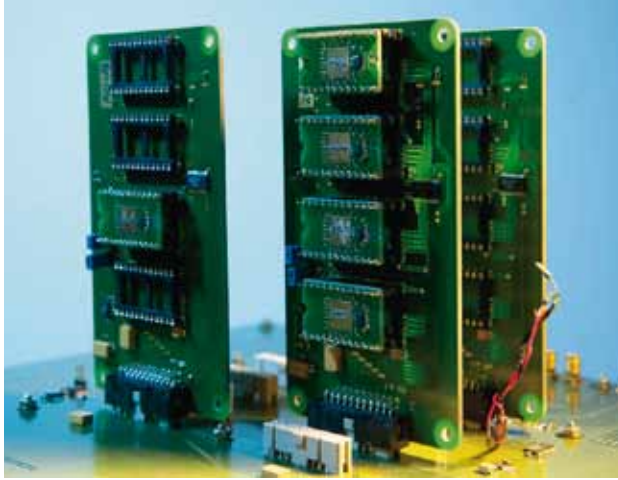
The research examples presented in this review represent only a small fraction of VTT's activities, although they do provide some idea of the many and varied ways in which VTT's know-how influences technical development in Finland.



- Worldwide semiconductor revenue grew 0.9 per cent from 2010, reaching US\$ 302 billion in 2011
- Intel held the top position with its 17% market share
- Cellular subscriptions worldwide totalled 6 billion in 2011, China and India now accounting for over 30% of world subscriptions
- Active mobile-broadband subscriptions amounted to 1.2 billion worldwide, with Asia as top region
- Nokia remained number one in total mobile phone shipments, with 2011 net sales of EUR 38.7 billion, down 9% compared to 2010
- Over 300,000 mobile apps developed in 2008–2010: most used in the USA are games, news, maps, social networking, and music
- eBay expects customers to buy and sell US\$ 8 billion of merchandise in 2012.

ICT, ELECTRONICS





Timing modules for telecommunications

A EU-commission funded project Go4Time aims to improve and miniaturise timing modules used e.g. in cellular phones. The goal is to combine an integrated circuit together with multiple MEMS resonators hermetically in a single package. Smaller size and lower power consumption will help to meet the green electronic challenge in consumer products.

The timing devices used in telecommunications relied for decades for quartz based technology only. Recent advances in packaging of MEMS resonators and in temperature compensation schemes have led to the introduction of MEMS-based timing devices.

Go4Time will target the realization of a generic miniature timing module relying on the combination of an integrated circuit together with multiple MEMS resonators assembled hermetically in a single package. One of the main system features is a temperature-compensated low-power 32kHz real time clock mode with a power consumption below 1 μ W and a very tight frequency stability (better than ± 2 ppm) over an industrial temperature range. By combining this with a higher frequency resonator and by using PLL techniques, a reconfigurable low-jitter clock of high spectral purity can be generated at any frequency below 200MHz on-demand. This low-jitter clock can then serve as a reference frequency for communication systems such as Bluetooth, GSM, wireless sensor networks, multi standards, software-defined and cognitive radios.

The project's achievements will strengthen the global competitiveness of European industries in microsystems and smart miniaturised systems in the 3B timing market. The proposed power-aware scheme will help meet the green electronic challenge in consumer products and strengthen the competitiveness of the associated industries by providing a generic timing solution with a much reduced bill of materials.

In addition to VTT, four other European research institutes are involved in the three-year pan-European Go4Time

project funded by the EU: CSEM (Switzerland), Fraunhofer Institut (Germany), Politecnico di Milano (Italy), and Delft University of Technology (the Netherlands). ST Microelectronics (Italy) and Micro Crystal (Switzerland) also participate in the project as industry partners.

Whereas VTT's focus is on research, VTT Memsfab Ltd offers customized micro- and nanoelectronics manufacturing services. The developed prototype is easy to take into production at VTT Memfabs Ltd, as the company uses the same equipment as VTT and technology does not need to be transferred to another plant. The transfer of technology to a larger plant may only become topical when the product has been successfully launched and the production runs reach thousands of silicon wafers (millions of chips).

Further information

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Advanced information security

The importance of information security is constantly increasing in the digitising society. The DIAMONDS project helps reinforce the information security know-how and international competitiveness of companies. VTT is also developing information security services for the industry in cooperation with Siemens.

In the DIAMONDS project, VTT is developing testing methods and tools that can be used effectively in testing the information security of networked systems. The project is also developing an open-source platform into which several information security testing tools can be integrated.

The project helps Finnish companies to improve the information security of their systems while adopting new, advanced information security testing tools and methods.

The DIAMONDS project is part of the European ITEA2 research programme (Information Technology for European Advancement). The project is developing model-based information security testing methods that already enable the detection of vulnerabilities at an early stage of system design. The project is also creating methods and tools for the detection of attacks targeted at networked systems and for preparations related to errors and accidents.

The Finnish participants in the DIAMONDS project are VTT, the University of Oulu, Codenomicon, Conformiq, Oy L M Ericsson Ab and Metso.

VTT is also cooperating with Siemens in developing industrial information security. In the future, Siemens will offer VTT's information security analysis as part of its industrial

services. VTT carries out the analysis independently, utilising the systems knowledge of Siemens experts when necessary. The analysis comprises an extensive study of the level of information security at a production facility; for example user management, backup copying and network security.

Further information

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Printed memory technology under testing

The printed electronic memory technology patented by VTT was tested in practice at an industry conference. The best exhibition stand of the conference was selected using electronic voting cards based on VTT's memory technology.

The voting card utilising VTT's printed memory technology was tested at the Printed Electronics Europe 2011 conference. The card was implemented in cooperation with Stora Enso, Enfucell and ANP. A total of one thousand cards were manufactured for the IdTechEx conference organiser.

The test was part of the EU's PriMeBits research project developing memory technologies suitable for printed roll-to-roll production. The project came up with application solutions based on the simple combination of memory technology with readers and sensors, e.g. RFID chips. The core idea was to use printing technology for products in which printed electronics is most competitive compared with traditional options.

One of the main competitive advantages of printed electronics is its cost-effectiveness. Printed intelligent products include printed memory, with numerous applications

already coming into the market. Overall, printed electronics is estimated to reach a significant market share by the end of the current decade.

The first printed memory applications use write-once memory technology, on which the voting cards were also based. The PriMeBits project also researched write-many memory applications, and charted memory technology applications for different uses, the future outlook and potential business models from the perspective of companies and consumers alike.

The participants of the project coordinated by VTT were INM Leibniz-Institut für Neue Materialien gGmbH, Evonik Degussa GmbH and Motorola from Germany, Mittuniversitet (Mid Sweden University) and Sensible Solutions Sweden AB from Sweden, the Swiss Ecole Polytechnique Fédérale de Lausanne, the Slovakian Ardaco a.s. and UPC Consulting Ltd / UpCode Ltd and Stora Enso oyj from Finland.

Further information

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VTT combined a mobile phone and a microscope

VTT has developed an optical accessory that turns an ordinary camera phone into a high-resolution microscope. Among those who will benefit from the device are the printing industry, consumers, the security business, and even health care professionals. A new Finnish enterprise, KeepLoop Oy, and VTT are already exploring the commercial potential of the invention.

An ordinary mobile phone turns into an instant microscope by attaching a thin, magnetic microscope module in front of the camera's normal lens. The device fits easily into the user's pocket, unlike conventional tubular microscopes. The mobile phone microscope developed at VTT can achieve accuracy to less than one hundredth of a millimetre.

The operation of the device is based on images produced by the combined effect of an LED light and an optical lens. Various surfaces and structures can be examined in microscopic detail and the phone's camera used to take sharp, high-resolution images that can be forwarded as MMS messages.

The plastic macro lens of the mobile phone microscope magnifies objects effectively. The camera's field of view is 2 x 3 millimetres. A number of LEDs have been sunk into the outer edge of the lens, allowing objects to be illuminated from different angles. When illuminated from several different



angles such images could be used, for example, to produce 3D topographic maps with mobile phone software. The 3D maps are accurate to one hundredth of a millimetre.

The competitive edge of the product is based on next-generation lens technology, the compact and user-friendly structure, and customisable extra features.

The mobile phone microscope could also be used to study surface formations, especially in the printing industry as part of quality control and in field conditions. In the security business the devices could be used, for example, for reading microcode in various logistics systems, while it is also suited for studying security markings, and for authenticating products as genuine as part of brand protection. The microscope is capable of detecting hidden symbols in products that would otherwise be invisible to the naked eye.

The device also has applications in the study of the environment, social media, community-based hybrid media and the world of gaming.

The first industrial applications and consumer models will be released in early 2012. VTT and KeepLoop Oy, the company commercialising the device, have been able to produce a package that combines scientific study of technology with commercial potential.

Further information

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Augmented reality leaps on to business cards

Augmented reality technology opens a door on more possibilities than today's consumers can even imagine. VTT is developing customised solutions based

on augmented reality technology for the needs of companies. The next step is the commercialisation of a printed business card, on the surface of which a living character, for example, can be displayed.

Augmented reality (AR) livens up a printed business card by linking it with video. A simple symbol is printed on the back of a normal-looking card. When you visit the company's website and show the symbol to a webcam, a video linked to the symbol starts playing. This allows the addition of a 'living' character on video on the card surface. With no need to download or install on a PC in advance, the application presented on the video is also easy for the user.

The technical solution is based on an ID developed by VTT that is quickly readable even with a low-resolution webcam. The ID does not need to be held close to the camera, nor is its position relative to the camera particularly significant. VTT has also implemented software that interprets the information contained in the printed ID, and has previously created video applications for magazines and its annual report.

Augmented reality applications are already seen in everyday consumer packages. In Denmark, for example, a football game could be downloaded to your mobile phone from a milk carton by means of an AR symbol printed on the side, allowing you to take shots at goal with a local celebrity between the posts.

VTT has founded the Future AR Media Ecosystem (FARMES) club. Its first output is a demonstration for Paino-Netti, a printer of business cards. It also includes a user test, the results of which are utilised in the further development of the AR business card. The goal of the club is to support companies interested in AR technology in making demonstrations and commercial applications utilising the technology in different ways.

Further information

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Speed for inter-machine communications

The international Usenet project, led by VTT, has developed a horizontal solution model that speeds the arrival of an all-encompassing M2M Internet based on inter-machine communications. This allows the launching of new products and services to the market more quickly and affordably than at present.

The horizontal solution model developed in the Usenet project helps the functioning of M2M (Machine-to-Machine)

applications in heterogenous wired and wireless network environments. The solution allows more rapid creation of new M2M services, reduced costs and the delivery of new, easier-to-use products and services to consumers at an ever fast rate.

In traditional, vertical M2M solutions, the customer has often been left dependent on the solution of one operator usually incompatible with the solutions of other vendors. For this reason, numerous business opportunities have remained unexploited and the M2M solutions have become expensive single-vendor solutions. Concepts for solving these problems were developed under ITEA2's three-year Usenet project, part of the Ubicom programme of Tekes, the Finnish Funding Agency for Technology and Innovation. The result was a horizontal operating model achieving cost and timing benefits for companies about to launch products on to the market.

The solution arrived at was extensively assessed by means of applications important to the project partners, who are currently exploiting the results in at least 13 different product cases. Applications demonstrated during the project related to telematics, public transport and industrial, domestic, construction and consumer environments.

Application examples include the utilisation of the Ouman remote control system in building automation and Rmon's wireless sensors and solutions related to the monitoring of car transporters. The project was also an essential factor in the creation of a spin-off company (Geosparc) concentrating on geographical information systems, and has produced 55 international publications.

The project has been a frontrunner in the field of horizontal M2M systems and also an active player in the launching of a new European standardisation organisation ETSI, an M2M standardisation working group. The project was presented with the silver award by the ITEA programme.

Further information

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Smartphone software as the foundation of new services

The new kinds of smartphone software developed by VTT produce varied, real-time information concerning the daily routines of the users. Based on this, new business can be developed in several different fields. The solutions work on the smartphones of different vendors.

The software components developed by VTT enable the tracking and identification of the daily routines of smart-phone users continuously and in real time. This behavioural data can be utilised in a variety of ways across different services, both for business and leisure.

As an example, the solutions enable trouble-free mobile functionalities for Customer Relationship Management (CRM), targeted online marketing functions, versatile health and well-being solutions and new kinds of security applications.

The software can be exploited to offer consumers a new kind of opportunity for immediate reaction to any deviations in their daily routines, such as the children not coming home from school at the usual time. In the field of health and wellbeing services the user can monitor his or her physical activity and energy consumption, if desired. The CRM applications, for example, allow anticipation of the customers' behaviour and the identification of various customer segments.

The mobile phone software delivers the information to VTT's Lifeline service, which allows the information to be analysed in more detail. The lifestyle and behavioural models can be viewed as weekly profile information or as more detailed daily snapshots.

Delivery of the behavioural data to external services can be performed in WLAN and 3G networks according to the current standards. The solutions support the most popular operating systems and function on, for example, the Symbian S60, Symbian^3 and Maemo/MeeGo platforms.

Further information

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Fuel sensor helps reduce emissions

Many new fuels have entered the market around the globe. For this reason, car manufacturers need to prepare for the flexible use of different fuels. The spectrometer sensor developed by VTT provides versatile measurements of a vehicle's fuel qualities and produces data that protects the engine and helps optimise fuel usage and engine operation while also reducing emissions.

The need to reduce transport-related emissions has brought many different transport fuels to the market, such as ester-based biodiesels and fuels containing ethanol. The fuels vary by region, depending on the desired speed of reducing oil-dependency. Modern car manufacturers must therefore prepare for the flexible use of fuels.

In the Euripides project coordinated by Continental Automotive SAS, VTT has developed a new kind of car fuel quality measurement sensor based on MOEMS. By utilising the optical measurement principle, many properties of the fuel can be determined, such as density, heating value, ce-

tane and octane number, sulphur content classification and viscosity. The same type of sensor is suited to both diesel and petrol cars.

The MOEMS-based spectrometer allows the optimisation of fuel injection, power and driveability, and reduces fuel consumption and emissions while also protecting the engine.

VTT is researching new sensor platforms based on Fabry-Perot interferometry, LED lighting and special sensor technologies for various areas of application such as the process industry, automotive industry, consumer, bio- and security applications.

The benefits of the next-generation solutions include smaller size, improved robustness, lower power consumption and price. Innovative development work helps move from the current heavy and bulky spectrometers to compact microspectrometers.

Further information

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- Based on current levels, less than half the biomass potential in EU countries is being exploited
- The IEA estimates that unless new energy-production or energy-saving methods are adopted the global average temperature will rise approximately 6 degrees over the long term
- The share of energy produced from oil and other fossil fuels is expected to fall from the present 81% of world energy to 75% by 2035
- A total of US\$ 260 billion was invested in renewable energy in 2011
- Chemicals are a nearly \$3 trillion global business, and the EU and US chemical companies are the world's largest producers.

FOREST, ENERGY, CHEMISTRY, ENVIRONMENT

Environmentally friendly and communicative packaging

Package research by VTT helps improve the environmental friendliness, usability and communicativity of packages, while also creating entirely new packaging features. Iscent Oy and VTT are in the process of commercialising VTT-developed hologram technology that can be printed on plastic-based and fibre-based packages and is suited to mass production. The technology enables eye-catching effects combined with anti-counterfeit security.

Thanks to the new holographic technology brand owners, for example, gain a guarantee of authenticity for their products through this difficult-to-copy technical solution. Printing houses can exploit the method to reduce ink use, while advertising agencies can create striking packages that are environmentally friendly. Applications include, for example, packaging and gift wrappings, which can be made more decorative without compromising transparency. The technology is also suitable for injection-moulded plastic products such as mobile phones, CD jewel cases and laptops, and for laminate solutions such as interior design elements and sports equipment.

Commercial hologram printing lines in the printing industry are almost without exception based on processes implemented for narrow products. A new Finnish company, Iscent, is opening up a completely novel range of business opportunities by investing in an end product that can be up to 1,200 mm wide, enabling large-volume products thanks to minimised raw material costs.

Commercial holographic technologies are based on metallised solutions, and often on laminated structures or effects produced with UV curable varnishes. The effect achievable with the new method is not dependent on these, or any extra additives, as the rainbow colours are generated solely by altering the topography of the plastic or paper surface.

The drivers towards more ecological packaging are not only the developing legislation but also the increased ethicality of consumers. Environmental friendliness emerged as one of the most important evaluation criteria when VTT studied consumer hopes and expectations as part of the Future Food Packaging research project.

A package is not just a case or a box protecting the product. It must also look good and communicate the right things. The Communicating Package project studied the meaning of a package for consumers, how a brand can be built with the help of packaging, and how digital print-

ing technologies could be used to increase communication possibilities.

Further information

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Plastic-like packaging material from birch fibril pulp

VTT and Aalto University have developed a method which for the first time enables the large-scale manufacturing of a wood-based and plastic-like material. This nanofibrillated cellulose film can be manufactured cheaply with the roll-to-roll method. The film is suitable, for example, for food packaging to protect products from spoilage.

Nanofibrillated cellulose typically binds high amounts of water and forms gels with only a few per cent dry matter content. This characteristic has been one of the bottlenecks preventing industrial-scale manufacture. In most cases, fibril cellulose films are manufactured through pressurised filtering, but the gel-like nature of the material makes this route difficult. In addition, the wires and membranes used for filtering may leave a so-called 'mark' on the film, which has a negative impact on the evenness of the surface.

In the new method developed by VTT and Aalto University, nanofibrillated cellulose films are manufactured by coating plastic films with fibril cellulose thinly and evenly, so that the spreading and adhesion on the surface of the plastic can be controlled. The films are dried in a controlled manner using various techniques. Due to the correct spreading, ad-

hesion and drying management, the films do not shrink and are completely even. The more fibrillated, or fine-grade, the nanocellulose material used, the more transparent the films that can be manufactured.

Several metres of fibril cellulose film have been manufactured using VTT's pilot-scale equipment in Espoo. All phases of the method can be transferred to an industrial production process. The film can be manufactured using equipment that already exists in the industry without the need for any major additional investment.

VTT and Aalto University are applying for a patent for the production technology of NFC film. Trial runs and the related development work are performed at VTT.

The invention was realised in the Naseva 2 – Tailoring of Nanocellulose Structures for Industrial Applications project that is included in the Finnish Centre for Nanocellulosic Technologies project entity formed by UPM, VTT and Aalto University. The nanofibrillated cellulose used in the trial runs and the project was UPM Fibrilcellulose supplied by UPM. UPM has begun the precommercial manufacturing of fibril cellulose and is developing new fibril cellulose applications in cooperation with its industry partners.

Further information

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Biomass resources charted

VTT is carrying out research in international projects with the goal of promoting the utilisation of biomass. In the EUBIONET III project, VTT charted the amount of biomass resources in the EU region. In the spring, VTT opened a research centre in Brazil that focuses on the utilisation of biomass.

Thanks to the EUBIONET III project the information available on biomass reserves in the EU is now more accurate. The project involved estimating the biomass potential in 24 EU Member States and Norway. The annual potential for bio-material gained from forests, fields and industry was eventually estimated at the equivalent of 157 million tonnes of oil.

According to the study, current bioenergy usage rates exploit less than half the bioenergy potential of the 24 EU Member States studied. The greatest potential for increase is in forest chips and herbaceous biomass. Finland aims to use forest chips to produce energy equivalent to the yield of 13.5 million cubic metres of solid biofuel, or 25 TWh.

Since the publication of the report, the countries involved have estimated in their national renewable energy action

plans that about 250 million tonnes of biomass reserves would be required to achieve the combined goals set. It has not yet been estimated at the EU level what the volume required for sustainable development might be. Moreover, some countries import their biofuel from other EU Member States or from outside the EU.

The data on biomass reserves established during the project are publicly available, and best practices are being exchanged between countries. Information on biomass fuel chains, for example, is utilised by enterprises.

The project also studied sustainable development criteria for solid biofuels, generated information for use in standardisation, and monitored biomass fuel price development since 1999. The project yielded information useful for new quality standards for solid biofuels, and a price index for international trade was developed together with businesses.

Solid biofuel standards will make international trade in biofuels easier. FOEX Indexes Oy, an enterprise specialising in monitoring indices, uses a standard as the basis for the index for industrial pellets.

VTT has founded a research centre in São Paulo, Brazil, one of the largest biomass utilisation centres in the world. The VTT Brasil LTDA company is supporting Finnish companies in the growing South American market, and developing research cooperation with local companies and research organisations. Its primary goal is to develop the utilisation of biomass to create chemicals, energy and pulp-based products.

Further information

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More effective water purification

VTT and the Lappeenranta University of Technology have launched the NoFoul research project, developing measurement methods for improving the operation of membrane filters used in the purification of drinking and process water. The three-year project is funded by the Water programme of Tekes – the Finnish Funding Agency for Technology and Innovation.



Membrane filtration can be used to produce safe drinking and process water, and is used in the production of drinking water out of seawater in, for example, Spain's Costa del Sol and the Middle East. In 2008 the method was used to produce 37 million cubic metres of drinking water each day at 14,000 plants. The number of plants is increasing all the time, as the stores of fresh water are dwindling and drinking water must be taken directly from the sea.

In Finland, membrane filtering is used in the purification of, for example, the forest industry's process water. The purified process water can be reused at the plant, thus reducing both the amount of wastewater out of the plant and the amount of clean water taken in by the plant.

The greatest challenge facing membrane filtration is the fouling of membranes during filtering. The fouled membranes can be cleaned by chemical washing. Oft-repeated washing, however, shortens the service life of the membranes and lowers the cost-effectiveness of the process. Costs are also increased by the downtime caused by washing, and through chemical costs and extra energy expenditure.

The NoFoul project is developing measurement methodologies that allow real-time monitoring of membranes during filtering in order to improve the cost-effectiveness and energy-efficiency of membrane filtering processes. The real-time information produced by the methods enables fouling to be slowed down significantly, as the measurement results allow the adjustment of the process conditions during the filtering.

Further information

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Researched information on fuels

A study conducted by VTT indicates that there is practically no difference between commercial petrol grades sold in Finland – 95E10 and 98E5 – with regard to fuel consumption in normal driving. The finding is based on driving tests conducted under laboratory conditions by VTT in the spring of 2011 using six used cars of different make.

During 2011 it was frequently claimed in public that fuel consumption is significantly higher with 95E10 petrol than with its predecessor 95E or the 98E5 petrol currently on the market. The suspected higher consumption deterred drivers of cars whose manufacturers recommend E10 from actually using it.



Measuring fuel consumption in precise terms is not as simple as it seems, because other factors affect consumption besides the fuel itself. Under laboratory conditions the other factors affecting consumption could be eliminated.

The VTT measurements show that the cars tested used an average of 10.30 litres of 95E10 per 100 km, as opposed to 10.23 litres of 98E5 per 100 km. The difference was 0.07 in favour of 98E5 on average, meaning that using 95E10 petrol, which has a higher ethanol content, increases consumption by 0.7%. A calculation of calorific values based on fuel analysis came out at 0.8% in favour of E5, which is highly consistent with the aforementioned 0.7% difference in consumption. Fuel consumption depends mainly on the calorific value of the fuel, i.e. its energy content per unit of volume or mass.

VTT measured fuel consumption using the simplest and most reliable method: measuring the weight of fuel consumed. As the density of the fuel grades was known, establishing the volume of fuel consumed was a simple calculation.

The driving programme used for the test drives was the FTP75 programme, which features more powerful accelerations and a high average speed than the EU standard test. Two drivers were used for the tests, both of them experienced and qualified for conducting accredited exhaust gas tests. The cars were divided between them so that each car was driven by the same driver in all tests.

The consumption of E10 petrol in Finland has increased steadily. According to the Finnish Petroleum Federation, its share was 51.1 per cent in December 2011. So far not a single case has been reported to the Federation where E10 petrol would have caused problems in a car for which the petrol has been announced as suitable.

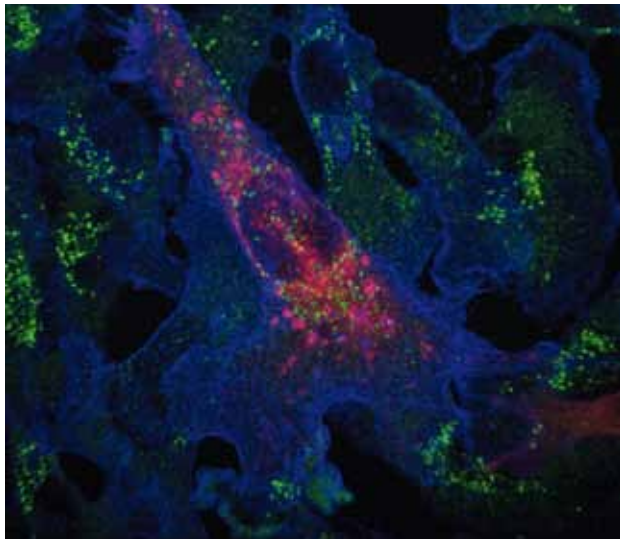
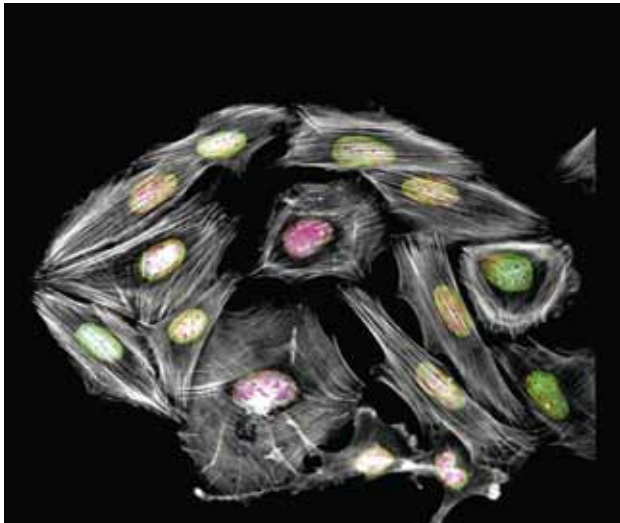
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BIOTECHNOLOGY, PHARMACEUTICALS, FOOD

- According to the OECD report approximately 75% of the future benefits and environmental impacts achieved through biotechnology are likely to come from agricultural and industrial applications
- Health applications absorb 80% of biotechnology research investment
- The world's top one thousand research-intensive companies spent US\$ 550 billion on R&D work in 2010, the largest contribution coming from the Roche pharmaceutical company
- The global pharmaceutical market is forecast to reach US\$ 1,043.4 billion in 2012
- North America remains the largest pharmaceutical market, constituting over 40% of global sales
- In the food industry, convenience and healthy eating are critically important consumer drivers in food products
- Probiotics, reduced sugar, healthy fats and multisensory perceptions are strong trends in food design.



The regulator of cancer cell activity found
 Research teams from the University of Turku and VTT have found the sharpin protein regulating the activity of cancer cells. The Finnish researchers also found a new mechanism inhibiting the spread and growth of cancer from breast cancer cells. Both results may have major significance for the development of medical drugs.

The hypothesis that there must be a protein that inhibits cell activity was posited as far back as in the early 1990s. Finnish researchers have now found that that protein is sharpin.

The research published in the Nature Cell Biology magazine shows that the sharpin protein regulates the movement and activity of inflammatory cells and of lung and prostate cancer cells. It is likely that, in addition to cancer, the new discovery will also have significant implications for other conditions, such as Crohn's disease, psoriasis, rheumatism and even MS.

Sharpin was found with the cell chip screening method developed by VTT. The method allows examination in a single test arrangement of the impact of all genes in an entire genome.

It has also been long held that cells use different mechanisms for regulating cell migration and growth. This conception was proved false by the researchers. Their findings on aggressively spreading breast cancer cells revealed – contrary to previous expectations – that a single cell protein (p120RasGAP) acts as an important inhibitor of both cell migration and growth.

Further information

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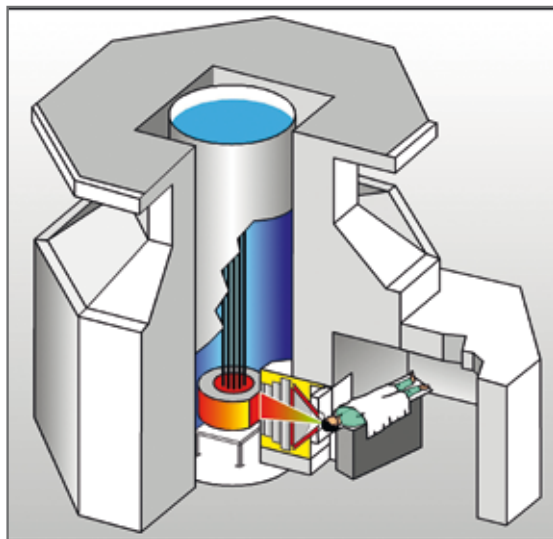
Enzyme research speeds biomass hydrolysis
 Japanese researchers and VTT have worked together to discover new molecule-level information on how cellulase enzymes move when breaking down cellulose. The results are significant for example, for use of biomass, biomass hydrolysis and in material sciences.

Japanese researchers used HS-AFM atomic force microscopy to study how enzyme molecules move on the surface of the cellulose crystal. It was discovered that the enzyme molecules move on cellulose in the same direction but at different speeds, which led to “traffic jams” on the surface of the crystal. The researchers gave the enzymes more “driving lanes” by chemically changing the structure of the cellulose crystal, which improved biomass hydrolysis. The research also showed that two different types of cellulase enzymes hydrolyse crystalline cellulose completely.

The material and imaging expertise of the Universities of Tokyo and Kanazawa and the cellulolytic enzyme expertise of VTT all benefited the research. The research results were published in Science magazine – one of the most distinguished scientific publications – in the autumn of 2011.

Further information

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Nuclear reactor becomes a unique cancer treatment station

A unique targeted cancer treatment facility operates in Otaniemi in connection with VTT's FiR 1 research reactor, utilising the neutrons produced by the reactor. Over 200 cancer patients have already been treated in the BNCT treatment station.

Since 1999, BNCT, or boron neutron capture therapy, has been given at the BNCT treatment station owned by VTT. The therapy has proven to be an effective and safe treatment method, particularly for recurring head and neck cancers.

The FiR 1 research reactor was ordered from the United States 50 years ago and started up one year later. The reactor was originally built for research and training use and for the production of isotopes. Today, BNCT treatment and related research are the reactor's main form of operation.

BNCT radiotherapy differs from conventional radiotherapy, as the radiation killing cancer cells is generated inside the cells. Thanks to the biological targeting, treatment can be targeted at the cancer so accurately that a radiotherapy dose typically corresponding to the radiation dose given in around six weeks of conventional radiotherapy can be given during one treatment session. One session lasts around half an hour.

Patients for BNCT radiotherapy come through Helsinki University Central Hospital. The neutron radiation required for the treatment is generated using VTT's research reactor.

The highly effective radiotherapy used in cancer treatment is enabled by the Fluenta™ neutron moderator material, developed by VTT. The material allows the energy of the neutrons to be modified to a level optimal for the patient, making the treatment both effective and safe.

Up to now over 200 cancer patients have already been treated in the BNCT treatment station. BNCT treatment is special health care, and in order to receive treatment, a referral from a central hospital is required in order for the treatment to be covered by public health care.

Further information

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Research data for prostate cancer drug development

Researchers from VTT and the University of Turku have discovered four metabolic enzymes that can play a crucial role in the growth and proliferation of prostate cancer cells. These findings may provide solutions for identifying different types of cancer, and could serve as novel targets for developing new drugs in the future. VTT is also involved in the EU's PREDECT project which aims to provide improved models for pre-clinical drug development of breast, prostate and lung cancer drugs.

Eicosanoid hormones, metabolites of fatty acids found in animal-based foods, are essential regulators of normal bodily functions. Metabolic dysfunctions related to these acids, known as arachidonic acids, is associated with many diseases. Prostate cancer cells use increased arachidonic acid metabolism and eicosanoid production to fuel their enhanced growth. New research published by researchers from VTT and the University of Turku has identified four enzymes that regulate arachidonic acid metabolism. This research has revealed that prostate cancer growth can be slowed down by interfering with the biological functions of these enzymes.

The study analysed the prevalence of enzymes involved in arachidonic acid metabolism in hundreds of prostate cancer samples, including normal prostate samples, and other healthy tissue. The enzymes with the highest prevalence in prostate cancer samples were selected for further studies in prostate cancer cells. The researchers discovered that certain enzymes were more prevalent than others in different clinical subtypes of prostate cancers. This knowledge can be used to identify and classify different

subtypes of cancer in the future. Simultaneously, since these enzymes can be blocked by small molecule inhibitors, the genes identified could also serve as targets for drug development.

The EU's PREDECT project is developing new research models for breast, prostate and lung cancer. VTT is coordinating the project's second work package, dedicated to the validation of drug targets and the creation of advanced cell culture models for prostate cancer.

Next-generation cell culture models, in combination with improved genetically engineered models, will help to understand the heterogeneity and complexity of human tumours in more detail. The model systems developed within PREDECT will be utilized to mimic the biological function of drug targets in multicellular and "organotypic" context. This is required to recapitulate the failure or success of anti-cancer drug treatments, and the recurrence of the tumours on the molecular level. More predictive models will be valuable to improve the efficacy of drug development and test novel treatment strategies.

The PREDECT project involves nine academic partners, three small and medium-sized enterprises, and seven medicine companies from the EU. The project, officially launched in February 2011, will last five years with total expenses of EUR 17.7 million.

Further information

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Intestinal bacteria contribute to development of diabetes

Research shows that prior to the onset of type 1 diabetes the diversity of certain bacteria in the body declines. These findings indicate new potential for early prevention of diabetes.

There is little knowledge on how environmental factors contribute to the development of type 1 diabetes. The incidence of infections and autoimmune diseases is growing faster than that of other diseases with a significant public health impact. It is estimated that the number of children under 5 years of age who develop type 1 diabetes will double in Europe between 2005 and 2020.

In connection with the DIPP population study (Type 1 Diabetes Prediction and Prevention) in 2008, VTT scientists noticed that anomalies in metabolic control can predict the onset of childhood diabetes years in advance. New research now illuminates the molecular-level changes in the



body that contribute to the emergence of these anomalies and the development of the disorder.

These molecular-level changes were investigated in a study conducted by VTT, the University of Turku, Aalto University and the University of Helsinki. The research team conducted tests on non-obese diabetic mice, or NOD mice. They found that young female NOD mice that later developed diabetes presented with metabolic changes similar to those found in diabetic children prior to the onset of the disease. These metabolic changes include increased secretion of insulin, which controls sugar metabolism, elevated levels of plasma leptin and adiponectin hormones, and a decreased diversity of *Clostridium leptum* bacterial group.

These findings indicate new potential for early prevention of diabetes. In ongoing further studies, VTT scientists are exploring the relevance of certain bacteria in the *Clostridium leptum* group for the prevention of type 1 diabetes.

Discovering the early mechanism behind the development of type 1 diabetes is one of the most important research areas in the Molecular Systems Immunology and Physiology Research team, appointed a Centre of Excellence by the Academy of Finland in 2011. The Centre of Excellence is headed by Research Professor Matej Orešič from VTT.

Further information

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Tasty and healthy food for senior citizens

The Seniori-Sapuska project co-ordinated by VTT promotes the wellbeing of ageing consumers by developing tasty foods and meals in packages that are of a suitable size and easy to use. VTT is also involved in the EU CHANCE project for developing nutritionally improved affordable foods.

In the Seniori-Sapuska project, ageing consumers are themselves invited to determine what constitutes a good meal and good product packaging. The study also aims to anticipate the wishes of senior citizens of the future. Sensory evaluation of product concepts is conducted in the project based on prototypes for foods, meals and product packages designed according to consumers' wishes.

The purpose of the project is to improve the wellbeing of ageing consumers and thereby curb the growth of public expenditure in social and health care services. The research findings will be exploited in meal services and in the food and packaging industry. The project will create potential for introducing novel, customised products for the growing ageing population and thereby improve the international competitiveness of the Finnish food and packaging industries and retail trade.

The Seniori-Sapuska project is being conducted together with the National Consumer Research Centre. The Taloustutkimus research company and the Service Centre of Design and Media DF Ltd are also contributing to the project. The nine enterprises involved represent food and packaging industries and meals services. The project receives Tekes funding.

VTT is also involved in CHANCE, an EU project for developing affordable, nutritionally correct foods in order to improve the general nutritional state and health of people at risk of poverty. Eurostat figures indicate that there are 81 million people in Europe at risk of poverty. The elevated risk of illness and inadequate nutrition associated with poverty cause considerable public expenditure in social and health care services.

In the CHANCE project, VTT is exploring how consumers in the risk of poverty could keep a healthy diet, and what prevents them from doing so. VTT is comparing attitudes and perceived obstacles to healthy nutrition among low-income and medium-income consumers. The project also aims to define in which nutrients low-income consumers have deficiencies. The study is being conducted through interviews and questionnaires in five European countries.



In this three-year project, VTT is also drawing on its expertise in the processing of nutritionally valuable whole-grain and high-fibre products in various food concepts. Consumer data collected in the previous phase will be used to develop customised product concepts for food raw materials. The technological and economic feasibility and usability of these product concepts will be analysed in the course of the project.

The EU CHANCE project involves 17 partners from 9 EU Member States. Ten universities and research institutions and five enterprises in the food and beverage industries are involved in research and technological development in the project.



Further information

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Solution for the early diagnosis of Alzheimer's disease

In the PredictAD project, researchers have developed new methods for identifying Alzheimer's disease and new kind of computer software for combining the data. The software enables an objective determination of the patient's condition. An early diagnosis combined with new treatments will reduce suffering in the future and lower the costs to society.

European researchers have taken several significant steps via the PredictAD project funded by the EU towards enabling the earlier diagnosis of Alzheimer's disease. The diagnosis requires a holistic study of the patient's status, combining data from many different sources such as clinical tests, brain images and blood samples.

The atrophy of structures in the inner temporal lobe such as the hippocampus is a known characteristic of Alzheimer's disease. Magnetic resonance imaging is an excellent tool for determining this tissue loss. The PredictAD project has developed effective tools for measuring the size of the hippocampus and the amount of tissue loss in

the hippocampus, and two modern approaches based comparing patient data to previously diagnosed cases stored in large databases.

Alzheimer's disease is known to affect the electrical functioning of the brain. A new kind of technique has been used in the PredictAD project to diagnose the disease, combining the activation of the brain using a strong magnetic field (TMS) and measuring the related response from the electroencephalogram (EEG). The strength of the TMS/EEG method is that it enables the direct activation of the cerebral cortex safely without requiring cooperation from the subject. The research has shown significant changes in patients suffering from Alzheimer's diseases compared with the changes in healthy elderly persons.

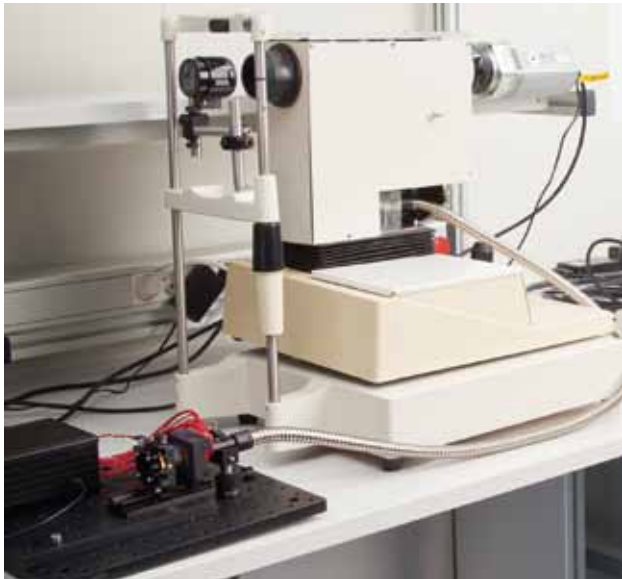
Molecular-level biomarkers currently play a major role in Alzheimer's research. Many biomarkers such as tau proteins and beta-amyloid 42 measured from the cerebrospinal fluid have been found to have a clear connection to the disease. However, taking the sample requires special expertise. Blood samples form a highly interesting source for biomarker discovery due to their ease of acquisition. Metabolomic and proteomic biomarker signatures were detected from blood samples showing a good accuracy in detecting Alzheimer's disease.

The PredictAD project has also developed an entirely new approach for the reliable and objective determination of the patient's condition. This decision-making support system, developed in close cooperation with doctors, compares the patient's measured data to the measured data of other patients, stored in large databases, and gives an index number and a graphical representation of the patient's condition. VTT has been actively involved in the development of this system.

A successful early diagnosis combined with new drugs under development and other forms of treatment may delay the patients' need for hospitalisation, reduce suffering and lower the costs to the society. If the onset of the disease could be delayed by five years, the costs incurred by Alzheimer's disease would be halved. Just a one-year delay in the onset and progress of the disease would reduce the number of people suffering from the disease by ten per cent.

Further information

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New diagnostic data with fundus camera

VTT has developed a microtechnology-based filter component for spectral imaging cameras and lighting sources. This technology enables the manufacture of a small, rapid-action fundus camera that may in the future be used for detecting various disorders such as diabetes.

VTT is studying the medical applications of spectral imaging and thermal imaging with the University of Eastern Finland and Kuopio University Hospital. The study is focusing particularly on how the technology can be exploited in imaging the fundus of the eye and in brain surgery. The ultimate goal is to develop a device with which physicians can easily, quickly and at low cost examine the condition of the fundus and diagnose disorders.

A light source developed at VTT, based on the Fabry-Perot phenomenon, is used in this project to illuminate the fundus with rapid bursts of light at various wavelengths. This yields data on various properties of the fundus, and combining these data can help determine, for example, the oxygen level in the bloodstream.

Application development of the filter technology developed at VTT is being pursued jointly with equipment suppliers.

Further information

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Accelerated pharmaceutical development using effective microchip technology

VTT has developed a method which allows a single microchip to be used to screen the functions of tens of thousands of genes simultaneously by means of RNA interference. Traditional methods only allow a few hundred genes to be screened with each microplate; this new method will thus improve the commercial potential of VTT in the area of pharmaceutical development.

RNA interference, an effective gene silencing technology used in cellular biology, has revolutionised functional research in genetic products over the past ten years. Gene silencing using RNA interference means halting the action of a specific gene, thereby inhibiting production of its end product, a protein. Potential future use of RNAi technology includes the diagnosis and treatment of illnesses.

Miniaturised cell spot microarray techniques, which are used to analyse the functioning of cells, have featured in drug development at VTT for a few years now, and are both an important research tool and a development priority. Ultra-high throughput screening (UHTS) techniques are used in laboratories to identify the factors that influence the functioning of human cells, promote health, or cause illnesses.

VTT has already tested the method on a panel of almost one hundred cancer cell types and found it to be both efficient and reliable. The method has been used especially in breast cancer and prostate cancer studies.

The primary benefit of the method is that it allows such a large number of samples to be analysed simultaneously, which saves both money and human resources, and speeds up research. The findings of the study were published in March 2011 in BMC Genomics, a publication specialising in the methodology of genetic research.

The unique method developed by VTT is mostly used in genome-wide analyses, generally a very expensive field of research. The new technology is now expected to yield a competitive advantage in genome research. Other potential applications include locating proteins and studying the combined effects of genes and drugs, which is of particular interest to the pharmaceutical industry. The method was also used in a VTT study on cell adhesion receptor control, the findings of which were published in the Nature Cell Biology series in November 2011.

Further information

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19th-century beer analysed

VTT has examined one of five bottles of beer salvaged in summer 2010 by divers from the wreck of a ship that sank an estimated 170 years ago in the Åland Islands. The examination yielded a wealth of detail about the beer, even indications of how it was brewed. Another of the salvaged bottles is still undergoing analysis.

VTT was commissioned by the Government of Åland to find out the nature of beer in the early 19th century, the recipe of the shipwrecked beer and the type of yeast used to brew it; the goal was to reverse-engineer the recipe so that the beer could be recreated for modern production.

The examination involved an analysis of the physico-chemical properties of the beer and microbiological and DNA analyses of the bottle and cork to isolate any living microbes found.

The bottle contained a liquid that was a beautiful pale gold colour, identified as beer because of the presence of malt sugars, aromatic compounds and hops typical for the beverage. The beer in the bottle examined had not stood the test of time well, as salt from sea water had contaminated it.

Dead yeast cells were found in the beer, demonstrating that fermentation had once taken place. Living lactic acid bacteria were also found. Lactic acid bacteria used to occur together with brewer's yeast in beer brewing in the past.

It would appear that the contents of the bottle examined by VTT were in worse condition than those of the bottle that broke in the course of the dive. Another of the salvaged bottles is still undergoing analysis. There is thus potential for further findings.

Further information

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Biomass in cars, foods and medicines

The necessity of curbing climate change and fluctuations in the prices of fossil fuels urge the development of new biomass-based products. Bioeconomy, or comprehensive exploiting of biomass, aims at replacing oil-based products with renewable bio-based products.

The term 'bioeconomy' refers to a sustainable economy where biomass is used comprehensively for creating high-end products. For instance, biomass can be processed like crude oil into energy, chemicals and raw materials. Biomass is renewable and can be reused or returned to the natural environment. A successful bioeconomy depends on robust expertise in chemistry and biotechnology.


VTT is focusing on developing biotechnology and chemical technology solutions to generate added value from renewable energy sources, particularly biomass unsuitable for food production.

One of the most important research areas for VTT is the 'cell factory' concept, which involves developing microbes and plant cells and their production processes to manufacture chemicals, biofuels, proteins, pharmaceuticals and foods. The cell factory concept also opens up interesting pathways for producing new, high-performing biomaterials.

One of the end products of the bioeconomy is bioplastic. There is a growing market for biomass-based plastic, the current production volume being about 300 to 500 kilotonnes per year. Research and technology are constantly bringing improved solutions to this emerging market. Bioplastics are of particular interest to the fluid packaging sector. The Coca-Cola Company, for example, already uses bio-based PET plastic in 30% of its packagings.

Further information

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A green Volkswagen Golf Hybrid is parked at a charging station in an urban setting. The car is connected to a charging station with a green cable. The background shows a multi-story building with many windows. The text "MACHINES, VEHICLES, METAL" is overlaid on the image. A black box in the top right corner contains a list of statistics.

- In USA, the estimated order-value of new machinery totalled US\$ 288.8 billion in 2010
- The highest value in new orders came in turbines, generators and other power transmission equipment
- More than a quarter of US machinery plants have scrap and rework percentages that are 5% or worse, and on-time delivery rates at 90% or worse
- New emission standards may require machinery redesign
- Smart machines will be made smarter by hybrid AI, combining several narrow AI techniques plus access to massive data in the cloud
- The total number of new vehicle registrations in Europe is forecast to reach 15.7 million units in 2011, and to continue rising to 18.2 million units in 2015.

MACHINES, VEHICLES, METAL

Saving fuel by reducing friction

No less than one third of a car's fuel consumption is spent in overcoming friction, and this friction loss has a direct impact on both fuel consumption and emissions. However, according to VTT new technology can reduce friction by anything from 10% to 80% in various components of a car, and thus save fuel.

There are 612 million cars in the world today. The average car clocks up about 13,000 km per year, and in the meantime burns 340 litres of fuel just to overcome friction, costing the driver EUR 510 per year.

Of the energy output of fuel in a car engine, 33% is spent in exhaust, 29% in cooling and 38% in mechanical energy, of which friction loss accounts for 33% and air resistance 5%. By comparison, an electric car has only half the friction loss of a car with a conventional internal combustion engine.

Annual friction loss in an average car worldwide amounts to 11,860 MJ: of this, 35% is spent in overcoming rolling resistance in the wheels, 35% in the engine itself, 15% in the gearbox and 15% in braking.

A recent VTT study shows that friction in cars can be reduced with new technologies such as new surface materials, surface textures, lubricant additives, low-viscosity lubricants, ionic liquids and low-friction tyres inflated to pressures higher than normal. Friction can be reduced by 10% to 50% just by using new surface technologies such as diamond-like carbon or nanocomposites.

It should thus be possible to reduce car fuel consumption and emissions by 18% within 5 to 10 years and up to 61% within 15 to 25 years.

Further information

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Maintenance-free wireless condition monitoring

Finnish industry is seeking new solutions for condition monitoring of processes and machinery. The VTT InterSync project has engaged in close co-operation with enterprises to produce solutions such as a new type of vibration-powered energy harvester for wireless sensor nodes.

Industrial enterprises wish to enhance their operations using sensor nodes that are wireless, easy to install and main-

tenance-free. The InterSync project jointly run by VTT and industry has involved creating energy-efficient measuring solutions that collect energy from their environment.

One of the items developed in the project is a new kind of vibration-powered energy harvester. Vibration is generally something to be avoided, but in sensor technology it can actually be an asset. Micro-actuated electronics regulate energy production, converting the power generated by the energy harvester into a suitable voltage. The power generated by such a device is typically in the order of milliwatts. The energy harvester operates on a wide spectrum of vibrations – in this case calibrated to 10–20 Hz.

Vibration-powered energy harvesters to date have operated on very narrow spectra, but the broad-spectrum energy harvester developed by VTT needs no frequency tuning and has more potential applications. The device can also harvest energy from rotating sources.

The project has also included developing solutions for transferring power to the sensor nodes over a wireless connection. The first applications were created for the companies involved in the project.

Because the sensor systems are wireless, they are easy to install and transfer, and also more reliable. There are also aesthetic reasons for favouring a wireless system. In order to be totally wireless, the sensor must be able to communicate wirelessly and to function without an external powering cable.

There are many ways to make a wireless sensor self-sufficient in electric power. The sensor can be equipped with an energy harvester that converts energy flows in the immediate vicinity into electrical current for the sensor to use. Energy can be tapped from light, radiofrequency electromagnetic fields, the movement of the sensor itself, temperature differences in the operating environment or temperature variations over time. To activate the energy harvester and to boost its operation, a specific wireless power transmitter can be installed near the sensor to feed it the power it requires.

InterSync is a research project belonging to the EFFIMA programme run by FIMECC Oy. In addition to VTT, the research consortium includes the University of Oulu and the Tampere University of Technology. The business partners are ABB Marine, Konecranes, Kone and Metso Automation.

Further information

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REAL ESTATE, CONSTRUCTION, SERVICES, LOGISTICS

- The global real estate and construction markets remain weak
- European construction markets are expected to show negative growth until 2014
- Sustainability is the most important trend in architecture and construction today, with around 20,000 low energy houses having been built in Europe
- Over recent years the combined share of various services in Finnish GDP has already risen to more than 65 per cent
- Of Finland's 250,000 companies approximately 70 per cent operate in the service sector
- Seven of the world's twenty largest ports are located in China
- New transport corridors between emerging countries and least developed countries are being established.



Services for active senior citizens

Present senior citizens are more healthy, wealthy and active than previous generations. They need new kinds of services, which in turn breeds new business opportunities. VTT is bringing a life perspective to service development, considering how the various areas of a person's life interact. It is important to co-design services together with the people who will be using them.

The concept of 'active ageing' is becoming current in public debate and in service and product development. This concept concerns the baby-boom generation and third-age pensioners and covers daily routines, leisure activities and wellbeing, and also the development of technology for the needs of ageing people who are still working.

The mainstream service development approach has more to do with the immediate use of services than the role of technology in people's lives. VTT would like to introduce a new angle, that of improving the quality of life with the help of technologies and services. The point here is to consider how the different psychological, socio-cultural and biological facts in life, as well as values and various roles in a person's forms of life interact and intersect, and how various technologies and services can be designed in a way that they would contribute to a good everyday life.

The service needs of the active ageing population are very different from those of young people: services are expected to be of high quality, to provide value for money and to support individualism and personal wellbeing. On the other hand, there is also concern for the impairments to coping with everyday tasks caused by normal ageing-related functional incapacities, and a desire to compensate these impairments, at least in part, with technology.

VTT has collaborated with the University of Jyväskylä to develop life-based design and evaluation methods consistent with the life-situation-oriented design aspect. These methods employ a form-of-life analysis to identify the technology needs of the ageing and the older adults and their functional challenges across the board, while combining human-technology interaction (HTI) design practices with corporate R&D processes.

The point of VTT research on ageing technology is to apply a new approach to generate R&D operations supporting active ageing so that users, enterprises, public sector actors and third sector actors can collaborate to generate, implement and evaluate new innovations.

Further information

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Potential for eco-efficient construction

VTT research indicates that the key obstacles to eco-efficient construction are low demand, insufficient design methods and a lack of means to demonstrate the benefits of sustainable construction convincingly, linking them to the value of the buildings. In a concept developed for the St Petersburg area, eco-efficiency is being taken into account from the regional planning stage.

In the Sustainable Building Processes project, VTT has generated new information on eco-construction processes and on potential for and obstacles to progress. Putting sustainable construction into practice requires its benefits to be better understood. According to VTT, it is vital to increase awareness among clients and building users of the benefits of sustainable construction and to develop means with which to place demands on sustainable construction.

Promoting sustainable constructions requires improvements to construction control, new business models, methodological development and continuing tightening of regulations on new construction as well as on building renovations. In an ideal situation, the control of all construction would be based on an analysis of sustainable construction. Elements of this are already incorporated in the Building Act and building code.

The prominent role of the principal designer is highlighted in a construction project, which is always a process involving teamwork, optimisation and taking user needs into account. Co-operation between other designers participating in the construction process must also be improved. Indeed, for the purposes of teamwork a new process description consistent

with sustainable construction is needed, and this should be applied in the task lists of the various job areas involved. Competitive tendering practice should also be developed so as to be conducive to team formation.

Sustainable construction also increases the need for information: methods are needed for ensuring the compatibility of and interaction between product libraries, general databases, evaluation tools, CAD tools and building information models (BIM).

Building supervision should also be developed so as to encourage the appropriate actions. Incentives and official practices would also facilitate this development.

VTT is collaborating with enterprises and other actors in the field to promote sustainable construction. Current efforts include the European SuPerBuildings project (Sustainability and Performance Assessment and Benchmarking of Buildings) for developing the leveraging of sustainable construction indicators at various stages of the construction process and solutions for integrating sustainable construction evaluation methods into the BIM process.

Eco-construction must be taken on board from the district planning stage. In the EcoGrad project, VTT created a concept for ecological city planning in the St Petersburg area. The concept includes a dense urban structure, a minimised need for private transport and maximised use of public transport and light traffic, a minimised energy consumption, the use of renewable energy with maximum efficiency, and sustainable waste and water treatment solutions. The concept also takes into account social and cultural aspects.

VTT is also developing community construction eco-efficiency evaluation tools in the KEKO project. This project belongs to the Tekes 'Sustainable community' technology programme and involves seven cities, two construction companies engaging in district development and the Ministry of the Environment besides the research institutions.

Further information

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Goal: emission-free residential districts
The results of the Tekes-funded EcoDrive project demonstrate that the building code and energy solutions covering entire districts have a major impact on emissions of greenhouse gases from residential districts. VTT calculations show that it is possible to reduce emissions by up to 80% compared with a conventional suburb.



Building regulations aimed at minimising emissions will be introduced in Finland's building code by 2020. By then, the default will be that new houses will have an energy balance close to zero. It is to this end that new, eco-efficient communities have been modelled, designed and implemented in the Tekes-funded EcoDrive project.

VTT examined the energy efficiency of residential districts being built under the EcoDrive project. Various energy generation solutions were drawn up for five communities in different parts of Finland, and emission levels for their various levels of energy efficiency were calculated. The communities varied in their energy efficiency; at their best, they complied with the EU-defined goal for 2020, with an energy balance of almost zero, while at their worst they complied with the 2010 building code.

VTT calculations indicate that it is possible to reduce emissions of greenhouse gases by up to 80% compared with a conventional suburb, but this requires solutions covering the entire district. If a near-zero energy balance is sought pursuant to the directive and other infrastructure costs remain at the same level as before, the overall costs will be about 10% higher than for conventional construction. The easiest and most cost-effective solution is for the district to be hooked up to a district heating network that uses renewable energy sources.

Experiences from the suburban reform project in the Peltosaari district indicate that the planning of a residential district must go beyond technical and town plan design. Development measures must have the support of residents, and this requires an efficient publicity policy and co-operation between planners and residents. The feasibility study for Itä-Pasila in Helsinki showed that roughly 20 % of the electrical energy use of the whole neighbourhood can be covered by renewable electricity production integrated in the existing buildings.

Further information

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Energy efficiency with risk management

The EU is pressing home its demand for all new construction to be near zero-energy by 2021. This energy target can only be achieved, and prevailing moisture damage risks made a thing of the past, if design and construction quality is ensured. As for the cost, energy efficient buildings carry a 2% to 7% higher price tag than conventional construction.

The EU Energy Performance of Buildings Directive is revolutionising construction across Europe. As a Member State, Finland is committed to slashing carbon dioxide emissions from the building stock. The energy objectives of low-energy, passive or zero-energy buildings can only be achieved if the necessary design and construction quality are up to scratch. This will also go a long way towards soundly eliminating the quality defects typically responsible for moisture damage.

Responsibility for preventing moisture damage lies with both the client and the construction and maintenance service providers. The appointment of adequately skilled designers and contractors and effective supervision of the interests of the client are the client's own responsibility. Clear objectives based on functionality must be set for the building, and these must be verifiable at the commissioning stage.

Moisture damage in buildings has traditionally been caused by leaking piping systems and substandard work quality. Rainwater penetration into structures is a classic sign of poor quality facade construction, or a simple lack of proper maintenance. Other common causes of moisture damage include inadequate or flawed waterproofing, incorrect storage of construction materials, and carelessness and negligence during construction or maintenance.

Energy efficient construction costs are 2% to 7% higher than the costs of conventional construction based on current regulations. For example, the costs of a multi-storey passive building constructed for TA Asumisoikeus Oy in Oulu, Finland, were 3.3% higher than those of an adjacent conventional apartment building of similar layout and design. Renewable energy installations are a key source of extra costs in zero-energy buildings.

A zero-energy building or, more specifically, 'net zero energy building', produces at least as much useable renewable energy as it uses from conventional energy sources. Similarly, a near zero-energy building meets a significant proportion of its energy needs with renewable energy that is produced either by the building itself or by a renewable

energy facility located nearby – as is the case with renewables-based district heating.

Commercial applications for zero-energy buildings have been developed around the world. Finland's first near zero-energy high rise apartment building, and the leading such example in the Nordic countries, was completed in Kuopio at the end of 2010. Another is to be built in Järvenpää this year. In addition, zero-energy single-family houses are being built and developed in Finland.

The IEA5 house built in Pietarsaari back in 1993–1994 is a near zero-energy building compliant with the EU Energy Performance of Buildings Directive. The house has been performing smoothly and greenly for more than 17 years.

Further information

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Tools for evaluating energy efficiency

The building stock is slow to renew, so major decisions concerning the energy efficiency of buildings must be made soon. VTT has developed the REMA calculation model for evaluating the energy requirements of the building stock to help in the decision-making process, and the Ekopassi model for evaluating the eco-efficiency of holiday homes.

Achieving an eco-efficient energy economy in the building stock requires more accurate information on the building stock itself and its energy consumption. VTT developed the REMA calculation model for information management and for evaluating the impacts of repairs to be made to individual buildings and the building stock as a whole.

A variety of technological scenarios have been analysed using the REMA tool, evaluating factors such as the technological potential for reducing carbon dioxide emissions from the building stock by more than 20% by 2020 through active energy efficiency measures and by using best technological solutions. The tool has also been used to outline cost impact scenarios for the most effective measures. The building stock incorporates a highly significant potential for energy conservation.

REMA helps choose the appropriate measures for buildings built in various decades and using various methods so as to improve their energy efficiency and reduce their carbon dioxide emissions. For example, the impact of improving the external shell of a building or changing the heating system on carbon dioxide emissions may vary enormously.



The REMA model developed by VTT can give owners of major real estate properties, building management companies, contractors and the authorities answers to questions such as which repairs are needed; what form of energy should be chosen; or whether a 1970s block of flats needs improved heat insulation or a ventilation heat recovery system, or perhaps solar panels.

The online Ekopassi service developed by VTT gauges the eco-efficiency of a holiday home using six indicators: energy consumption, percentage of renewable energy, carbon footprint of construction, waste sorting and recycling, water and waste water management, and location and accessibility. The eco-efficiency rating of a holiday home is calculated based on the point scores awarded for each indicator. The rating is given on a five-step scale, the highest rank being Eko+++, followed by Eko++, Eko+ and Eko. The lowest rating is Eko-.

Using Ekopassi is simple. Users need only answer a few questions about the building in the online application and indicate the structures of the building using the choices provided. The application evaluates the energy consumption and carbon footprint of the holiday home and gives it an eco-efficiency rating.

VTT Expert Services Ltd offers assessment, measurement and compliance certification services for the energy efficiency of buildings, structures and technical building services. Service coverage includes ensuring functionality at all stages of the construction project, investigations in support of product development and marketing, and analyses required for condition surveys.

Further information

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Towards a transport system of the future

VTT and Mercedes-Benz are collaborating on a transport system of the future where vehicles communicate with one another, receive real-time traffic information and also collect and transmit data themselves. A test area is being set up in Tampere to explore the services Finnish drivers would like to have and how these would affect the safety and flow of traffic and the environment.

The European DRIVE C2X project launched in 2011 is intended to develop and field-test new smart traffic services for drivers and passengers, conveying real-time information from one road user to another. Transport is expected to become more efficient, with fewer accidents, once road users become more aware of what is going on around them.

The new systems will be what are known as 'co-operative systems', where vehicles communicate with one another and with the environment, conveying position-specific real-time data. This means in practice that drivers can be alerted to an approaching emergency vehicle or a particularly slippery bend.

The new systems will be put to the test within a year once the test area is set up. The main feature in the project is studying how the applications and services being developed affect driver behaviour, traffic safety, traffic efficiency and the environment in actual road use circumstances. The results will be usable for practical applications within 2 to 4 years of the project conclusion.

This three-year project is being implemented by European research institutions and major European car manufacturers, led by Daimler as the co-ordinator. VTT is the largest actor in the project in terms of its budget (EUR 2.1 million) and person-hours. The overall project budget is EUR 19 million. The participating countries besides Finland include Germany, the Netherlands, Sweden, Italy, France and Spain.

In Europe, 43% of traffic accidents leading to injury occur at intersections. VTT has previously participated in the INTERSAFE-2 project, whose purpose was to improve safety at intersections. Four safety systems for anticipating and avoiding hazards were developed under the project. Safety systems assist drivers in hazard situations, being intended to reduce the impact of accidents or to prevent accidents altogether.

Delivery of the behavioural data to external services can be performed in WLAN and 3G networks according to the current standards. The solutions support the most popular operating systems and function on, for example, Android 2.3+, Symbian^3 and MeeGo platforms.

Further information

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Breakthrough in intelligent transport development

VTT and corporate partners have developed the Vedia multi-service concept for transport services and has piloted its first applications. Vedia, for example, could automatically find the nearest parking space that the driver can book and pay for securely using a terminal device.

Positioning-based traffic information and user services have been around for some time, but the services available have been fragmentary and device-specific. VTT brought together a strong group of Finnish service providers and other intelligent transport operators to develop the device-independent Vedia all-service concept.

The Vedia concept allows the use of several interactive geographical-information services on the same terminal device, whether smart phone, tablet or other mobile device. The idea of a multi-service is to create a virtual one-stop shop where users can access services easily through their terminal devices when on the move – on foot, on public transport or in a car.

The Vedia pilot involves some 30 vehicles in the greater Helsinki area. The vehicles are being used for testing basic Vedia features: kilometres driven, travel analysed by road type, and emissions based on the vehicle ID data and emission category.

Vedia services will initially be offered to professionals. Examples of services include automatically generated driving logs and travel reports, as well as transport monitoring and control, and updated maintenance services. Consumer services will be added later.

The Vedia multi-service will provide drivers with real-time information, for example on traffic congestion, slippery roads and the best deals on petrol, etc. The terminal device can also instruct the driver on how to drive to conserve fuel and keep emissions low. When approaching the city centre, the driver can use the service to find a free parking space, and to book and pay for it. Arriving at the car park, the driver can check public transport timetables and routes on a mobile device to find the best way to get to work. Voice output will be developed to enable the services to be used safely.

The long-term aim for Vedia is to create a situation where vehicles and people on the move can be online all the time if they so wish, accessing the services they require.

The Vedia multi-service platform has been developed by DNA, G4S, Indagon, Logica, Media Mobile Nordic, Nokia Siemens Networks, Semel, Teliasonera and Tieto, in addition to VTT.

Further information

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BUSINESS RESEARCH, COMMERCIALISATION

Enhanced product development through online communities

Companies can make use of online communities for new, fresh ideas for revitalising and specialising products and services, as well as feedback on points that customers appreciate. However, using online communities efficiently to boost innovation requires motivation, incentives and tools for participants.

A doctoral study shows that customers participate in collaborative online communities because they value new angles, effectiveness, a sense of community and the entertainment value. Interesting topics, an open and constructive atmosphere, the gaining of better products, winning competitions and receiving rewards are also incentives for participating in online communities.

Consumers like to participate in product development if they feel this is a way of obtaining better products. Consumers often have more radical ideas than the manufacturer's product developers. The more passionate the customers are about the product, the better for the company.

The study showed that companies and consumers do not have enough potential for collaboration in innovative online communities because of a lack of proper tools. Ideas submitted by individual contributors and comments posted by other participants may arrive with a delay of several days and are therefore not useful for brainstorming. Tools for real-time brainstorming online should be developed so that participants can feel they are actually taking part in a work in progress. Besides providing tools, the service operators must participate actively in the online community.

The study shows that it is important to reward customers for their participation, especially if their contribution is of a good quality. Rewarding practices for participants must be simple and transparent. Rewarding should be flexible, enabling the recipient of a reward to choose the reward himself/herself. In addition to material rewards (money or goods), immaterial rewards such as commendations are important to participants.

Further information

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Allergy vaccine being developed

VTT Ventures Oy is involved in launching a spin-off company, Desentum Oy, to develop new-generation allergy vaccines. The company's business is based on a technology patented by VTT. Bringing the vaccines to market will require years of research, testing and licensing.

The method patented by VTT involves using gene technology to change the structure of the allergen, i.e. the protein that causes the allergy, so that it causes less severe symptoms but still functions as an allergy desensitisation treatment.

Desentum Oy aims initially to develop a product line of 20 to 25 new hypoallergens that could function as vaccines against the principal allergens, such as birch, grass and ragweed pollen, pet allergens and food proteins (fish, nuts, apple, celery).

The allergy vaccine development is based on the scientific breakthrough made five years ago, in a joint project run by VTT, the University of Eastern Finland and the Skin and Allergy Hospital of Helsinki University Central Hospital, in which scientists demonstrated how an allergen and an IgE antibody bind to one another. The scientists were the first to describe the precise 3D structure of this bond, which proved to be different from the prevailing assumption of scientists worldwide. This structural description led to two significant discoveries concerning the general structural properties of allergens, which in turn facilitated the development of vaccines for safer and more effective allergy desensitisation treatments.

The aim is to create a vaccine that can be taken orally in tablet form. The first products are expected to enter clinical testing within three years.

Because the incidence of allergies and severe allergic reactions has increased, these are now considered to be one of the top five disorders in industrialised countries in terms of health care costs. In Finland, more than 20% of the population suffers from a type I allergy, where the sensitising agent is an environmental allergen.

In the USA alone, the market for allergy medicines is expected to exceed USD 15 billion by 2015. The market potential for the new allergy vaccines was estimated at about USD 700 million in 2010.

Further information

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Recommended measures to promote competitiveness

VTT and the Tampere University of Technology have worked with the Federation of Finnish Technology Industries to explore the kind of research and development that will be required to improve the international competitiveness of Finnish manufacturing industry over the next 10 years. The findings have been written up as recommendations that can help support decision-making by industries, research bodies and funding providers.

The recommendations focus on a strategic approach to production, networks as a resource, the potential for achieving a technological advantage, caring for expertise and experts, and how the public sector can support Finnish production industry.

The recommendations emphasise strategic and management development in SMEs and activating R&D. They propose a tax incentive scheme for R&D and the encouraging of SMEs to participate in international projects and programmes for strategic centres of excellence. The importance of human resources and of experienced employees is also highlighted.

According to the report, R&D in companies in the near future will focus on customer processes and networks. In a one-year perspective, development will focus on employees. According to current views, R&D will be more technology-oriented in four or more years. There is a shared interest among sectors in attaining an international competitive advantage for Finnish production industry.

Finnish technology industry can prosper in the global economy if it is at the top of its league in terms of competitiveness. The building blocks of the future must be sought in increased productivity, technology development and new markets.

This Tekes-funded study focused on the piece goods industries, specifically the engineering and metal products industry. The project involved a systematic and extensive exploration of the views of enterprises and other actors concerning development needs in the technology manufacturing industry and future success factors in production, manufacturing processes and business models. The special features of Finnish enterprises were taken into account.

Further information

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RESEARCH AND INNOVATION VISION 2020



Our world is facing grand societal challenges in the near future. VTT's Research and Innovation Vision 2020 is built on a platform of sustainable solutions and steers VTT's research and innovation activity in response to key questions for the future. Six impact areas have been chosen, each containing significant potential for creating business founded on new technologies and innovations. The areas selected are bioeconomy, low-carbon energy, resource-efficient industries, clean globe, people's well-being and digital world.

A new and better future will demand that we give up many of our current models. This will concern technologies, business concepts, and even industrial and economic structures. Rather than stand by and watch this happen, VTT is actively involved in creating alternative solutions that will improve the quality of life of each and every individual, that will foster sustainable economic growth, and that will create a clean living environment.

VTT's vision has sought out those areas that are seen to contain attractive business potential and thus the opportunity to achieve considerable impact through implementing innovation. Today's waste will become tomorrow's valuable raw material. The global objective for industry is zero-emission production based on closed cycles. Much better efficiency in water re-use is vital. Smart and low-carbon energy production is a necessity. The new bioeconomy creates a sound platform for sustainable economic development. The resource-efficiency of industry will be ensured by ecoinnovations that implement more effective use of raw materials and energy, higher product quality and improved safety and security. Information technology and electronics will spread and are embedded in all business areas to improve their competitiveness and create entirely new business activities and models. Innovations enabling the well-being of every individual are based on multi-disciplinary research in which biological, food technology and pharmaceutical competencies are linked to those in diagnostics, information technology, electronics, behavioural science and business.

VTT's spearhead programmes

Industrial biomaterials - Competitive edge from bioeconomy and renewed forest cluster

This spearhead programme develops biomass-based materials and chemicals that strengthen the principles of sustainable development and have no adverse effects on food production



value chains. The biomasses to be used include forest industry masses, food production side streams, agricultural wastes, and the fractionation products of natural materials.

In 2011 this programme has focused on developing new biopolymers from forest industry streams, and the research results have led to successful development of new roll-to-roll bio-based packaging materials, which can prevent oxygen and grease from passing through the packaging material, for example. Research work has succeeded in developing excellent transparency and moldability for these products. The programme also researches the application possibilities of nano cellulose as raw material for bio-based products, such as materials and composites of technical devices and constructions.

Further information: Ali Harlin, Programme Manager

eEngineering – Digital product process as a success factor for technology industries

An efficient digital product process reduces by half the time needed for designing and starting production in the technology industry. The digital product process can also enable the use of a new type of product development process, where different alternatives can be compared virtually by combining simulators from different areas of technology. The programme results are used by domestic and international machinery and logistics industries, manufacturing and process industries and, especially, the forest and energy industries.



VTT's research and innovation visions 2020:
www.vtt.fi/files/publications/vtt_research_and_innovation_visions_2020.pdf

The eEngineering programme develops an open software platform (Simantics) for modelling, simulation, design information management and lifecycle management. This platform enables the different models to communicate and interact with each other, something that is often found to be extremely difficult. New versions of both the Simantics environment and VTT's Apros software were made during 2011. In addition to the design stage, VTT has also succeeded in using compatible virtual models in end user training.

Further information: Olli Ventä, Programme Manager

Open smart spaces - Digital world and ubiquitous computing

This spearhead programme is based on the view that bridging physical environment and the digital world is the next revolution of the ICT industry. The development of ubiquitous ICT and the Internet of Things (IoT) will bring about a revolution in the technology and business worlds. In addition to complete renewal of traditional business models and ecosystems, this development requires substantial research efforts. The key technologies researched in this programme are context awareness, augmented and mixed reality, and the interoperability solutions of devices and services.

In 2011 one of the most important achievements of this programme was setting up Europe's first uID server. uID is a general and unique naming system developed by the University of Tokyo which enables the naming and identifying

of any object. Technologies for identifying user activity and use context, for example, have been developed over the past year under the programme. New business activities have emerged around these new technologies.

Further information: Heikki Ailisto, Programme Manager

Green solutions for water and waste

The goal of this spearhead programme is to develop environmentally efficient solutions for treating waste and water, as it is evident that both water shortages and lack of clean water will become more widespread, and expertise in this industry will have strong international demand. This also means that resource efficiency must improve in the future, with the development of waste recovery an essential part of meeting this challenge. The resource efficiency challenges in particular connect the programme goals to the requirements of several customer industries. The mining industry, for example, requires substantial development of water treatment and resource efficiency in the near future.

The main goal of the first year of the spearhead programme was strong internationalisation and expansion of VTT's customer base. Research work related to phosphorus recovery and water treatment membrane technologies has been carried out in cooperation with international research organisations, for example, in Australia and Singapore. The programme's development work led to filing seven invention disclosures related to sustainable chemical use in water treatment.

Further information: Mona Arnold, Programme Manager

Major innovation programmes

- Nutritech – Health and Wellbeing through Eating
- Technologies for Health
- Fuel Cells
- Intelligent Energy Grids
- Energy Efficiency and New Fuels for Transport
- Intelligent Transport
- High-performance Microsystems
- Cognitive Communications
- Multiscale Design (2012–)

VTT's key technology fields

Applied materials

- Extreme conditions materials
- Bio-based and organic materials
- Functional surfaces and colloids
- Water, waste and environmental technologies

Bio- and chemical processes

- Sustainable chemistry
- Biomass refining and fibre technologies
- Biotechnology for health
- ICT for health
- Industrial biotechnology

Energy

- Nuclear energy
- Combustion and gasification technology, emission control
- Bioenergy
- Energy and emissions in transport
- Distributed energy, fuel cells and wind power
- Energy in forest industry
- Energy systems, economy and climate change

Information and communication technologies

- Interacting with the real world
- Gratifying user experience
- Managing design complexity
- Moving 1 Gbps per user
- Finding relevant information
- Serving 100M users

Industrial systems

- Operations research
- Human technology interaction
- Machine and vehicle technology
- Manufacturing systems and networks
- Industrial management
- Systems engineering
- Technology, business and innovations
- New production methods

Microtechnologies and electronics

- Photonic solutions
- Printed intelligence
- Diagnostic platform technologies
- Micro- and nanosystems

Services and the built environment

- Service science and service business
- Safety and security
- ICT and processes in the built environment
- Performance of buildings and districts
- Transportation systems and telematics

Business research

- Innovation management
- Foresight
- Global product, production, service and business concepts, delivery chains
- Business technologies
- Innovations and innovation systems

Further information

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International and domestic cooperation

Challenges at the global level are changing the operating environment for enterprises. VTT's response to social challenges is to reform its research and innovation vision, and to act as a provider of networking opportunities for Finnish and European stakeholders in a global environment. Transfer to an eco-efficient economy requires strong innovation partnerships. VTT is strongly committed to furthering the EU 2020 goals.

European research co-operation and strategic partnerships

In 2011, 506 (2010: 414) international public research projects were under way at VTT – 90% of them within the framework of European Union programmes (the Seventh Framework Programme; the Competitiveness and Innovation Framework Programme; Artemis, Eniac and FCH initiatives; and programmes under EIT and ERA; as well as Nordic co-operation).

Participation in international research and innovation co-operation through EU framework programmes is important, and also supports the renewal of the European economic structure. VTT is a major organisation yielding EU-level influence and, with the help of EU and ERA projects, is developing cutting-edge technology, international impact, networks and innovation partnerships. VTT received a quarter of all Framework Programme funding in Finland. VTT's projects are focused particularly on information and communications technologies, nanoscience, materials and new production methods, energy, biotechnology and transport.

VTT's strong position in European strategic alliances – EERA, NULIFE/NUGENIA and ETSON (energy), HTA (micro- and nanoelectronics), EIT ICT Labs (ICT), JIIP (innovation policy) and AERTOs (horizontal partnerships among research institutions) – has afforded it an active role in shaping European research and innovation policy. Experience from new modes of co-operation such as these is important with a view to the development of the innovation system, both in Finland and across the EU. VTT's representation in the European High-Level Expert Group on Key Enabling Technologies (HLG KETs) in 2010 and 2011 provided VTT with an opportunity to present the views of research and technology organisations on the development of European industrial



and innovation policy and prioritisation of the contents of the forthcoming Horizon 2020 programme.

International mobility of VTT personnel

In 2011, 62 VTT research scientists (3.2% of research staff) spent at least one month working abroad (2010: 79). The most important host country was once again the United States, where 14 research scientists worked. 252 foreign personnel (majority were research scientists or research interns) spent at least one month working at VTT. International research scientists with an employment contract made up 8% of research staff. Research scientists came from 49 different countries, but primarily from Germany, China, Great Britain, and India.

VTT strengthened its international office network

VTT made substantial contributions to implementation of its internationalisation strategy during 2011 within selected strategic focus areas, including industrial biotechnology, renewing forest industry, energy, and ICT/electronics. VTT had a total of eight foreign contact points in 2011. Three of these are research units, where VTT conducts active research and innovation co-operation, and five are contact points operating as networking and marketing offices.

VTT's foreign research units are located in Brazil and Korea, and in the United States at Berkeley, California, and administratively are organised under VTT International Ltd. The research activity of VTT's Brazilian unit focuses on biomass use, water technology and research serving the needs of forest industry. In VTT's Korean unit the focus is on research and development operations within the fields of ICT and electronics, with the involvement of local universities and research institutes. VTT/MSI Molecular Sciences Institute in the U.S. Berkeley focuses on basic and applied research on industrial biotechnology, strongly utilising the competencies of local universities and co-operation partners.

Four of VTT's five contact points are part of FinNode, the joint network of Finnish innovation operators, and are located in Japan, China, Russia, and in Washington D.C. in the United States. VTT's Washington D.C. office focuses on marketing environmental and electronics competences to major corporations operating in the region. The office has also been used for enhancing co-operation with local universities and other partnerships. In Japan the emphasis was especially on co-operation in the ICT sector with local research institutes and universities. In Shanghai, China, the main focuses were the manufacturing industry and the energy sector. The St. Petersburg office in Russia concentrated mainly on the transport and logistics sector. In addition, VTT has an office in Brussels, in connection with EARTO, through which it supports the EU's project activity and participates in developing the European Research Area together with other leading research organisations.

In 2011, VTT International Ltd surveyed new opportunities for internationalising VTT's activities in Australia and Singapore, and assessed the potential for expanding the operations in China.

VTT as a driver of renewal in Finnish innovation activity

VTT has been highly active in preparing and launching Strategic Centres for Science, Technology and Innovation (SHOK) – established with the aim of renewing Finnish innovation activity – and in all of them acts as shareholder, board member, author of strategic research agendas and researcher. SHOKs offer VTT new opportunities and synergies in both research and operations. VTT is involved in almost all the current SHOK programmes. Several of the programmes are led by a VTT programme director.

VTT participated in more than thirty national research and technology programmes, with those run by Tekes and the Academy of Finland playing the main role. The operation of research alliances established with industry and science partners remains active. The key alliances include the Finnish Centre for Nanocellulosic Technologies, the Institute for Molecular Medicine Finland (FIMM), and Oulu's Printocent innovation centre programme in the area of printed electronics and optical measurement technology, as well as the Centre of Water Efficiency Excellence (SWEET) with Kemira Oyj and VTT Research Centre of Finland as principal partners. The forest bioenergy research and innovation programme prepared under BETA (Bioenergy Technology Alliance) co-operation between VTT and the

Finnish Forest Research Institute (Metla) was launched at the beginning of 2012.

VTT is also steering the Finnish Research Programme on Nuclear Power Plant Safety SAFIR2014 set by the Ministry of Employment and the Economy and acting as the co-ordinator in the Finnish Research Programme on Nuclear Waste Management (KYT2014).

VTT's research and innovation vision 2020 guides VTT's strategic co-operation network with domestic universities, as well as the development of significant and internationally unique joint research infrastructures. Micronova, owned jointly by VTT and Aalto University and based in Otaniemi, acts as a centre for the design, development and fabrication of micro- and nanosystems. The Remote Operation and Virtual Reality Centre, ROViR, of VTT and Tampere University of Technology, conducts research and development related to the international ITER fusion reactor project.

VTT is accelerating regional innovation activity

VTT is an active participant in regional research partnerships and project-based development. In addition to having a number of offices in different parts of Finland, VTT operates regionally in close co-operation with universities, research institutes and universities of applied science. Intensive local networking has continued.

The operations of VTT regional representatives in 14 locations have been developed further. With their assistance, events have been organised for enterprises in various regions presenting VTT's operations and seeking opportunities for co-operation. For SMEs, VTT plays a significant role as an active provider of international contacts and participation in international projects. In 2011, a promising number of Finnish SMEs filed applications for EU Research for SME projects, in which companies have excellent opportunities for international networking and the creation of new business activity.

VTT developed an operating concept with SMEs involving collaboration with growth-oriented enterprises and high-tech companies as the special target. The possibilities offered by VTT's services and co-operation have been communicated in various seminars across Finland, especially at trade fairs and in extensive media reporting of research results.

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Research policy faced with the need to find solutions

The past few months have been characterised by economic uncertainty. Western Europe has slid into a mild recession, with no obvious means of exiting the debt crisis. In Asia, economic growth continues, albeit at a slower rate than previously. Isolated positive changes have been reported with respect to economic development in the United States, but overall economic activity has remained at a weak level.

The drop in Finnish exports is turning out to be as great as many had feared. The current export value of goods and services, when projected to an annual level, is nearly 20 billion euro less than in 2008, when the value of exports peaked prior to the onset of the economic crisis.

Once a slump is over, Finnish exports have traditionally bounced back relatively quickly to pre-recession levels, regaining their growth momentum. Now, the situation is different. It is no longer a question of a transitory slump; in fact, there is a significant risk of exports remaining permanently at a lower level.

Finland's well-being is fundamentally dependent on revenues obtained from exports. Unsurprisingly, the developments and scenarios outlined above bode tough times for Finland. Bearing in mind the well-being of future genera-

tions, the state cannot continue to sink deeper into debt at the current rate, which means that government spending must be cut, even drastically in places.

Research funding will not go unaffected by the current economic climate. Although the importance of research is widely acknowledged as a means of developing new ideas and providing a prerequisite for innovations, both educational and research budgets are under growing pressure, with cuts to be expected.

This will affect the prospects of VTT. VTT has been successful over the past few years, achieving a recognised role in strengthening the competitiveness of Finland's economy. Customers are mostly satisfied. VTT is the principal Finnish actor in EU research programmes, and plays a key role in Strategic Centre of Excellence projects (SHOK). However, for VTT to sustain its position as one of the mainstays of Finland's economy, it must be prepared to regenerate its operations.

VTT must become more focused with respect to how it operates as an organisation. Increased emphasis must be placed on sectors that are vital for Finland's future. The collaboration with Finnish universities must be strengthened and division of duties clarified. International cooperation must be expanded from the current Europe-centred approach to embrace truly global dimensions. The goal must always be to form partnerships with the world's best professionals. It should not be forgotten that US universities and research institutes continue to be the technological powerhouses of the world, irrespective of the sector.

A strong hand is needed, and necessary measures must be taken, before damaging blanket budget cuts arrive. Our goal must be a VTT that is stronger than ever.

Martti Mäenpää
Chairman of the Board

VTT's Board

Chairman: Martti Mäenpää, the Federation of Finnish Technology Industries

Vice Chairman: Paula Nybergh, Industrial Counsellor, The Ministry of Employment and the Economy

Members:

Aaro Cantell, Chairman of the Board, Normet Oy,

Kaija Pehu-Lehtonen, Director, Oy Metsä-Botnia Ab

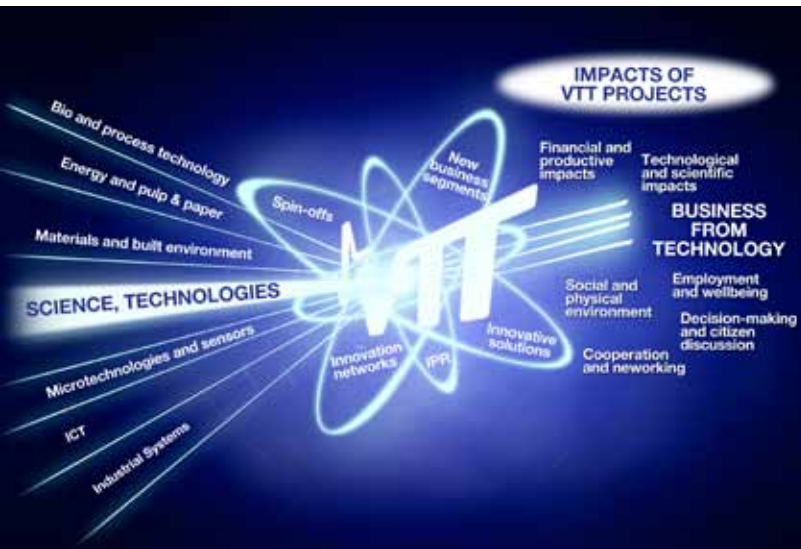
Mikko Hietanen, CFO, Rautaruukki Corporation

Pirjo Stähle, Research Professor, University of Turku, Finland Futures Research Centre

Merja Strengell, M.Sc. (Tech.)

Anu Vaari, Research Scientist, VTT (Staff representative)

Impact, prizes



Impact of VTT's projects

- 91% of the respondents to VTT's customer survey reported that their knowledge base and expertise had improved.
- 74% had already commercially utilised the results of their VTT project or expect to do so within the next three years – 28% said that it wasn't even their goal.
- 67% believed that a VTT project had speeded up or otherwise improved research and development work.
- 66% confirmed that new products, services or processes were created.
- 55% thought that a VTT project had promoted networking.
- 55% believed that a VTT project had contributed positively towards the opening up of new business opportunities.
- 49% reported that their competitiveness had improved.
- 48% said that a VTT project had promoted their marketing.
- 28% reported that a totally new technology was adopted.
- 17% said that a new business concept or a new earnings model was created.

Taloustutkimus Oy, VTT customer survey, 2011

Significant prizes and accomplishments

- Professor Kai Sipilä, Vice President, Strategic Research, was the first Finn to be awarded the prestigious Johannes Linneborn Prize for his leadership in promoting biomass as a sustainable energy source within the European Union and worldwide.
- Research Professor Johanna Ivaska was awarded one of the biggest Nordic awards within the field of biomedicine, the Anders Jahre Prize for Young Scientists, for her accomplishments in cancer cell research.
- The Association of Automotive Technical Societies in Finland (SATL) gave the Automotive Technician of the Year award to Nils-Olof Nylund, Research Professor in Traffic Energy Use and Engine Technology at VTT, for his accomplishments in research on vehicle emissions and alternative energy sources.
- The Finnish Society of Automation gave the Automation Award 2011 to the VTT and Semantum Oy working group that has been developing the simulation integration platform Simantics.
- A team of researchers from VTT and Åbo Akademi University received the Jasper Mardon Award 2011 at the annual conference of paper manufacturers in New Zealand.
- VTT's Research Professor Kim Wallin – as the first non-American – was presented with the Award of Merit by the global standardisation agency ASTM International Committee, for exceptional and sustained contributions to fracture mechanics within Committee E08 on Fatigue and Fracture.
- The Celtic Excellence Award in Gold was given to WINNER+, a project that developed future key technologies for mobile phone systems, in which VTT was involved.
- The research group on inkjet printing was granted an award for remarkable scientific achievement and industrially significant and commercially viable research on substrates for digital printing.
- The European Physical Society presented VTT Research Scientist Leena Aho-Mantila with an award intended for postgraduate students for her research on fusion plasma.
- Jussi Manninen, Development Manager, was granted the VTT Award 2011 for his achievements in the promotion of co-operation within the VTT Group.
- For the second year in a row, VTT was the favourite employer among technology students in the employer image study conducted by Universum.
- VTT's communications award 2011 was given to Juhani Laurikko, Senior Scientist, for his meritorious and active communications efforts.
- President and CEO Erkki KM Leppävuori was appointed member of the Research and Innovation Council of Finland.



SUSTAINABILITY AND RESPONSIBILITY

At VTT we take account of the principles of sustainable development both in our research and service operations and in our internal operations. We are developing our reporting in line with the GRI G3 guidelines on corporate responsibility.

This review illustrates corporate responsibility by means of examples. The appropriate C-level GRI metric, which is complemented over the course of the year to correspond to the B-level, is published on the VTT Internet website: www.vtt.fi/files/gri_table_2011.pdf. The majority of reporting refers to this review, with some references focusing on the VTT Group's principles of good governance and personnel review.

VTT's Research and Innovation Vision 2020 responds to the grand challenges facing society, and contains the objectives of a clean world, a sustainable economy and a good life. VTT's research investment in environmental technologies, bioeconomy, resource-efficient industries, low-carbon energy, peoples' well-being, and digital world, produces entirely new kind of solutions for furthering sustainable development. VTT's spearhead programme "Green Solutions for Water and Waste", together with our three innovation programmes for tackling environmental challenges in the energy sector, are key instruments when it comes to implementing our chosen strategy. Furthermore, VTT's

research activities create an excellent knowledge base for public decision-making on the path to a society founded on sustainable development.

Environmental issues

VTT has been recognised as a Green Office since 2009. The standards apply to every one of VTT's offices across Finland. VTT's Green Office metrics are electricity consumption, domestic flights and paper consumption.

VTT operates at more than forty addresses. Total electricity consumption amounted to 39.7 GWh. Consumption compared to the previous year is down by more than 400 MWh. This figure includes electricity consumed by both premises and research activity.

Domestic flights have also decreased, in this case by 100,000 flight miles over the previous year. Flights amounted to a total of 23.2 million flight miles, generating almost 3,600 tonnes of carbon dioxide emissions. A factor in the reduced number of domestic flights was the continuing increase in use of electronic conferencing tools. A further aim was to reduce the number of work trips carried out by personnel using their own cars. The number of kilometres driven on journeys compensated as work trips nevertheless increased by 7% over the previous year. Use of VTT



cars stalled at around 630,000 kilometres after six years of continued growth.

A reduction in the use of paper at VTT was achieved to the extent of around one ream per head, with the quantity of paper purchased down to just over 5 reams per head. The number of printouts also fell by close to a million (7.5%) compared to last year, although colour printouts were up both in absolute numbers and as a share of the total.

The 2011 award for the outstanding act in promoting the environment went to Micronova's procurement of granular scrubbers for the capture of clean room etching and growth gases and their reaction products.

An oil leak was detected at one of VTT's premises in connection with work on the Otaniemi metro site. The most probable source of the leak was traced to an overflow tank in an engine testing facility. An internal pool out of metal has now been constructed for the overflow tank to prevent any further spillage. Ramboll Finland Oy has surveyed the area and in accordance with recommendations has sent its report to the City of Espoo Environment Centre and the Uusimaa Centre for Economic Development, Transport and the Environment (ELY) for possible further action.

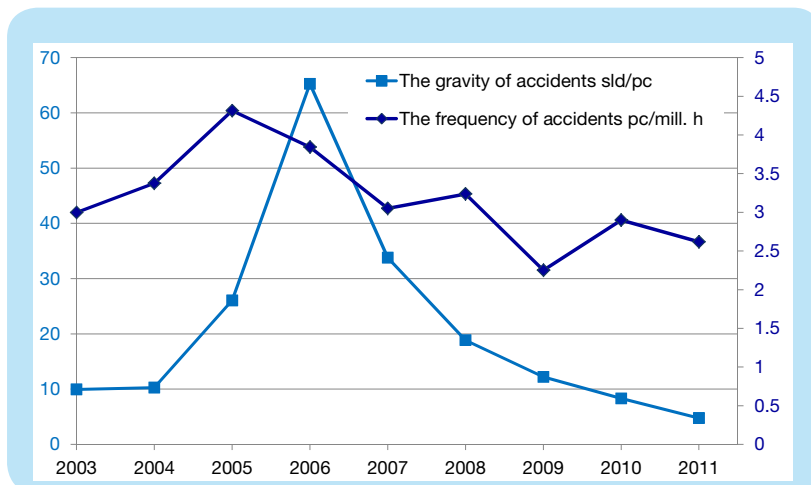
Responsibility for our own personnel

The results of the 2011 personnel survey are in line with those of the previous year. The share of personnel responding to the survey was 76.8%. The index indicating overall satisfaction matched that of the previous year at 3.3. A clear strength continues to be the functionality of the relationship with immediate superiors. A statistically significant improvement occurred in the balance between work and leisure, although at manager level the workload, personal energy levels and ability to cope with the work continued to be viewed as problematic.

The frequency of accidents, as calculated by the Zero Accidents forum method, remained at 3 per million work hours, while the gravity of accidents was less than ever before, with under 5 days of sick leave per single accident occurring in the workplace and resulting in sick leave. For the first time we were rated as a "world-class company" in respect of both the low frequency of accidents in the workplace and the absence of accidents of a serious nature.

The occupational safety authorities issued VTT with operating instructions for a fixed period concerning the cutting of the credit balance on the working time account of personnel. VTT has agreed the corrective measures required. Two line managers were fined in 2011 for the forklift accident that occurred in 2008.

The Finnish Parliamentary Ombudsman stated in his decision that VTT had violated the liberty of speech of two VTT researchers. VTT started renewal of its instructions following the alignments of the decision given by the Ombudsman.



GRI table 2011 at web site:
www.vtt.fi/files/vtt_gri_table_2011.pdf

Further information
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 tel. +358 20 722 5533

VTT in figures

Internal income statement

	1.1. - 31.12.		
	2011 (M€)	2010 (M€)	Change %
REVENUE	286.5	281.7	2
Turnover	278.5	273.6	2
External revenue	192.6	185.8	4
Revenue, domestic private sector	62.9	66.8	-6
Revenue, domestic public sector	79.5	76.4	4
Revenue from Tekes	55.4	56.2	-1
Other revenues, domestic public sector	24.1	20.2	19
Revenue, foreign private sector	15.9	11.1	43
Revenue, foreign public sector	34.4	31.5	9
Revenue from EU	30.8	27.7	11
Other revenues, foreign public sector	3.6	3.7	-4
Basic governmental funding	86.5	88.1	-2
Turnover adjustment items	-0.6	-0.3	125
Other operating income	8.1	8.1	-1
EXPENSES	279.4	273.6	2
Personnel expenses	160.2	159.4	0
Materials and consumables	15.7	14.6	7
Rents	27.8	26.8	4
Purchases of services	45.9	45.7	0
Other expenses	14.1	12.8	10
Depreciation	14.5	13.5	8
Financial expenses and revenues	0.8	0.9	-2
Extraordinary expenses and revenues	0.3	-0.0	-11 486
RESULT	7.1	8.1	

VTT

Financial information

- turnover 278 M€ (VTT Group 307 M€)
- external revenue 193 M€ (69% of turnover)
- basic governmental funding 87 M€ (31% of turnover)
- revenue from abroad 50 M€ (18% of turnover)

Personnel

- personnel 2,818
- university degree: 79%
- doctors and licentiates: 25%
- 63 persons on assignment abroad
- 252 foreign visiting persons at VTT

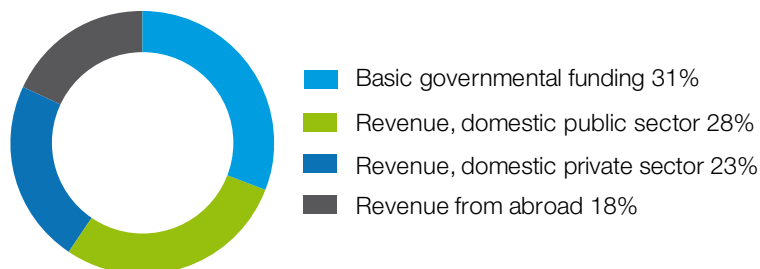
Customers

- 1,520 customers
- 930 domestic companies
- 360 foreign companies
- 230 public organisations in Finland and abroad

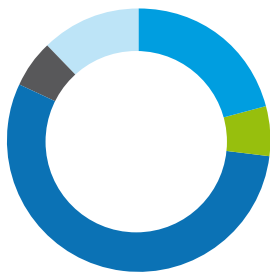
Results

- notifications of inventions 239 and software notifications 32
- over 1,200 patents and patent applications in VTT's patent portfolio
- publications 1,780, of which scientific articles 600 (2010: 560)

Turnover by type of revenue

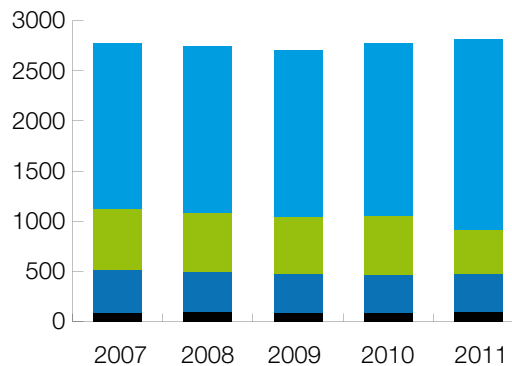


Education of VTT personnel



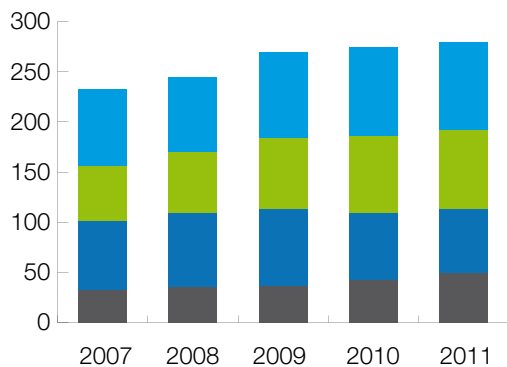
- Doctors 21%
- Licentiates 6%
- Other university level degree 55%
- Lowest level tertiary education 6%
- General and vocational education 12%

Personnel strength and structure



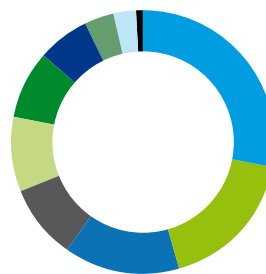
- Research scientists
- Other research staff
- Administration
- Management

Turnover, M€



- Basic governmental funding
- Revenue, domestic public sector
- Revenue, domestic private sector
- Revenue from abroad

Revenue from commercial activities in the domestic private sector (*)



- Energy 28%
- Forest industry 18%
- ICT 14%
- Chemistry and environment 9%
- Machines and vehicles 9%
- Biotechnology, pharmaceuticals and food industries 8%
- Electronics 6%
- Real estate and construction 4%
- Services and logistics 3%
- Metal refining 1%

¹⁾ Classification according to VTT's customer segments.



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Lappeenranta, Kajaani and Raase. VTT also
has regional representatives promoting VTT's
contacts with businesses in their areas.

VTT's offices abroad: Berkeley and Washington
(USA), Shanghai (China), Tokyo (Japan),
St. Petersburg (Russia), Seoul (South Korea),
Brussels (Belgium) and São Paulo (Brazil).

More information on VTT activities and research:

www.vtt.fi

Webversion of VTT Review:

www.vtt.fi/vtt2011

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This review is printed on Galerie Art Silk
printing paper, which has been granted the
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years of technology for business and society

From sawmills to biorefineries
From oil to bioenergy

From radio to smartphones
From computers to ubisociety

Business from technology
From product substitutes to functional foods
From wastewater to sustainable development
From road surfacing to future transport systems
Future well-being through technological innovations

From product substitutes to functional foods
From war indemnity ships to nanomaterials
From wastewater to sustainable development
From hospital technology to molecular diagnostics
From road surfacing to future transport systems
Future well-being through technological innovations

From sawmills to biorefineries
From computers to ubisociety
From oil to bioenergy



VTT – 70 years of technology for
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www.vtt.fi/vtt70years

VTT Technical Research Centre of Finland is the largest multitechnological applied research organisation in Northern Europe. VTT provides high-end technology solutions and innovation services.

From its wide knowledge base, VTT can combine different technologies, create new innovations and a substantial range of world class technologies and applied research services thus improving its clients' competitiveness and competence.

Through its international scientific and technology network, VTT can produce information, upgrade technology knowledge, create business intelligence and value added to its stakeholders. VTT is a non-profit-making research organisation.



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