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Pilot Flagship Initiatives pull-out

Future and Emerging Technologies

Science beyond fiction

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Community Research and Development Information Service

http://cordis.europa.eu

FET researchers: architects of future technology

© European Union, 2010

Neelie Kroes

When we think about the future, we usually think of a brighter, more advanced world. We think about the problems we will have solved and the riches we might have gained. Having spent many years thinking along these lines, it is an exciting privilege for me to introduce you to the people and the research programmes that are helping to make that future possible.

Of course, research is mostly about grinding work and hard choices, but in these pages I hope you find an overview of both the inspiring and practical elements of our research work. Overall, our goal is to make investments that will bring future growth and competitiveness: new ideas, new technologies, and skilled people. To do this we bring together the best scientists, creating a basis of fundamental research across different disciplines which can connect to applied research and deliver the innovations that will improve our lives.

In order to address these challenges, the European Commission's Future and Emerging Technologies (FET) scheme supports long-term ICT programmes under three pillars: the 'Open scheme' is ready to receive any new idea without pre-conceived boundaries and without deadlines; the 'Proactive scheme' spearheads transformative research and supports community-building around a number of fundamental long-term challenges in ICT; and finally, the new 'FET flagships'. They are designed to be true European science partnerships that will cut across different national and European programmes and unite our brightest researchers in the pursuit of ambitious goals at the frontiers of scientific knowledge.

Taken together, the three pillars of FET are key to our future progress. The following pages explain how FET works, from funding for young researchers and high-tech SMEs to a pull-out section on the best proposals for 'FET flagships'.

The one lesson I draw from our FET efforts so far is the value of passion and enthusiasm. When you bring together people who want to change the world — and let them loose with their intellect and creativity — there is no boundary to what can be achieved. Those are the dynamics Europe needs; we can be proud that our taxpayers' money helps to make this happen.

Neelie Kroes
Vice-President of the European Commission
Commissioner for the Digital Agenda

The projects featured in this issue of *research*eu focus* are a select representation of the depth and breadth of research activities underway in this field. For a more detailed picture of the range of FET-Open and FET-Proactive research projects we recommend you visit the links provided on page 39.

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Frequent acronyms

CORDIS	Community Research and Development Information Service
DNA	Deoxyribonucleic acid
ERA	European research area
FET	Future and emerging technologies
FP	Framework Programme of the European Community for research, technological development and demonstration activities
ICT	Information and communications technology
MEMS	Micro-electromechanical systems
QIPC	Quantum information processing and communication
RTD	Research and technological development
R & D	Research and development
SME	Small and medium-sized enterprise
TDCS	Transcranial direct current stimulation
TMS	Transcranial magnetic stimulation

Get your **FET together!**

OPEN AND UPCOMING CALLS …
in the EU Future and Emerging Technologies scheme

- Unconventional computation
- Dynamics of multi-level complex systems
- Minimising energy consumption of computing to the limit
- Quantum ICT
- Fundamentals of collective adaptive systems
- Neuro-bio-inspired systems
- Coordinating communities, identifying new research topics for FET Proactive initiatives and fostering networking of national and regional research programmes
- Challenging current thinking
- High-tech research intensive SMEs in FET research
- FET young explorers
- International cooperation on FET research

More information:
http://cordis.europa.eu/fet

FET: pathfinder of the ICT programme

Future and Emerging Technologies (FET) is the incubator and pathfinder for new ideas and themes for long-term research in the area of information and communication technologies (ICT). Its mission is to promote high-risk research which is offset by potential breakthroughs with high technological or societal impact. The scheme promotes the exploration of radically new ideas and trends for future research and innovation and provides sustained support to emerging areas that require long-term fundamental research. FET targets breakthroughs in ICT that open the way towards radically new forms and uses of information and information technologies. Its mission is to go beyond the conventional boundaries of ICT and venture into uncharted areas, increasingly relying on fresh synergies, cross-pollination and convergence with different scientific disciplines (for instance, biology, chemistry, nanoscience, neuro- and cognitive science, ethology, social science, economics) and with the arts and humanities.

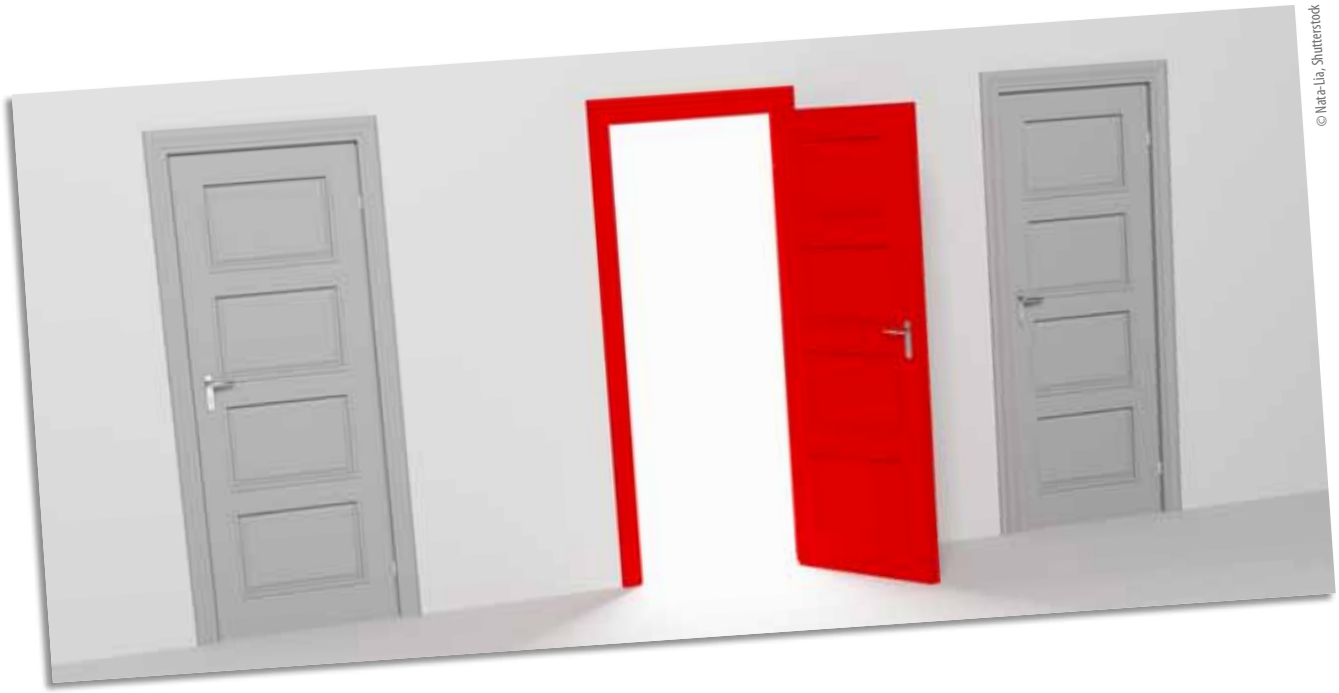
FET schemes

FET is built around two major schemes, Open and Proactive, that together aim at the consolidation of new and emerging foundational trends in future information technologies and their applications, while remaining open and responsive to fresh and unexpected ideas and developments. Another prominent and promising new initiative, also towards the next framework programme, is the **FET Flagship Initiatives.**

- ***FET Open* is a bottom-up approach for exploring promising visionary ideas** that can contribute to challenges of long-term importance for Europe. It flexibly accommodates the exploration of new and alternative ideas, concepts or paradigms that may not be supported elsewhere in the ICT programme. The scheme acts as an easy entry point by being open in terms of themes within ICT and call implementation (continuous and light two-step submission process). In FET Open, 78 projects were selected for a total EC funding of EUR 141 million since the beginning of FP7. The areas addressed by the retained projects reflect the broad coverage of scientific and technological fields relevant to ICT.

- ***FET Proactive* fosters foundational ICT research through a set of topical initiatives** that are defined in wide consultations with research communities. The proactive initiatives are focused on novel and non-conventional topics that aim to spearhead research and support the maturing of new multidisciplinary research communities. Proactive initiatives involve a set of complementary and collaborating projects, supporting the building of new multi-disciplinary research communities and enhancing Europe's innovation potential. In FET Proactive, 14 proactive initiatives have been launched. A total of 83 projects, covered by EC funding of EUR 234 million, are active since the beginning of 2007.

- ***FET Flagship Initiatives* are large-scale, goal-oriented, science-driven research initiatives** putting Europe in the forefront of science, providing a strong and broad basis for future technological innovation and economic exploitation in a variety of areas, as well as novel benefits for society. In 2011, a number of preparatory actions have been launched to prepare the ground for the FET Flagship Initiatives centred around ICT future and emerging technologies. The preparatory work will develop research roadmaps for the flagships, a model for their implementation and initiate the commitments of key stakeholders. The objective is to launch at least 2 flagships by 2013. The funding of these flagships is expected to be up to EUR 100 million per year over a period of up to 10 years.



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There are three additional dimensions to FET:

• ***FET Young Explorers:*** Some of the greatest discoveries and innovations emerge out of an open, free-thinking research environment, where risk-taking and youthful exploration are encouraged, not frowned upon. The FET Young Explorers scheme aims to unlock the vast potential of Europe's young scientists, by capturing their creative potential and fostering their leadership and participation in collaborative research projects.

• ***High-tech Research Intensive SMEs in FET Research:*** This scheme fosters the participation of high-tech and research-intensive SMEs in a driving role in collaborative research projects targeting visionary, multidisciplinary research. This will link novel ideas with marketable ideas, and allow SMEs to establish themselves as future innovation players. SMEs can be the first to crystallise the new and alternative visions for information and communication technologies that will propel them as leading innovators into future markets.

• ***International Cooperation on FET Research:*** Because of its foundational nature, FET research is especially well placed for global collaboration. A new international cooperation scheme provides opportunities to extend running FET projects through new collaboration components involving the best researchers worldwide, so as to create global interest and raise the level of ambition around research avenues conceived within FET.

'The flagship projects will be visionary and highly ambitious, on a scale much larger than FET Proactives. In order to reach the ambitions set, sustainable support is needed for at least 10 years. We envision these flagships to take on grand scientific challenges with huge technological and societal impact. They will align European research priorities at EU and national level, and require annual budgets of up to EUR 100 million per flagship per year. This will be an unprecedented commitment to science-driven, cutting-edge research.'

Wolfgang Boch,
Head of FET Proactive at the European Commission

Young researchers break the scientific mould

Some of the greatest discoveries and innovations emerge out of an open, free-thinking research environment, where risk-taking and youthful exploration are encouraged, not frowned upon. And this is where the FET Young Explorers programme enters the picture, to unlock the vast potential of Europe's young scientists.

Young researchers represent a special group of scientist when it comes to high-risk research. Many young scientists have a natural attitude to think out-of-the-box, and to target frontier challenges. Unbiased by received wisdom, they tend to embrace new trends early and to invest energy in high-risk transformative research

At the same time, they are frequently locked in professional settings that discourage them from taking scientific risks. For many, the only options are to participate in research programmes designed by others, not least to secure those all-important high-impact papers during short-term post-doctoral contracts.

Other young researchers are constrained by traditional, vertical hierarchies where their freedom to explore is frequently severely limited by the local academic culture. Too often, taking scientific risks is tantamount to taking a substantial career risk. Add to this the relative inexperience in the complex grant application procedures, and it is easy to see why so few young researchers are truly in the lead of high-risk research projects.

Yet truly transformational science is likely to emerge only from fresh approaches that challenge established thinking — unlocking this potential of young scientists is the key target of the new pilot call 'FET Young Explorers'.

While current funding through many national and European research programmes frequently pays for these young researchers' salaries, not many funding mechanisms support young researchers in developing their own, independent, high-risk research projects. The FET Young Explorers scheme intends to fill this gap, especially when it comes to conceptually new ideas that cross disciplinary boundaries.

Small teams of young researchers can jointly apply for funding to pay their salaries for typically three years, in order to explore new research domains targeting a concrete and specific breakthrough. In addition, anonymous evaluation of their grant application at the first stage guarantees that the focus is on the quality of the idea.

More information about the scheme can be found:
http://cordis.europa.eu/fp7/ict/fet-open/ye_en.html

NEW FET ACTIVITY: HIGH-TECH SMES

Calling on dynamic SMEs that 'think future'

The European Commission has launched a new scheme within FET for high-tech research-intensive SMEs, designed to help them to turn science into a new technological basis for taking on future and emerging markets.

The current FET work programme in FP7 features a new, continuously open call targeting high-tech and research-intensive SMEs that want to push their own research agenda on future and emerging technologies (FET objective ICT-2011.9.2).

Small and medium-sized enterprises (SMEs) working in high-tech sectors are an essential link between novel ideas from science, on the one hand, and marketable ideas on the other. They can be the first to crystallise the new and alternative visions for information and communication technologies that will in turn propel them as leading innovators into future markets.

Becoming a leading innovator does not happen overnight. The longer-term research and innovation efforts within growing companies are all too often quenched by the inevitable pressures of short-term development and the more immediate need for sales and profit. Also, such companies struggle to expand the research and innovation (R&I) ecosystem within which they operate — crucial to provide vital oxygen in terms of ideas, competences and future market onsets. This is where the new FET-Open track 'High-tech Research-Intensive SME's in FET Research' comes in to help.

High-risk collaborative research in FET projects has proven to be a valuable tool for some high-tech research-intensive SMEs to secure future innovation potential. What the European Commission hopes to achieve is to get more such SMEs to take the lead in setting the research agenda and to be the prime beneficiaries of its outcome, rather than being auxiliaries in consortia that are driven by academics or large enterprises. The new scheme will let them strengthen and diversify their strategic scientific and technological base, positioning them more firmly as future innovation players in an emerging future market.

FET is not looking for short-term commercial outcomes, but as with all of its activities, nurtures the potential for future scientific and technological leadership. This initiative is for the high-tech research-intensive SME that thinks 'future' and needs to absorb new science and technology capabilities to make it happen.

The Commission hopes to see more high-tech and research-intensive SMEs taking the lead in FET research, turning risk-taking into a valuable strategic tool for pioneering future markets. The effect will be win-win: it will also increase the visibility, exposure and impact of FET research and infuse the programme with the sparkling sense of urgency, dynamism and exposure that typifies the trailblazing SMEs that are set to capture the future.

Continuous call for trailblazing SMEs

Are you a high-tech research performing SME with a visionary idea that could be the next big thing for the company, some years down the line? Team up with the best in science and technology to submit your proposal and make it happen. Short five-page proposals to FET are welcome any time.

More info:

http://cordis.europa.eu/fp7/ict/fet-open/high-tech-sme_en.html

Bio-ICT: a match made in, well, … labs

Convergence is a wonderful buzzword among techies. They talk about the convergence of devices, where a camera, mobile phone and PC all get rolled into one. There's the convergence of services, where a company like Google offers you everything from image banks to office software. And now scientists are talking about a bio-ICT convergence. Now that sounds a little scary, but intriguing all-the-same.

When the worlds of biology and computers come together wouldn't you get something like a cyborg? Well, yes, that's exactly what scientists are trying to do, albeit not in quite the same way as the maverick researchers in sci-fi films.

The FET BIO-ICT initiative is breaking new ground in marrying these two disciplines together. In some cases researchers are exploiting our understanding of information processing in biological systems and applying this knowledge to improve technologies, making them more functional, resilient or adaptable. Other teams are working to develop novel ICT technologies, like implants and bio-sensors, which can be naturally combined with biological systems.

The project 'Biomimetic technology for vibrissal active touch' (Biotact) is taking its inspiration from two tiny animals — the Norwegian rat and the Etruscan shrew. Both these species are 'tactile specialists', sweeping their facial whiskers around to explore their environments. The project partners are probing the whisking action of these animals and will then use their findings in a number of ways. Their work is already gaining widespread attention (see box).

First they are designing new computational methods to generate the whisking behaviour of the rodents which scientists have shown are exquisitely modulated by sensory feedback to precisely position the whiskers and maximise information uptake. The project team will then devise information processing mechanisms, also inspired by the neural activity of the animals, to use the tactile information to determine accurately the position, shape and texture of objects. Finally, the researchers want to develop technologies which will be able to track the movement of objects (like the prey of the rat and shrew) using the tactile sense alone.

The project is building two prototype devices to demonstrate their work. The Biotact sensor will be an active array of hundreds of whisker-like sensing hairs which will possess tactile sensing functions far beyond any existing tactile gadget. The second device will be a whiskered robot, which will combine its tactile sensors with artificial intelligence and information processing to seek out, identify, track, and capture fast-moving target objects.

Another project 'Biologically inspired computation for chemical sensing' (Neurochem) tries to mimic the sense of smell rather than touch. 'Biological olfaction outperforms chemical instrumentation in so many ways,' the team explains. This outstanding performance is due to the unique architecture of the olfactory pathway.

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'We will be able to explore how the brain processes information in far higher resolution than has ever been achieved before.'

Cyberrat project

The project partners are working to model the activity of the different components of the olfactory pathway; this model will then be rendered into algorithms, which express the complexity of the biological system as rules and maths. By adding these algorithms to a large-scale chemical sensor array the project hopes to boost the sensitivity and performance of chemical sensing technologies.

The Brain Storm project ('On-chip simultaneous intracellular recording and stimulation of electrical and biochemical activities from hundreds of neurons') meanwhile is working to develop chips which will bridge the gap between electronic and biological signals generated by nerve cells. The idea is to use neuro-electronic hybrid systems for basic research and for achieving direct communication between brains and computers.

Brain Storm participants are combining their expertise in neuroscience, electronics and information processing to build a microchip which can be inserted into cells as a two-way device — sensor for biochemical activity within the cell, but which also stimulates internal cell activity. The chips will be used to record and trigger activity in hundreds of neurons simultaneously. They will have special protrusions or 'micro-nails' extending out of the cells which act as electrodes for taking measurements of internal cell activity or send pulses to stimulate the cells. The protrusions also work as mini-syringes through which drugs or other biochemical agents can be directed into the cells.

The Cyberrat project, meanwhile, seeks to create 'A brain-chip interface for high-resolution bi-directional communication'. In other words, the project is developing a silicon chip which can be inserted in the brain of a rat to measure brain activity, but also stimulate brain cells. 'We will have unprecedented control and visualisation of neuronal activity in a mammalian brain,' notes the project team. 'We will be able to explore how the brain processes information in far higher resolution than has ever been achieved before.' The project is focusing on neuronal circuits which regulate voluntary movement.

The project will have a major and direct impact on basic neuroscience, the burgeoning field of brain-machine interfacing and could lead to new therapies for neurological disorders. The project could contribute to advances in brain-activated prosthetic devices and help to improve therapies such as deep brain stimulation currently used to treat Parkinson's disease and epilepsy.

The 'Self-constructing computing systems' (SECO) project takes another property of living systems — their ability to self-organise — and tries to endow computer technology with this ability. 'As circuits get exponentially smaller and faster, we face exponential increases in their production cost,' notes the project team. 'Current ICT hardware demands extremely low failure rates for individual components, so when industry is fabricating huge circuits, yields are still low.

'But nature has solved these problems. Our neocortex, a cellular computer that generates intelligent behaviour, constructs and configures itself starting from a single precursor cell, using genetic information and interactions with its environment. Understanding this process would revolutionise computer technology.'

The SECO team is combining experimental neuroscience, detailed physical simulation, and theoretical analysis to try and understand the principles by which a population of real or artificial neurons can grow and assemble themselves into functioning circuits. 'We will demonstrate the principles of self-construction for simple neuronal circuits by inserting some genetic code into neuron precursor cells,' the team explains. 'This code will initiate cell development, growth and the formation of connections between them. But we will also apply the same principles to show how you can also build artificial computational circuits.'

More info

For more information on these projects and others like Renachip (see page 14) and Lampetra (see page 37-38) being supported under the EU's 'Future and emerging technologies' programme, consult the websites:
Biotact: www.biotact.org
Neurochem: www.neurochem-project.org
Brain Storm: https://projects.imec.be/brainstorm
Cyberrat: www.cyberrat.eu
SECO: www.seco-project.eu
FET BIO-ICT: http://cordis.europa.eu/fp7/ict/fet-proactive/bioict_en.html

Raunchy rat

Biotact project is reporting high-profile interest in its rat-like sensing technologies. Stories about their work have appeared in such publications as the UK dailies, the *Guardian* and free-press *Metro*, and the frisky rat-bot has even found its way into *Playboy*.

See for yourself: www.biotact.org/index.php/frontpage/media-coverage

Listening lessons

Undoubtedly speech is the method of choice for human communication. You can quickly convey a great quantity of detailed information or add subtleties and depth of meaning to interactions. But computer systems which use speech have one major flaw: they are deaf. Researchers are now using observations of human dialogue to improve the intelligibility of generated speech.

'We regret to inform our passengers,' announces the station tannoy, 'that the express service for bzz bzz due to depart from platform bzz will bzzzzz.'

A groan spreads round the crowd of waiting passengers. 'Was that our train cancelled?' one person asks. 'Am I on the right platform?' another cries out. The public address remains silent.

'When people speak, they also listen,' notes Professor Martin Cooke, coordinator of an EU-funded project called 'The listening talker' (LISTA). 'When machines speak, they do not listen. As a result, there is no guarantee that the intended message is intelligible, appropriate or well-timed. The current generation of speech output technology is deaf, incapable of adapting to the listener's context. It lacks the naturalness that comes from rapid appreciation of the speaker-listener environment.'

LISTA — The listening talker
EU contribution: EUR 1 791 000
Total cost: EUR 2 338 250
Starting date: 1 May 2010
Duration: 36 months
Coordinator: Universidad del Pais Vasco
http://listening-talker.org

LISTA project is developing solutions to these problems and creating the next generation of speech systems (using synthetic, recorded and live sources). The researchers are looking at how, by listening as they talk, people alter what they say and how they say it depending on the background noise in their environment and their interactions with others. They are then using this knowledge to enable speech systems to modify what they deliver.

The current generation of speech output technology is deaf, incapable of adapting to the listener's context.

Studies so far have found that in environments where speakers have to compete with other conversations they modify the rhythm of their speech. Pausing, repeating and elongating sounds makes it is easier for listeners to understand. The researchers on the LISTA project are now discovering what strategies speakers use in different contexts and noise environments.

Studies have also shown that people adjust their speaking style to fit the context; in noisy environments people over-articulate and at other times use more extreme articulations to make themselves better heard and understood. A synthetic speech engine developed by the University of Edinburgh, a project partner, allows articulation to be controlled, and the LISTA team is applying its observations of human behaviour to modify the articulation of speech generated by this technology.

Another strand of the project is showing how it is possible to boost particular frequencies or amplitudes in parts of the speech to make it more intelligible over background noise without having to turn up the overall volume (which typically just leads to distortion and tires out listeners). Using recent models of speech intelligibility, the LISTA team is able to predict the effect of altered speech without testing panels of listeners.

Context-aware speech modifications could help to deliver more comprehensible information to specific listener groups, for example people with hearing impairments or those listening in a second language. The LISTA team hopes to improve the intelligibility of everything from station announcements to satnav directions. Perhaps those poor passengers won't be left stranded and angry for long.

Research finds the right balance

People who have problems with their inner ear find it hard to maintain their balance. Now European scientists are combining cutting-edge micro-sensors and electronics to develop devices for these people. New implants will detect the movements and position of a person and transmit this information directly to nerves in the brain so that the body can keep steady.

Although we take standing up on two legs for granted, there is an awful lot going on in our bodies and brains to stop us tipping over. Subconsciously, the brain is constantly adjusting the tension in our muscles to reposition our bodies so we maintain our equilibrium.

Yet some people have to live with dizziness all the time. Following an infection, head injury or as a symptom of certain diseases, the connection between the inner ear and the neurons that go to the brain can sometimes be disrupted or damaged. People with these problems may find it hard to stand up, have blurred vision or feel they are moving when they are not.

'A closed-loop neural prosthesis for dizziness suppression' (CLONS) is a project creating an artificial inner ear implant that will return balance to people with these vestibular conditions. The device will provide information about the rotation of the head directly to the neurons that connect the inner ear into the brain, using technologies similar to those in cochlear implants.

'There has been significant progress in the implantable hardware including chronically implanted multi-site electrodes. […] The development of external components has also been rigorous. A novel treadmill has been developed which can extensively perturb a patient's balance; thus thoroughly evaluating the capabilities of the prosthetic.'

Journal of Automatic Control, Vol. 20:27-32, 2010

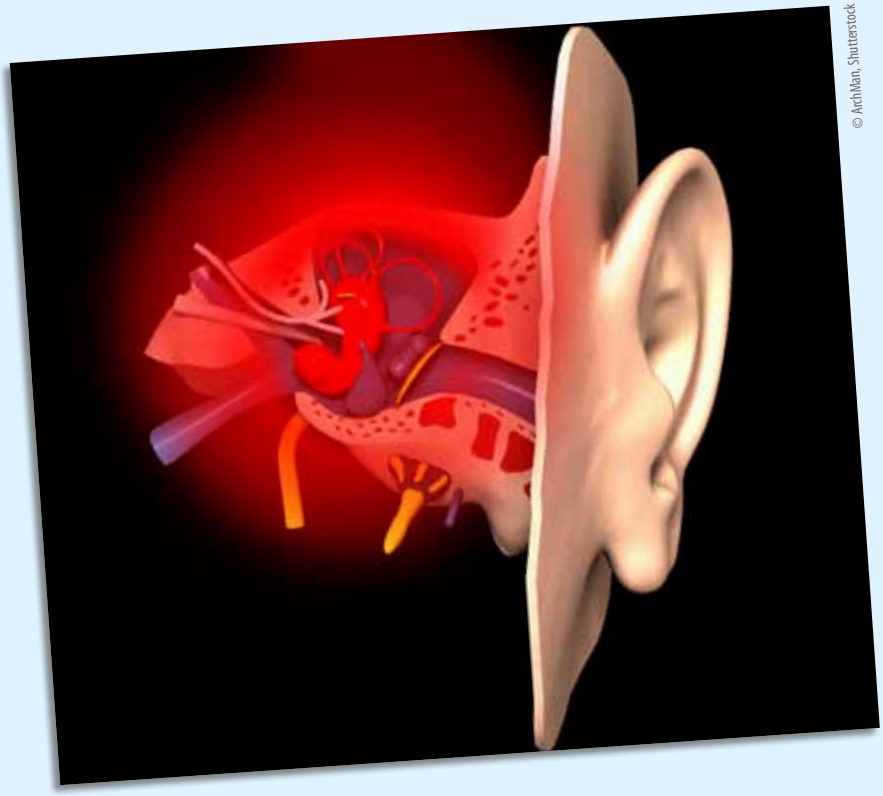
At this prototype stage the neuroprosthetic device will use a head-mounted system that integrates a variety of innovative sensor technologies, for example a micromechanical gyroscope to replicate the inner ear's monitoring of equilibrium and balance.

Signals from the external sensors will be processed using algorithms that have been developed and refined from studies of the vestibular organ so that the information can be relayed to downstream nerves using electrical signals.

An important feature of the device is its so-called closed-loop circuitry, where the sensory information is also used to adjust the performance of the sensors themselves. This kind of feedback mechanism occurs all the time in natural systems to reduce error rates. Before the device can be used in humans it must be 100 % reliable, so the research partners are also developing new technologies to prevent malfunctions. The sudden failure of the power supply, for instance, could have catastrophic consequences if the wearer was driving a car or using machinery and suddenly felt dizzy and collapsed.

Instead of a single, direct power source, the device will use an array of tiny capacitors, each of which supplies a pulse of current at regular intervals. When put together the output from these capacitors can power the device, but the failure of one or two of these components would not stop the implant from working normally.

'This project's outcomes will include increased neuroscientific, clinical, and technological knowledge specifically for the addressing vestibular disorders,' note the project team. It can also contribute to guidelines for developing other bi-directional interfaces and neural prostheses, they conclude.



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CLONS — A closed-loop neural prosthesis for dizziness suppression

EU contribution: EUR 3 329 699
Total cost: EUR 4 340 732
Starting date: 1 January 2009
Duration: 48 months
Coordinator: Scuola Superiore Di Studi Universitari E Di Perfezionamento Sant'anna, Italy
www.clons-project.eu

A new communications medium

Digital displays are everywhere — and European researchers are developing technologies that will enable these displays to be harnessed to form a brand new global communications medium with the same potential impact as the internet.

At the moment most, public displays are used to push adverts to passers-by with the result that we are all getting better at simply ignoring them. The PD-NET project envisages a world in which display networks combine ambient intelligence and electronics wizardry to reflect the hopes, aspirations and interests of the people in the vicinity — adding real value by their presence.

The aims of the project 'Towards future pervasive display networks' (PD-NET) are to explore new ways to link up every public display and to open them up to new interactive content and applications. Not only will public digital displays and advertising screens be interconnected in massive global networks, but the content they show will be interactive and responsive to the local environment and the people passing nearby.

People will even be able to publish innovative new applications to serve their own communities and businesses — and it is this openness that has the potential to truly revolutionise the way we think about public displays. Imagine being able to create your own applications for display networks that you see every day — from practical systems to help in emergency situations such as missing children through to new forms of artistic endeavour — the applications are almost limitless.

'We believe there is a potentially really interesting, under-exploited technology out there … These screens are already part of our lives — we see them everywhere on the underground, at bus stops but there is so much more that we could do with them …[It] would represent a huge shift in the way we think about information dissemination in public spaces.'

PD-NET project leader Nigel Davies
Lancaster University's School of Computing and Communications

The project is at the forefront of the research effort in this domain, identifying the major scientific challenges ahead and assessing new technologies that will enable these large-scale networks and their associated sensors to emerge.

The partners are testing a variety of different technological solutions for a robust platform to link and control displays and their sensors. The open platform will allow all displays — regardless of their manufacturer or owner — to interact and will also allow third parties to create content for these screens, leading to a burgeoning creative market which will hopefully boost growth of this new technology.

One of the biggest features of these displays is their ability to use sensing technologies to interact with people around them and personalise content. It may sound scary, but we are getting quite used to it — internet advertising uses a host of tricks, from cookie tracking to our personal profiles, to determine which advertisements to serve up on our screens. The displays will also take account of where they are located. This is especially important for mobile displays found on buses, cars, trains and the increasing use of personal wearable displays.

The project is keen to ensure this technology gets into the real world, so complementary studies are looking at some of the more social issues that could prevent the expansion and adoption of these displays. The partners are exploring the tensions between privacy and personalisation, acceptable approaches for user interaction and the business and legislative requirements for the successful spread of these displays.

Displays to encourage healthy lifestyles in children

Jack is six years old and participates in his local "walk to school programme" — an initiative aimed at increasing fitness among school children and addressing childhood obesity. To encourage participation among children a simple game has been deployed on the area's public display network. As Jack walks to school he passes a number of public displays. At each display he sees a cartoon character that gives him an update on his own progress and that of his friends. By visiting the displays Jack also collects "golden leaves" on his mobile phone — when he has enough of these leaves his school redeems them for a sticker book corriger.

PD-NET — Towards future pervasive display networks
EU contribution: EUR 1 446 029
Total cost: EUR 1 901 743
Starting date: 1 May 2010
Duration: 30 months
Coordinator: Lancaster University, UK
http://pd-net.org

Truly 'joined up' thinking

The boundary between biology and technology is increasingly blurred. Today artificial implants are connected directly into the brain to restore lost functions including hearing, sight and movements. But European scientists are now taking this approach to new levels: they want to show that implants can also restore our ability to learn.

The elderly often complain that they are losing their memories. And it is a sad truth that parts of our brain begin to lose their function as we age. For example, experiments have shown during the ageing process that we lose our ability to acquire conditioned behaviours due to some dysfunction in the area of the brain called the cerebellum.

Pavlov's famous dogs provided the first demonstration of conditioned behaviour, salivating at the mere sound of a bell because they had learned to associate the sound of the bell with receiving food. Experiments in humans show that the eye blink reflex can also be conditioned. If you sound a particular noise or tone just before sending a puff of air onto someone's eye, the subject soon automatically blinks at the sound of the tone without any physical stimulus.

But while older people can still hear the tone and blink these input and output signals are not 'joined up' by the cerebellum to create the conditioned behaviour or response.

The EU-funded project 'Rehabilitation of a discrete sensory motor learning function by a prosthetic chip' (Renachip) is developing a so-called biomimetic implant which replaces the missing connections in the neural pathway and restores the learning response.

'We believe that the use of biomimetic implants provides a tremendous opportunity to recover function to a range of nervous system deficiencies. Our aim is to create a synthetic biomimetic model of the brain microcircuit associated with the motor eye-blink learning response and to implement this in a microchip. The device will be integrated with an animal model to create a biohybrid in which a lost motor function is replaced.'

Angela Silmon, Newcastle University, INEX

The project focuses on driving technological advances in three areas. First, the team is developing microelectrode arrays that can 'record' what is going on deep in the cerebellum. Data on the activity of this brain region is helping the researchers to build better models of the cerebellum's circuitry and how it is regulated. With these models, the Renachip device can be programmed to stimulate the brain where function has been lost.

Second, the Renachip partners are investigating methods to detect signals related to the stimulus and blink response within the recorded cerebellum physiological data.

And finally, the Renachip device — which is hooked up to electrodes that go deep into the brain — must associate the detected input and output signals and develop the conditioned response. Computer models of the cerebellum's function have demonstrated its ability to learn. The project is turning the models into hardware form.

'This integration of the complete system in a biohybrid is the ultimate goal of the project as it moves into its final year,' notes Angela Silmon, the project's coordinator, in *European Medical Device Technology Magazine* (June 2010). 'These results will put the project firmly on the path to demonstrating the Renachip concept and bringing the prospect of clinical therapy one step closer,' she concludes.

In the future the Renachip could help to restore brain function following a major trauma or stroke or provide a controlled treatment for drug resistant epilepsy.

Renachip — Rehabilitation of a discrete sensory motor learning function by a prosthetic chip
EU contribution: EUR 2 599 917
Total cost: EUR 3 298 360
Starting date: 1 February 2008
Duration: 36 months
Coordinator: The University Of Newcastle Upon Tyne
www.renachip.org

An eye to the future of digital vision

Despite all our technological advances, it is still often hard to beat nature when it comes to solving problems. Now a project is taking its inspiration from the insect world to build a man-made compound eye, designed to detect motion with a high temporal resolution.

Compound eyes are a truly astounding feat of evolution. They appeared on the scene hundreds of millions of years ago and are found today in insects and many other animals. Made up of hundreds or even thousands of individual lenses, compound eyes are perfectly fit for detecting movement: as a predator or prey crosses the eye's field of view its image is progressively picked up by lenses across the eye.

Scientists participating in the 'Curved artificial compound eyes' (Curvace) project have set out to copy the compound eye design. The idea is to build curved arrays of microscopic lenses, with each lens focused onto a photoreceptor. When light passes through a microlens at the right angle it will hit the receptor and trigger an electric signal; the signals coming from the eye can be combined and analysed to provide a stunning level of detail about the movement of objects picked up by the lens.

The researchers are working on a vision sensor that will be well adapted for accurate and fast navigation in three dimensions. Compared to conventional cameras, artificial compound eyes will offer a much larger field of view in a smaller size and weight. The Curvace eye will be able to locate contrasting objects and detect motion with very high accuracy over a wide visual field — the distance between the lens surface and the photoreceptors will indeed be constant over the entire field of view, which is not the case in conventional cameras.

You could stick a tape Curvace for example on the backpack of a child… The 'eye' would be able to detect obstacles in front or the approach of a fast car from the side.

The project partners also want to produce eyes of different shapes, effectively bent to the contours of different surfaces. The project is testing a unique fabrication process in which flat patches of 'eyes' (clusters of lenses and their photoreceptors) will then be flexed, keeping the optics perfectly aligned to maintain the core functionality of the compound structure.

The plan is to construct three eye shapes: cylindrical, spherical and tape (flexible), which could have a wide range of applications. You could stick a tape Curvace for example on the backpack of a child or on the hat of a blind person. The 'eye' would be able to detect obstacles in front or the approach of a fast car from the side.

The testing of prototype Curvace eyes will again take inspiration from nature. The team plans, in particular, to assess the performance and benefits of the eyes for navigation in flying micro-robots and as wearable sensors.

Curvace — Curved artificial compound eyes
EU contribution: EUR 2 090 085
Total cost: EUR 2 726 578
Starting date: 1 October 2009
Duration: 42 months
Coordinator: Ecole Polytechnique Fédérale de Lausanne, Switzerland
www.curvace.org

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No more moods: technology to cheer you up

Computing intelligence is being woven into the fabric of everyday life. As everything gets smart, we will begin to discover that technology may work to actively brighten our mood and reduce our mental stress.

Imagine coming home from work in a rotten mood. But as you walk through the door your hi-fi instantly begins to play. But being smart, it analyses how you react. If you appear to relax, maybe nod along or hum, it automatically turns up the volume. If you show signs of boredom or stress, it switches tracks. It may even dim or brighten the lights or change their colour — light has a big influence on our mood.

The EU-supported 'Responsive flexible collaborating ambient' (Reflect) project is developing the underlying technology that will make our hi-fis and many other everyday objects so clever. Using a variety of external sensors, reflective systems will assess our mood and then behave appropriately, sometimes to fit with our mood and sometimes to change it.

The sensing element of this so-called adaptive technology makes use of numerous psychophysiological characteristics — physical responses of the body which indicate what is going on in a person's head. These characteristics include their facial expression, skin conductance, general muscle tension, heart rate and heart rate variability. Sensors will also take measurements of the physical environment (e.g. ambient temperature) and the movement of the occupant being assessed (the subject).

The smart 'reflective' systems will use all these measures to determine a person's emotional state and their cognitive engagement (e.g. their level of concentration on a task).

The project is seeking to improve the sensor systems. Studies are underway to find strong correlations between the psychophysical and environmental factors and the subject's mood, emotional state and cognitive load. This knowledge is being used to create algorithms that power the reflective functions in a variety of applications.

One of the big tests for the concept is in the so-called reflective car. The idea behind the reflective vehicle is to overcome the potential shortcomings of a solitary driver by providing a friendly co-driver. Its task is to observe the driver and take into account his or her emotional, cognitive and physical states, as well as the vehicular, driving and traffic conditions, in order to optimise the vehicle's configuration and actively participate in the complex process of driving. For example, by changing the choice of music and lighting in the vehicle it can improve the driver's mood, and by eliminating distractions to the driver (blocking incoming telephone calls) or adjusting the cabin temperature or making adjustments to the driver's seat.

[The reflective car's] task is to observe the driver and take into account his or her emotional, cognitive and physical states… For example, by changing the choice of music and lighting in the vehicle it can improve the driver's mood.

The reflective vehicle aims to make driving safer, more pleasant and less stressful — something we can all certainly appreciate.

Reflect — Responsive flexible collaborating ambient
EU contribution: EUR 2 600 000
Total cost: EUR 3 999 961
Starting date: 1 January 2008
Duration: 36 months
Coordinator: Fraunhofer IAF
http://reflect.pst.ifi.lmu.de

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Flying the flag for FET

FET FLAGSHIPS

FET Flagships will be large-scale, science-driven research initiatives targeting visionary scientific goals which may seem fantastic today, but could soon be within our reach. To get there, strategic support is needed for Europe's best scientists to lead the best coordinated research efforts.

Aligned by a shared vision, concerted research like this yields benefits in the short term, but ultimately provides a basis for waves of future technological innovation and economic exploitation across several areas, as well as novel benefits for society.

FET Flagships are envisioned to run for at least 10 years, with a budget of up to EUR 100 million per year, per initiative. This scale can only be achieved through cooperation between the European framework and national research programmes, with participation of global partners and industry. FET Flagships represent a powerful new instrument in shaping and building the European Research Area.

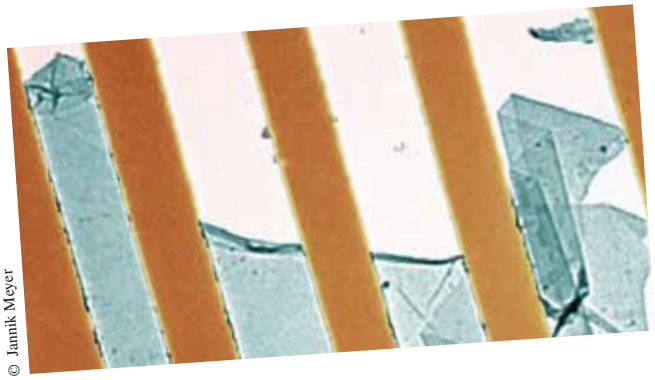
The Commission is launching the programme with six pilot projects which *research*eu focus* introduces in this exclusive pullout.

THE PILOT PHASE

The Flagship concept is still in an embryonic stage. A pilot phase will begin from May 2011 in preparation for the launch of the full initiative to coincide with the start of the Eighth Framework Programme in 2014. The Commission is currently consulting with key stakeholders, including national science research programmes, to define its implementation plan for the FET Flagship Initiatives and outline the research agenda.

Six preparatory Pilot projects will run for 12 months from May 2011. Their main purpose will be to identify and prepare proposals for fully fledged FET Flagship proposals; two of these proposals will be selected for launching in 2013. An additional support action will assist the work of these Pilots, seeking to find efficiencies, helping with administrative tasks, promoting networking opportunities and organising events of shared interest.

OUR CARBON FUTURE 'Graphene-driven revolutions in ICT and beyond' (Graphene)



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WHAT IS THE PROBLEM?

Graphene is a form of pure carbon where the carbon atoms are arranged in large, flat sheets that look like atomic chicken wire. This structure gives it many properties which could be exploited for new types of carbon-based electronics, photonics and quantum computing. But graphene's potential is still poorly understood, and its analysis requires highly sophisticated methods.

THE GRAPHENE SOLUTION?

A Graphene flagship would drive forward the development of graphene electronics, widely recognised throughout the ICT sector as one of the most likely and attractive solutions to sustaining the evolution of ICT devices and technologies beyond the limits achievable with silicon.

By exploiting the unique electrical and optical properties of graphene, the flagship would create novel electronic components with ultra-fast operational speeds and electronic devices with transparent and flexible form factors. The flagship would also investigate fabrication methods and advance cheaper graphene materials which combine structural functions with embedded electronics, in an environmentally sustainable manner.

The future flagship would extend beyond mainstream ICT to incorporate novel sensor applications and composite materials that take advantage of the extraordinary chemical, biological and mechanical properties of graphene.

WHAT CAN EUROPE EXPECT TO GAIN?

Carbon has been the driving force behind several technological revolutions: energy production in the 19th century and plastics in the 20th century. Now carbon promises a third technological revolution, this time in ICT. A Graphene flagship would place Europe's microelectronics industry at the heart of innovation in this sector.

'Graphene is probably the only system where ideas from quantum field theory can lead to patentable innovations.'

Nobel Laureate Frank Wilczek,
the Nobel Symposium on Graphene, May 2010

INFO BOX

Coordinator: Dr Jari Kinaret
Coordinating institute: Department of Applied Physics, School of Physics and Engineering Physics, Chalmers University of Technology, Sweden
Start date (planned): May 2011
Duration of pilot phase: one year

GETTING TO KNOW YOUR GREY MATER
'The human brain project' (HBP)

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WHAT IS THE PROBLEM?

Neuroscience has come a long way in the past three decades, yet the ultimate object of research — the human brain — manages to defy our careful ministrations and attention. With some 50-100 billion neurons, the complexity of our brain continues to largely baffle the research community, which is now turning to the power of ICT as the key to progress.

Supercomputers come in different forms, but they are the largest, fastest or most powerful computers available. Many of today's supercomputing solutions actually cluster or harness the power of numerous computers, linking them together to make them more powerful, so they can tackle data and processing heavy jobs like quantum physics, climate research, genomics and of course brain research.

Only through the incredible capacity of supercomputers to perform billions of simultaneous calculations can brain scientists hope to discover — and then exploit — exactly what goes on inside our heads.

INFO BOX

Coordinator: Professor Henry Markram
Coordinating institute: Brain Mind Institute, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland
Start date (planned): May 2011
Duration of pilot phase: one year

THE HBP SOLUTION?

The proposed HBP flagship intends to build the necessary informatics, modelling and supercomputing infrastructure which will be required to perform unprecedented simulations of the human brain. But this ambitious aim will require a highly interdisciplinary and coordinated research effort. Research will be required in a wide variety of areas including high-performance computing, neuro-morphic computing (emulating brain circuitry to perform complex calculations), brain-machine interfaces and robotics.

The work of these different collaborative groups will be brought together in the proposed Facility for Brain Simulation which will be located at the École Polytechnique Fédérale de Lausanne in Switzerland. This facility will create numerous models based on the work of flagship teams and analyse their output. It will also create and manage an internet-accessible 'simulation cockpit', through which researchers from all over world would be able to conduct *in silico* experiments and interact collaboratively with data, models and simulations.

ICT with only a fraction of [the brain's] capabilities would transform 21st century science, technology and indeed the social fabric.

WHAT CAN EUROPE EXPECT TO GAIN?

The human brain has capabilities unmatched by current computing systems. It is a very fast, massively parallel, distributed machine with negligible energy consumption (just 20-30 watts). It is resilient to damage; it can categorise patterns in rapidly varying noisy data; it can learn and adapt; it can predict the consequences of its own behaviour and that of other intelligent agents; it can think, express itself in language, and understand or learn the language of others.

Information and communications technology with only a fraction of these capabilities would transform 21st century science, technology and indeed the social fabric.

ENTER THE POWER GUARDIANS
'Zero-power intelligent autonomous systems-of-systems' (Guardian Angels)

WHAT IS THE PROBLEM?

We find smart sense and control technologies all around us, from home heating thermostats to active car safety features. Technology plays the role of guardian angel, helping us from our infancy to old age in complex or dangerous situations and environments.

These mostly tiny and embedded sensing, computation and communication technologies are often required to work indefinitely or in portable devices. But a perennial problem raises its head with all electronics: how can we power these little sensors?

THE GUARDIAN ANGEL SOLUTION?

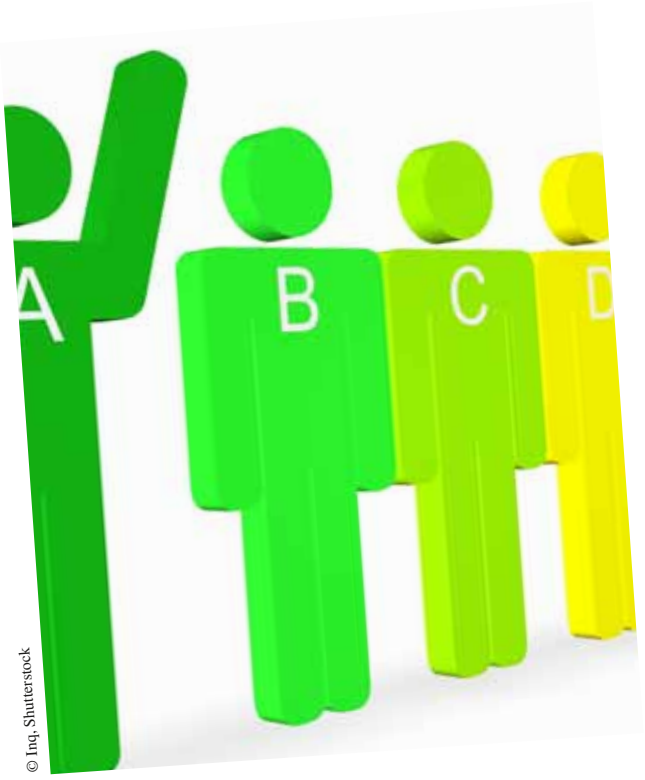
The answer to the big 'power-supply' question is simple. We don't power them. They take care of themselves. Guardian angel technologies must be zero-power. In other words, they must have the ability to extract energy from their immediate environment, wherever they happen to be.

A Guardian Angels flagship would provide the coordination and impetus across Europe for researchers to work together on energy harvesting systems. They would develop disruptive materials and devices to reduce the energy consumption of computational components and also harvest solar and thermal energy and generate power using vibrations and electromagnetic waves.

The scientists would also explore new bio-inspired energy production, for example synthetic photosynthesis. The overarching aim of the flagship would be to create new low-energy nano-electronics and systems which could scavenge energies of tens of mW per cm^2 (or per mm^3), far beyond what has been achieved with today's technologies.

WHAT CAN EUROPE EXPECT TO GAIN?

We are quite used to plugging in our computers, and regularly charging our mobile phones; electronic devices depend largely on traditional electrical



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energy sources, whether supplied by the mains or batteries. There is a huge market for zero-power devices, for portable gadgets, wearable health monitors and critical safety technologies which must have uninterrupted power. The scope of zero-power technology is hard to quantify, but should usher in a new era of autonomous 'guardian angel' systems which will become our revolutionary, smart companions, improving many aspects of our lives: our health, our safety and even our relationships.

There is a huge market for zero-power devices, for portable gadgets, wearable health monitors and critical safety technologies which must have uninterrupted power.

INFO BOX

Coordinator: Prof. Adrian Ionescu
Coordinating institute: Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland
Start date (planned): May 2011
Duration of pilot phase: one year

SOFT, GENTLE AND FRIENDLY ROBOTS
'Robot companions for citizens' (RoboCom)

WHAT IS THE PROBLEM?

Global society is facing many new and critical challenges: the ageing of the population, increasing urbanisation and an urgent need to preserve our environment. But a new generation of robotic technologies can come to the help of humans in all these areas.

This new class of machines — soft, gentle and sentient robot companions — will help us to maintain our quality of life in a changing world. They will work alongside us at home, at work, in factories and hospitals. But before these robots can be given such responsibilities they must acquire the necessary skills to interact with us physically, emotionally, socially, and above all safely.

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THE ROBOCOM SOLUTION?

A RoboCom flagship would bring together scientists from the information, communication and robotics technology communities to combine their expertise and begin to integrate all the components necessary for building safe, interactive robot companions. These novel robots will be ubiquitous and user-friendly, preserving or augmenting human capabilities and experience, extending the active, independent life of citizens, and maintaining our planet.

Robot companions are soft, sentient, predictive and hybrid machines. Their bodies will be made of purpose-designed new materials (such as artificial bio-materials or hybrid materials containing living tissue) which combine solid moving parts with flexible, compliant and self-healing properties. Thanks to research into the human brain and other animals, these robots will also have new levels of perceptual, cognitive, emotive and behavioural capabilities including advanced social intelligence based on internal cognitive models of themselves and of the environment.

Thanks to research into the human brain and other animals, these robots will also have new levels of perceptual, cognitive, emotive and behavioural capabilities…

WHAT CAN EUROPE EXPECT TO GAIN?

These companion robots will help to improve our quality of life and will increasingly become a key enabling technology providing affordable welfare for all citizens, young and old alike. The proposed RoboCom FET flagship will also help to transform the entire robotics industry, creating a completely new generation of real-world technologies employing breakthrough biomimetic, adaptive and self-organising principles thanks to new scientific insights and technological innovations.

Last but not least, the flagship will shift industry from its current information-focused ICT base to a much broader action-oriented information, communication and robotics paradigm.

INFO BOX

Coordinator: Professor Paolo Dario
Coordinating institute: Italian Institute of Technology, Scuola Superiore Sant'Anna (IIT@SSSA), Italy
Start date (planned): May 2011
Duration of pilot phase: one year

YOU, ME AND US — PLUS A GOOD DEAL OF ICT
'The FuturICT knowledge accelerator: creating socially interactive information technologies for a sustainable future' (FuturICT)

WHAT IS THE PROBLEM?

It is easy to believe in the inevitability of advances in ICT. Microchips, mobile phones, the internet all stemmed from research and transformed society. But technology research, development and uptake do not occur in a vacuum. They all occur within a social context, but still little is understood about how society influences the direction and speed of technological change. Today, the ICT industry forges ahead and promises that technology will be at the heart of our future sustainable world. But should we not find out more about how that world may tick?

THE FUTURICT SOLUTION?

One of the greatest challenges for scientists today is to reveal the hidden laws and processes which bind people together and make societies work — at local, national and global scales. For it is only by understanding people and how they interact with one another that we can really get a full sense of the drivers and barriers to scientific and technological developments. Today we hear a lot about the increasing need for more robust, trustworthy and adaptive ICT, but how and where will they work, what does society want out of such advances?

The proposed FuturICT flagship seeks to integrate ICT, 'complexity science' and the social sciences to facilitate a symbiotic co-evolution of ICT and society. Building on the globe-spanning ICT system, FuturICT will establish a 'nervous system' of society providing data to facilitate social awareness and new models of techno-socio-economic systems. In turn, insight from these models will inform the development of a new generation of socially adaptive, self-organised ICT systems.

FuturICT intends to turn the massive quantity of social data into knowledge and technological progress. It will collect and analyse a mass of information from dynamic data sources, ranging from crowd sourced sensor information through digital media, social networks and blogs, to public infrastructure. This data could be used to assess shifts in collective opinions and social attitudes, changes in consumer behaviour, emergence of tensions in communities, demographics, migration, mobility patterns, or health trends.

In particular, the flagship proposes to build a sophisticated social simulation, visualisation and participation platform, known as the Living Earth Platform. This platform will model societies and could be used by policy-makers and citizens, for example to detect and mitigate crises, and identify areas for targeted technological development.

[Living Earth Platform] … will model societies and could be used by policy-makers and citizens, for example to detect and mitigate crises.

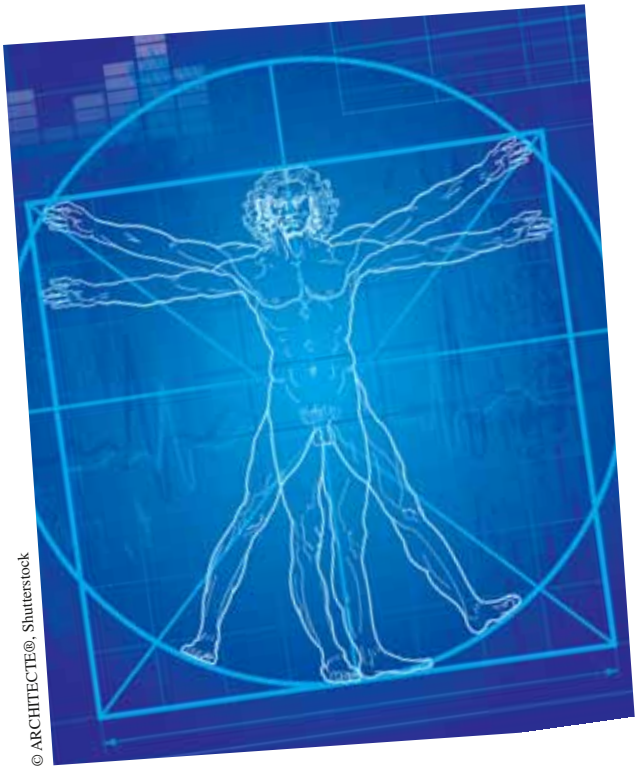
WHAT CAN EUROPE EXPECT TO GAIN?

The FuturICT project would be the first large-scale research project worldwide to foster the scientific and ICT breakthroughs needed to address the challenges of humanity in the 21st century, from financial, economic and social instability to crime and conflict. By creating realistic global-scale simulations and techno-socio-economic models, the flagship would provide an important platform to drive fundamental breakthroughs in the social sciences and economics. For industry, FuturICT would increase the resilience and usability of large-scale ICT systems through socially inspired system engineering and a better understanding of the social context for technological developments. The Living Earth Platform would also be used by public authorities and policy-makers, for example, to predict and prevent crises or test the social and economic effect of policies.

INFO BOX

Coordinator: Professor Steven Bishop
Coordinating institute: Department of Mathematics, University College London
Start date (planned): May 2011
Duration of pilot phase: one year

IT GIVES MEDICINE THE PERSONAL TOUCH
'Modelling in health and medicine' (ITFoM)



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WHAT IS THE PROBLEM?

In the past, advances in ICT were primarily driven by the demands of 'large' physics (like CERN spawning the web) and the need for big business applications including multimedia entertainment platforms. Medicine has greatly benefited from these developments, but only played a minor role in shaping the R&D agenda. But this is about to change; the arrival of new, data-rich, individualised medicine calls for intensive data analysis and modelling technologies likely to surpass the limits of today's ICT capacity — each individual is made up of 100 trillion cells, each containing 30 000 genes. The future of medicine depends on the development of radical new data integration and ICT infrastructures.

INFO BOX

Coordinator: Prof. Hans Lehrach
Coordinating institute: Max Planck Institute for Molecular Genetics, Dept. of Vertebrate Genomics, Germany
Start date (planned): May 2011
Duration of pilot phase: one year

THE ITFOM SOLUTION?

Europe needs to set the stage for this information-focused medicine of the future. The ITFoM flagship would develop novel workflows and ICT architectures that would make all relevant genomic and clinical information accessible to the patient and their doctor along with imaging, pathological, environmental and individual patient histories. These zetabytes of data would then enable better medical understanding by revealing pathological patterns, and would power individualised patient models to help doctors deliver better diagnoses and treatment.

A key challenge in this process will be to develop and deploy standardised interfaces for different data sets and suppliers, as well as sophisticated modelling tools. An important task for ITFoM would be to generate procedures to facilitate data integration and data access via the web or specialised networks. Researchers also need to find new ways to handle the massive data files that individualised medicine will soon generate (an entire human genome, which could soon be sequenced in just a few hours, is about six gigabytes of data).

An entire human genome, which could soon be sequenced in just a few hours, is about six gigabytes of data.

WHAT CAN EUROPE EXPECT TO GAIN?

We are entering a new era of medicine and with the supporting ICT systems, citizens will benefit from bespoke treatments and regimes, optimised to fit their individual metabolism, environment and genetic make-up. This new information-intensive healthcare will offer more specific and better tested treatment, enable preventive medicine, and improve clinical outcomes whilst reducing the costs of medical treatments. Furthermore, the technological advances required for individualised medicine will increasingly influence the wider ICT field and benefit many other areas.

FET Flagships

IN A NUTSHELL

In essence FET Flagships will take some of the best in FET research and take it further, going far beyond the typical 5-10 year perspective of the FP7 ICT work programme.

Of course, the ambitious goals and scale of the Flagships will only be achieved through close collaboration between a large number of leading researchers gathered together from across Europe and beyond, all working towards a shared goal. Such long-term initiatives require a federated effort from all key stakeholders. The massive funding requirements, for example, will be accomplished by combining existing and new European and national resources and industrial funding to create critical mass.

MORE ON FLAGSHIPS:

The Flagship programme: http://cordis.europa.eu/fp7/ict/programme/fet/flagship

Flagship brochure: http://cordis.europa.eu/fp7/ict/fet-proactive/docs/flagshipcons09-02_en.pdf

FLEET OF FOOT

FLEET is a 30-month horizontal action supporting the FET Flagships' set-up phase. It will assist Flagship Pilots in designing efficient policies and programmes, as well as with instrumental and funding dimensions.

FLEET is coordinated by eutema from Austria and includes experts in industrial and research programming policies. Building on previous knowledge acquired in an extensive study on the FET Flagships, the team has identified various practical challenges that the Pilots are likely to face. FLEET will thus provide information on 'lessons learnt' from previous initiatives of similar size and comparable scope and help to avoid redundancies between pilots — creating effective implementation processes, identifying suitable legal instruments, and highlighting the benefits of joint effort for stakeholders in order to achieve the highest impact on emerging technologies in Europe.

MORE ON FLEET:

www.fet-f.eu

Post, don't publish

For centuries researchers have spread their knowledge and shared ideas by writing scientific papers. Now a European project advocates a new model for science communication which exploits the power of social networks.

You would be forgiven for thinking that scientists spend most of their time in the lab doing research. But they don't. More often than not you will find them at computers writing papers, or sitting next to piles of journals trying to catch up on the latest findings.

'The more papers you produce, the more brownie points you get,' says Fabio Casati of the University of Trento, Italy. 'So most of your time is spent writing papers instead of thinking or doing science.'

But the current dissemination model is highly inefficient because peer review performs poorly in selecting 'good' papers and because the credit attribution system pushes scientists to write numerous papers. The very same credit metrics, based on citations, have also been shown to be flawed.

The EU-funded 'LiquidPublication: Innovating the scientific knowledge object lifecycle' project offers an alternative. The idea is to replace traditional peer reviews, citation-based metrics and paper publications with a faster, fairer and more flexible process. To do this, the team harnessed the power of the web, including its ability to speed up communication, facilitate data storage, search and retrieval, and foster communities of interest.

Following the lead of physicists and mathematicians who for years have been posting early versions of their papers on a website called arXiv.com for quick dissemination and peer critiques, the project is encouraging all scientists to jumpstart the dissemination of their findings by posting them on the web. Every research group can easily create its own 'liquid publication' which collates any relevant published research, datasets, experimental protocols and even blogs generated by the group or other researchers in the field. A set of applications facilitates the construction of this 'web of scientific resources' by making it convenient for scientists to create liquid publications for the purpose of collecting, organising, discussing, and sharing knowledge with their colleagues.

Readers of liquid publications can then add comments, tag and analyse the data themselves and indicate links between papers. And through these interactions publications will be updated and refined. The dissemination function of journals is therefore carried out by 'sharing' rather than 'publishing'.

But what about quality control which should block sloppy work?

'We've studied this and found that peer review doesn't work, in the sense that there seems to be very little correlation between the judgement of peer reviewers and the fate of a paper after publication,' says Mr Casati, LiquidPublication's coordinator. 'Many papers get very high marks from their peer reviewers but have little effect on the field. And on the other hand, many papers get average ratings but have a big impact.'

Mr Casati and the LiquidPublication team suggest replacing peer review with the implicit assessment given by the relevant community, the 'crowd', while sharing and tagging liquid publications. This mimics the way most of us discover knowledge today: via colleagues pointing out contributions and commenting on why they are interesting.

The consortium is putting its ideas into practice, starting with an open source software platform and applications that facilitate the collection, discussion, sharing and assessment of knowledge, such as inter-disciplines, instant communities, liquid journals, and liquid books.

If LiquidPublication can make scientists' work even 10 % more efficient the team believes that is a huge benefit to the scientific community.

LiquidPublication — Liquid-Publication: Innovating the scientific knowledge object lifecycle
EU contribution: EUR 1 603 939
Total cost: EUR 2 170 150
Starting date: 1 May 2008
Duration: 36 months
Coordinator: Universita Degli Studi Di Trento
http://project.liquidpub.org

New lease of life for chemistry

Biochemists have an amazing capacity to compress the wonder of life into a bunch of chemical equations. Respiration boils down to the Krebs cycle, our nerve impulses become nothing more than the passage of sodium and potassium across cell membranes.

But when you look at life this way, as a set of chemical steps, you begin to wonder: could biochemistry provide the basis for a radical new kind of information processing? Today computers handle bits of data, using electrons to represent the ones and zeros of binary digits. Could information also be represented by molecules and be processed and manipulated down different chemical pathways?

The FET's 'Bio-chemistry based information technology' (CHEM-IT) programme is supporting this burgeoning 'chemistry meets ICT' field. It is laying the foundations for a radically new kind of information processing technology inspired by chemical processes in living systems.

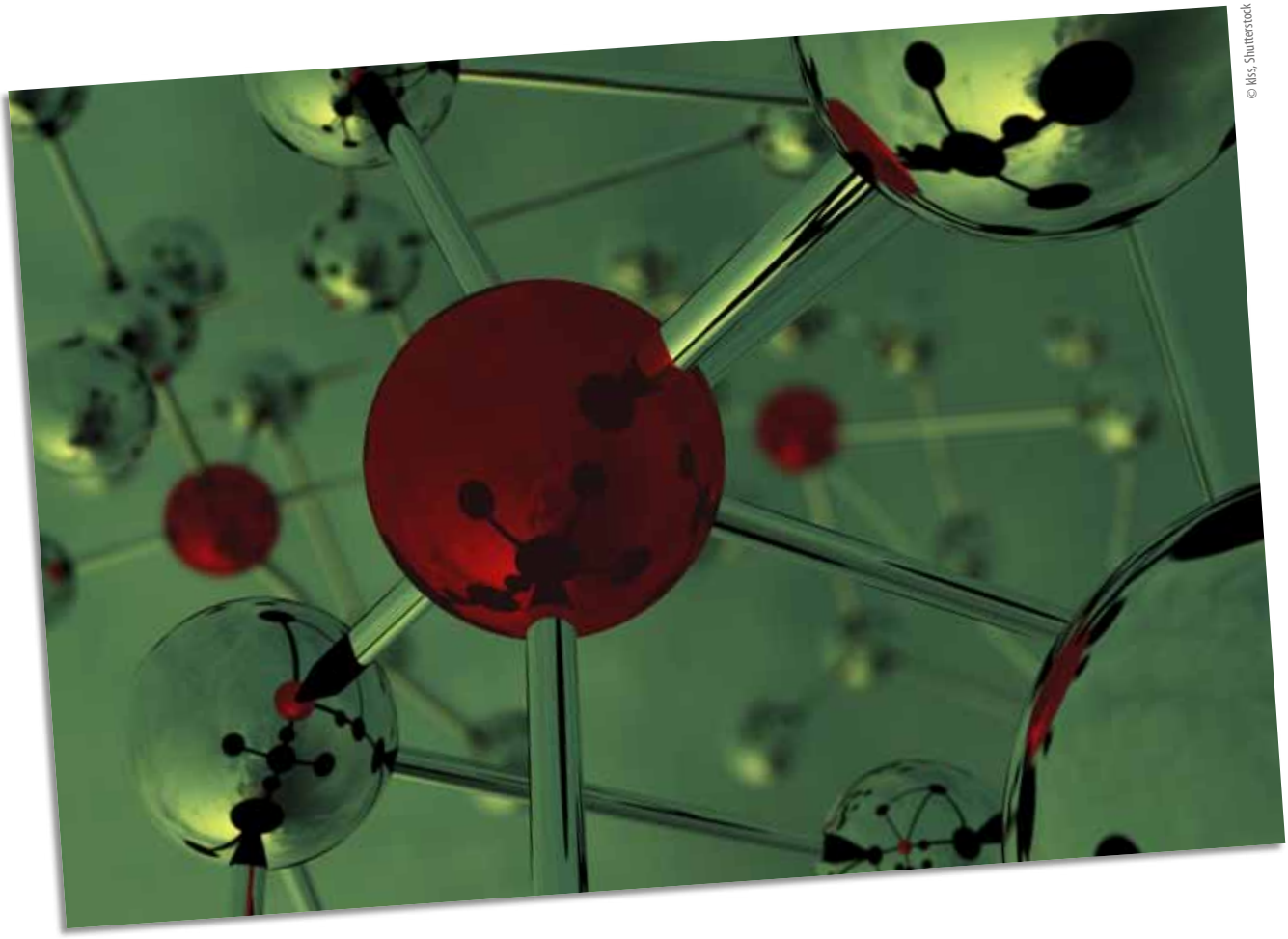
This new application of ICT, perhaps best described as chemical computation, will have several advantages over existing silicon-based electronics. For example, the simultaneous processing of molecular signals in different chemical pathways effectively opens the door to new levels of parallel processing. Biological systems also have an amazing ability to adapt, evolve and reconfigure themselves in response to changing conditions.

Over the past decade or so, biochemists have managed to construct their own sets of chemical processes that mimic the biochemistry of living organisms. But just like life in the real world, even these simple artificial systems end up being extremely complex; scientists are struggling to control and direct these reactions, let alone analyse what is going on at a molecular level.

So biochemists must rely on conventional ICT before they can create anything resembling functional chemical computation. With the development of technologies such as micro-electromechanical systems (MEMS), researchers are at last beginning to bridge the gap between their 'wet' chemistry and ICT and find ways to regulate their chemical calculators into true 'wet computers'.

The 'Matrix for chemical IT' (Matchit) project, for example, is building molecular-scale containers which could be used like mini-reaction vessels. These 'chemtainers' will be made of self-assembling small droplets which enclose chemical reactions and move through tiny channels etched into a silicon chip. The outside of these containers will be labelled with DNA; the sequence of the DNA, like an address on an envelope, will direct the movement and interactions of the droplets with each other and thus the sequence of chemical reactions that may take place.

The Matchit system will imitate internal functions of a biological cell, namely information processing, self-programming, self-repair, self-assembly and self-replication. The system can even make its own decisions — just like a biological cell operates as a combined information processing and production machine, identifying and creating what is needed.



Another project, 'Artificial wet neuronal networks from compartmentalised excitable chemical media' (Neuneu), is also using droplet containers, this time to try and create artificial networks of reaction vessels. Each component will crudely resemble biological neurons and be capable of excitation and self-repair. These basic 'neurons' will also be connected to one another to form small devices, perhaps capable of very simple calculations.

'This ambitious collaboration among computer-scientists, biophysicists, chemical-physicists, biochemists, chemical-biologists, and electrical engineers will develop the core science needed to build a future massively parallel computing infrastructure,' says the Matchit team. 'We are working to deliver prototype devices, and pave the way to harnessing bio- and nano-materials for a novel approach to cognitive computing.'

The project 'Bacterial computing with engineered populations' (Bactocom) aims to build a simple 'wet' computer out of bacteria. Living bacteria already possess all the necessary traits for computation — sensing, processing information and responding and interacting. The trick is to get them to respond in a defined and programmable fashion.

Scientists hope to pull this off by altering the bacterial cell's internal 'program', encoded by its genes. By introducing artificial 'circuits' made up of genetic components, the project is adding new behaviours and modifying existing functionality within the cell.

Living technology

'The technology we're developing is different from anything we know today,' remarks Professor Steen Rasmussen from the University of Southern Denmark, project coordinator for Matchit which is developing a system that will imitate the internal functions of a biological cell.

'It will be based on the same principles as life. If your mobile phone breaks, somebody needs to fix it. But if you cut your hand, it heals itself. Living technology has potential applications in all sectors of our society and therefore has the potential to change how we live. The possibilities are endless — both beautiful and scary.'

Bactocom will then harness the natural evolution of bacteria to improve on their work. 'We begin with a large number of simple DNA-based components, taken from a well-understood toolbox, which may be pieced together inside the cell to form new genetic programs,' explains the research team. 'A population of bacteria then absorbs these components, which may (or may not) affect their behaviour.

'The better bacteria are allowed to release their program components back into the environment in much larger numbers than the other, less impressive cells. As these "good" components are then increasingly taken up by the population of cells, in a continual cycle, we gradually refine the internal program, until the whole population performs well.'

There are many potential benefits to this work, from both a biological and ICT perspective. By 'evolving' new functional structures, the team gains insight into biological systems which inform new methods for silicon-based computing — in the way that both evolution and the brain have already done.

'In building these new bio-devices, we offer a new type of programmable, microscopic information processor that will find applications in areas as diverse as environmental sensing and clean-up, medical diagnostics and therapeutics, energy and security,' the team suggests.

More info

For more information on these projects and others in the FET's CHEMI-IT programme, consult the websites:
Matchit: http://fp7-matchit.eu
Neuneu: http://neu-n.eu
Bactocom: www.bactocom.eu
FET CHEM-IT: http://cordis.europa.eu/fp7/ict/fet-proactive/chemit_en.html

Carbon nanotubes: a matter of mats

As our demand for miniaturised electronics continues unabated, scientists are on the lookout for new materials which will let them shrink microchips down to the nano-scale. Tiny tubes of carbon are attracting a lot of attention, but more research is needed to improve their performance and find more economical methods for their mass production.

Carbon nanotubes are basically made up of flat sheets of carbon atoms rolled up into cylinders that can measure as little as just a couple of nanometres in diameter.

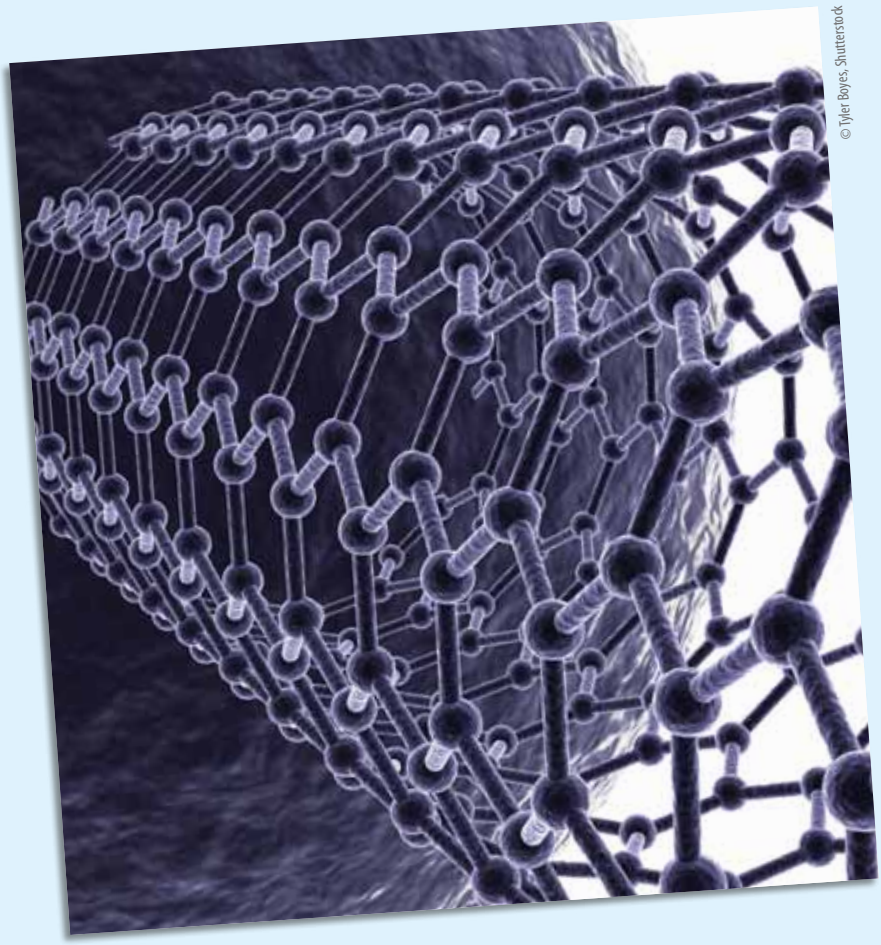
As carbon molecules, the nanotubes have unique electrical properties and scientists are getting increasingly excited about their potential to replace today's copper interconnects in microchips, helping to shrink the size of components yet further. Carbon nanotubes can carry a much higher density of current and have better thermal conductivity than copper wires.

However, to really compete with copper, you need to form each interconnect from a large number of nanotubes, bundled together, as it were, to form a tightly packed nanotube wire.

The EU-funded 'Carbon nanotubes for interconnects and switches' (Viacarbon) project has ambitions to advance nanotube production techniques so they can move out of the lab and become a stock material for the semiconductor industry.

Project partners from France, Ireland and the United Kingdom have worked together to find new ways to 'grow' carbon nanotubes in high density mats — around 10 000 billion tubes per square centimetre — and in such a way that is compatible with the requirements and existing fabrication methods of industry.

Viacarbon has achieved the highest densities of carbon nanotube grown by any research group in the world, beating the previous record set by scientists from Fujitsu in 2009.



© Tyler Boyes, Shutterstock

Viacarbon — Carbon nanotubes for interconnects and switches
EU contribution: EUR 2 530 000
Total cost: EUR 3 519 200
Starting date: 1 January 2008
Duration: 36 months
Coordinator: University of Cambridge
www.viacarbon.eu

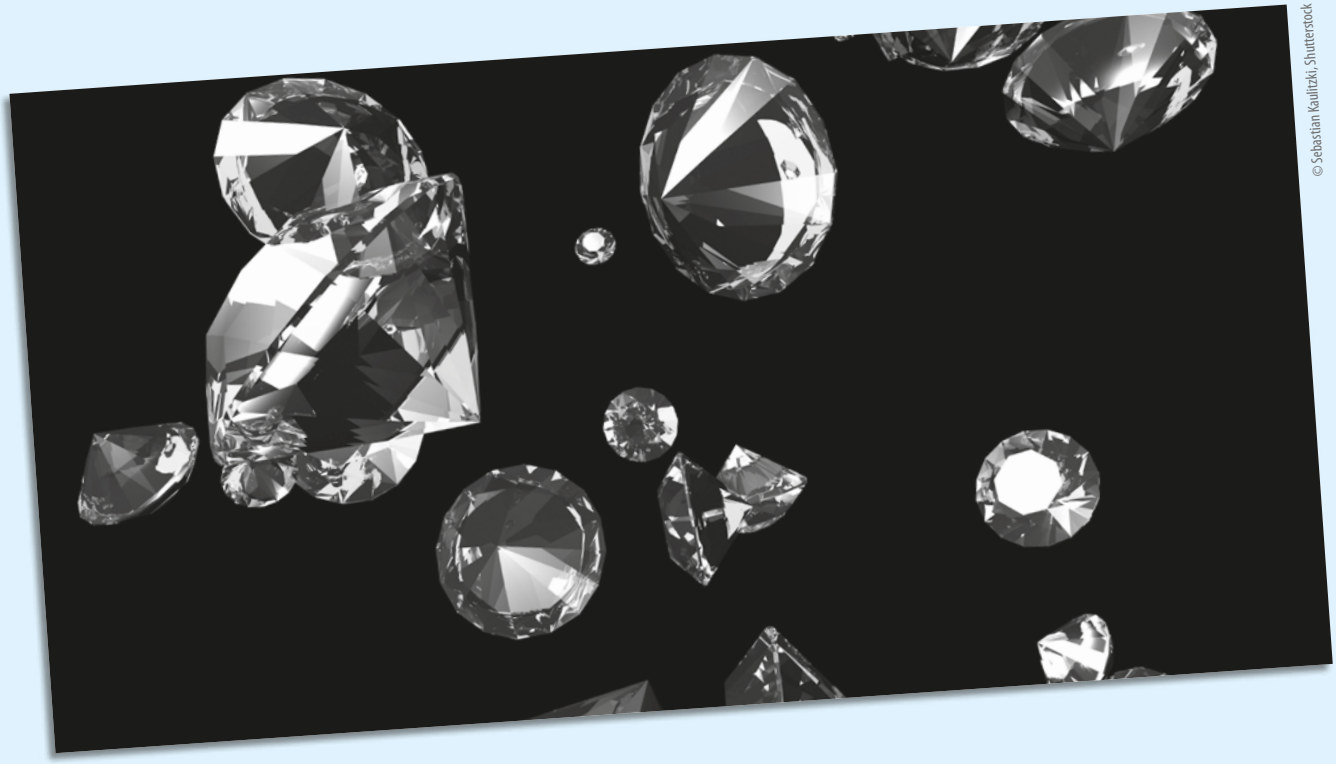
The project has been successful in refining a method by which the nanotubes are anchored onto an aluminium-copper electrode embedded into a silicon wafer and made to grow out from a small hole where they can be topped by a second electrode, thereby forming the interconnect (known as a 'via') between the two electrodes.

A densification process using the chemical isopropanol effectively squashes all the nanotubes grown in a hole, turning them into a tight bundle. These have the highest nanotube densities achieved by any research group in the world, beating the previous record set by scientists from Fujitsu in 2009.

Studies have also shown that the contact between the bottom aluminium-copper electrode and the carbon nanotube bundle is very low, making them highly efficient and producing little energy loss.

A second arm of the project has used similar techniques to grow horizontal nanotube mats to make a nano-electromechanical switch. The nanotubes are held between aluminium oxide-iron at one end and a platinum electrode at the other. The nanotubes have just enough flexibility to physically bend and so can function like a nano-scale electrical component called a bi-stable latch with an on and off position.

Viacarbon has made a significant leap forward in the integrated production of carbon nanotubes in semiconductor components. Thanks to its work, European science is getting close to meeting the specifications for carbon nanotube interconnects set out by the International Technology Roadmap for Semiconductors.



Jewel in the crown for quantum computing

The FET programme is investing heavily in projects that are pushing towards the next big ICT revolution: quantum computing. In a major breakthrough, a European-funded collaboration has successfully grown a pure crystal of diamond which, operating at room temperature, possesses all the properties required to control and read data in a quantum machine.

Diamond-based quantum computers use electrons to store data bits, and photons (individual packets of light) to read and control the data bits. Diamond has been identified as a promising candidate for solid-state quantum computing; unlike other approaches which generally require complex and expensive cooling systems, diamond can operate at room temperature.

The project 'Engineered quantum information in nanostructured diamond' (Equind) was established to investigate the special optical features of diamond that make it so attractive for quantum processing.

Using a proprietary technique, the project partner Element Six, has used chemical vapour deposition to make single crystals of ultra-high purity diamond which contain carefully engineered nano-scale structures and less than 0.3 % of the carbon isotope C-13 which disrupts the quantum properties of the diamond lattice. These designer crystals can be used to develop structures with the unique properties demanded by quantum computing.

One of the most exciting properties of these quantum-grade diamonds is their long 'coherence time', the length that single electron spins remain in phase. It is important that electrons retain their quantum information (direction of spin) long enough to make computational calculations. The diamond crystals developed by the Equind project diphase after about 1.8 ms, the longest ever observed in a solid-state system at room temperature.

With these crystals we have been able to control and read information as needed for a practical computer.'

Equind press release

'With these crystals we have been able to control and read information as needed for a practical computer,' note the researchers in a statement about this breakthrough. 'We believe that we can scale it up to what we call "a register", the basic computing heart of a conventional computer used to store and manipulate information.'

The work of Equind and other FET projects like AQUTE (see page 31) and Corner (page 30) in this field could pave the way for novel computer designs based on quantum mechanics, which govern the behaviour of energy and matter at the atomic scale. If successful, it could lead to significantly faster computers which could be particularly good at cracking complex codes, searching through large databases and working with complex modelling problems.

Equind — Engineered quantum Information in nanostructured diamond
EU contribution: EUR 1 660 000
Total cost: EUR 2 130 000
Starting date: 1 January 2007
Duration: 36 months
Coordinator: École Normale Supérieure de Cachan
www.equind.org

When every noise appals me

Noise is never good, but quantum systems are particularly susceptible to even the tiniest disturbances in the environment. Now a team of European researchers hope to identify correlations between different noise-induced errors in quantum systems and develop new ways for counteracting the problem. Improvements in error handling should help to move quantum computing from the theoretical world of simulations to real-world hardware.

'It is a tale, Told by an idiot, full of sound and fury, Signifying nothing,' according to Shakespeare's Macbeth. Of course Shakespeare was speaking about the brevity of life, but his words apply equally to noise in a signal.

A signal — any signal — inevitably has some noise, a degree of imprecision that carries no information, literally signifying nothing, and even confusing the underlying data. Most of the time engineers work very hard to ensure a high signal to noise ratio — lots of signal for very little noise.

But when you get down to the microcosm of the quantum world, the problem of noise gets even worse. Here the laws of probability rule; it is all too easy to end up with nonsense.

'The progress of the quantum information revolution is facing one major obstacle: quantum systems tend to be very susceptible to "noise" — unwanted and uncontrolled disturbances from their environment,' explain researchers who want to tackle this problem. 'To make further advances we need to either fight this "quantum noise" effectively or design efficient schemes that can tolerate or perhaps even be assisted by the noise present.'

The 'Correlated noise errors in quantum information processing' (Corner) project is taking a comprehensive look at the many different steps involved in quantum systems in an attempt to understand more about how the presence of noise may be linked across a system.

'We are paying particular attention to a previously unexplored area: correlated noise errors that commonly arise in space and/or time, especially in large-scale operations,' the partners explain.

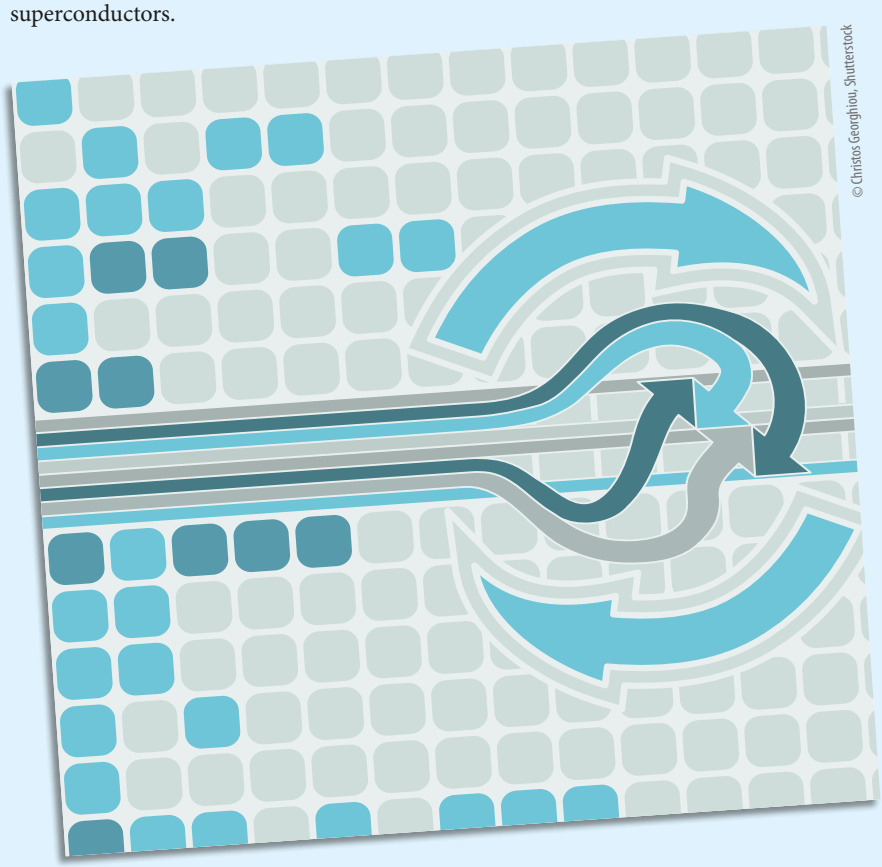
Current quantum noise models typically treat each error in a quantum system as a statistically independent event. But Corner is seeing how errors may be related to one another, as is obviously the case when you look at real-world systems.

The project is combining theoretical and experimental approaches, exploring a number of different elements of a quantum systems including quantum communication channels (how quantum information is passed around), different coding and decoding methods and quantum memory technologies. The group also hopes to refine methods for estimating correlated noise effects in these systems.

Much of the work on quantum computing is still very much at a theoretical level. Corner hopes that its work to solve the problems of noise inherent in any quantum system will help scientists to build real-world physical quantum computing platforms including secret communication, enhanced precision instruments and a greater ability to model and understand exotic materials such as superconductors.

Indeed, the scope of Corner's research programme would have pleased even the notably ambitious Macbeth, who laments: 'How is't with me, when every noise appals me?'

Corner — Correlated noise errors in quantum information processing
EU contribution: EUR 2 086 998
Total cost: EUR 2 734 206
Starting date: 1 July 2008
Duration: 36 months
Coordinator: Uniwersytet Mikolaja Kopernika W Toruniu, Poland
http://corner.fizyka.umk.pl



The quantum combo

Combined with the achievements of other EU-funded projects in the quantum field, such as Equind and AQUTE (see pages 29 and 31), Europe has earned its place at the forefront of the 'Quantum information processing and communication' (QIPC) field.

Spooky computers on their way?

A large-scale integrated project is developing several state-of-the-art atom and ion chips, which use the counterintuitive laws of quantum physics for secret communication, lightening-fast data processing and extremely accurate measurements. And all this thanks to the laws of Nature, allowing atomic particles to be quantum-correlated in two places at the same time. We report rapid progress using modern microchip devices for such quantum processors.

'Atomic quantum technologies' (AQUTE) is a large-scale integrated project involving 19 partners from across Europe, Australia, Singapore and the United States. The project is working to develop quantum technologies based on atomic, molecular and optical systems, including quantum processing chips which could be integrated into the first functional quantum computers.

The project is also pursuing entanglement-enabled technologies, which exploit a quantum property of particle pairs. Using entanglement, you can measure the state of one particle and immediately determine the state of its pair. This property, described by Einstein as 'spooky action at a distance', promises high importance for secret communication far beyond the possibilities of today.

Project partners are making great advances in many related areas of this exciting new field. For example, one team has worked on techniques that could one day be used to improve digital encryption, make computer security virtually 'uncrackable' and help networking between future quantum computers. And they are well on their way.

They have already created a system that can produce verifiably random keys for (quantum) encryption. The researchers used Bell's test to study entangled pairs of atoms — the atoms collapse into a random state that only the information sender/receiver know. Any attempts to intercept the communication can be detected. For this to work, the team had to trap the ions, separate them in space and perfectly record the atomic collapse. Over months, the researchers measured thousands of entangled pairs this way, producing a random sequence of 42 binary digits.

AQUTE — Atomic quantum technologies
EU contribution: EUR 5 300 000
Total cost: EUR 8 653 301
Starting date: 1 February 2010
Duration: 36 months
Coordinator: Universitaet Ulm
http://qurope.eu/projects/aqute/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Flagchip box
Visit the Qurope site for the latest developments in 'Quantum information entanglement-enabled technologies' (QUIE2T). Also on the site, you can see highlights — a small video and the accompanying poster — of AQUTE's so-called flagchip box, described as a 'wondrous box containing the state-of-the-art atomic chips that have been displayed in several ICT events', the latest being ICT 2010 in Brussels.

The site: http://qurope.eu/projects/aqute/aqute-flagchip-box

In a striking example of quantum metrology, entanglement is also being exploited to significantly (by up to 85 %) trim the 'noise' affecting the accuracy and performance of today's classic atomic clocks. By trapping super-cooled atoms within a 'chip trap' made up of gold structures much finer than the width of a hair, researchers managed to strengthen the proportion of collisions between atoms such that they get quantum entangled with each other.

Such groundbreaking quantum systems developed by the project come in micro-structured and thus scalable quantum chip devices — known as the 'AQUTE Flagchips' (see box for examples) and have been displayed and presented at several conferences and events. The success of the wide-ranging research is also evident from the number of papers that partners have had published in top scientific publications including *Physical Review Letters, Nature and Science*.

Other quantum research in this issue of *research*eu focus* can be found on page 29 (Equind project) and page 30 (Corner project).

Supermodels: the latest fashion in climate change research

In the past decade almost every country in Europe has seen weather records smashed. We've had the hottest-ever summers, the coldest-ever winters, record snowfall, record floods. Enough to convince you of climate change? Perhaps, but meteorologists prefer more scientific proof.

Scientists do not have crystal balls through which they can peer into the mists of time and catch glimpses of our future. However, they do have access to extremely powerful computers and when it comes to predicting the future, nothing beats a good computer model.

Meteorologists use computer modelling simulations all the time. Computers iteratively churn through large sets of data, calculating values according to the rules of whatever weather or climate model being used. Daily weather forecasts and 50-year climate predictions are both based on scientific models of how we think the weather and climate work.

But all computer climate models, by their very nature, are not perfect. Different models make different assumptions and simplifications; they use different sets of parameters and starting values. And that means you get some very different answers.

So which model is most accurate or reliable? Big international decisions are being made on the basis of the predictions from these models; so it is crucial to get this right.

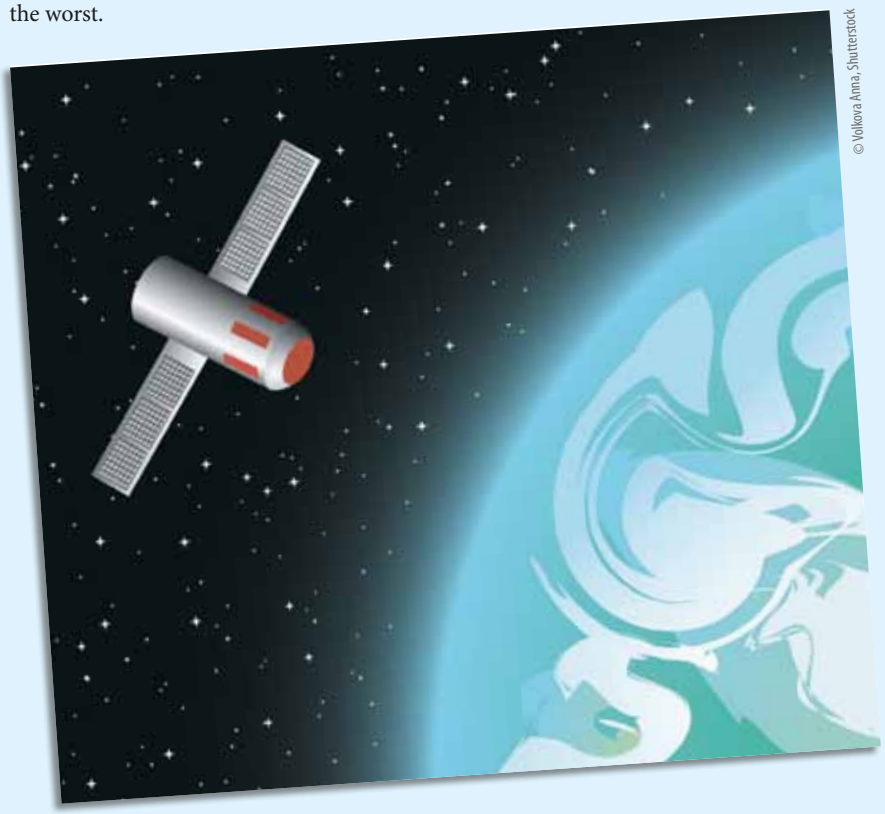
The premise of the EU-funded 'Supermodeling by combining imperfect models' (SUMO) project is that every imperfect model has something to contribute to the debate. So the project set out to combine them all into what can only be described as a 'supermodel'. The idea is that all the climate models can be interconnected; the output from one can contribute input to another.

Using artificial intelligence or 'machine learning' SUMO's supermodel is also likely to learn the strengths of each model and how to use them effectively.

The project is therefore testing the feasibility of this approach and showing that the output of supermodels can be superior to that of any component models. It should also be superior to the results obtained by just averaging the outputs of the individual models. The method might be compared to a group of scientists engaging in dialogue, instead of just voting or averaging their predictions.
The idea came to the project partners to build this supermodel from three climate models and 'train it' using climate data from 1870 to 1980. Once fully trained it can be used to run simulations which generate climate data for the period 1980-2010. The supermodel's output can then be compared with the real-world recorded figures for this 30-year period.

If the supermodel's simulation for the past 30 years proves to be close to the actual numbers it can then be used to run simulations for the forthcoming century. Indeed, climate supermodelling like this could be a powerful tool for helping us to prepare for the worst.

SUMO — Supermodeling by combining imperfect models
EU contribution: EUR 1 402 881
Total cost: EUR 1 870 109
Starting date: 1 October 2010
Duration: 36 months
Coordinator: Macedonian Academy of Sciences and Arts, Macedonia
www.knmi.nl/samenw/sumo



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Promising climate supermodeling

Scientists with the SUMO project have published promising early findings on the value of climate supermodeling compared with 'imperfect' individual models. In their paper, 'A multi-model ensemble method that combines imperfect models through learning', published in October 2010 in the online *Earth System Dynamics*, a journal of the European Geosciences Union, they explain how the 'ensemble' models exchange information during simulations and learn how to 'combine their strengths into a best representation of the observed climate'.

The authors conclude that supermodeling is a very good approximation of the truth, certainly better than imperfect models on their own: 'These illustrative examples suggest that the super-modeling approach is a promising strategy to improve climate simulations.'

Many hands, feet and eyes make light work

Ants may be small with little brains, but when they work together they can achieve great things. European researchers are now applying this principle to robotics, creating small, highly adapted robo-limbs which work as a swarm to achieve tasks which would otherwise be impossible without collaboration.

The behaviour of ants, bees and other animals that flock, swarm or live in colonies has attracted the interest of computer scientists since the 1990s. Scientists believe that this power of collaboration could also help them develop some impressively intelligent robots. Ant behaviour is now being programmed into robots that will be able to think, interact and work together.

The benefits of such robot 'swarms' are clear: a collection of cheap cooperative robots can achieve the same results as a single, expensive and much more complex machine. Moreover, it doesn't matter if one or two individuals in a swarm malfunction or fail — as a whole the swarm will continue with its task.

The EU-funded 'Swarmanoid: towards humanoid robotic swarms' has created a swarm made up of three distinct types of simple mini-robots.

The eye-bots do all the looking. They hover about and communicate their robo-bird's eye view to the others. The eye-bots also have a variety of other sensors so they know their location and avoid collisions.

The foot-bots, meanwhile, are designed for movement, specialised in moving on rough terrain and transporting either objects or other robots. These foot-bots were developed within the predecessor Swarm-bots project.

'Ants first captured the attention of software engineers in the early 1990s. A single ant cannot do much on its own, but the colony as whole solves complex problems … That rang a bell with people like Marco Dorigo … [who] was one of the founders of a field that has become known as swarm intelligence.'

The Economist, 12 August 2010

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Finally the hand-bots have arms with sophisticated grabbers that can pick up objects or be used to climb up vertical surfaces such as bookcases. The hand-bot can also move vertically up and down a cable that it shoots up to the ceiling and which attaches using a magnet. The hand-bot is not able to move on the ground (it relies on the foot-bots for a lift) and has a very weak perception of its distant environment because it relies on the eye-bots for this information!

Swarmanoid — Swarmanoid: towards humanoid robotic swarms
EU contribution: EUR 2 500 000
Total cost: EUR 2 733 023
Starting date: 1 October 2006
Duration: 42 months
Coordinator: Universite Libre de Bruxelles, Belgium
www.swarmanoid.org

Most amazing is that the cooperation between the swarmanoids is not programmed centrally. As in ants, the organisation of the swarm occurs as a result of simply one-to-one interactions between individuals. There are no bosses telling anyone what to do. The control algorithms are distributed across the individual bots. They exchange information when they are near each other and then act on the shared information available.

The swarmanoids have been successfully tested in computer simulations and field trials have proven the concept beyond doubt. Ultimately these mini-robot swarms could be adapted for search and rescue missions or to recover important items from a burning building or a contaminated area that would be otherwise too dangerous for humans. Software using ant problem-solving logic has already been developed and used in transport logistics, solving the travelling-salesman conundrum of finding the shortest, most efficient travel route.

Ant logistics

Migros, a Swiss supermarket chain, and Italian pasta-maker, Barilla, both manage daily deliveries from their warehouses to retailers using AntRoute, ant-inspired optimisation software developed by AntOptima, a spin-off from the Dalle Molle Institute for Artificial Intelligence (IDSIA).

Award-winning soft computing

Migros, a Swiss supermarket chain, and Italian pasta-maker, Barilla, both The Swarmanoid project has published widely on the subject in leading journals and Dr Marco Dorigo, the project coordinator, formerly of IDSIA and now with Brussels Free University, was awarded a Cajastur International Prize for Soft Computing (www.softcomputing.es) for his contributions to the advancement of soft computing, by developing the ant colony optimisation (ACO) methodology.

The social spread of coughs and sneezes

In the winter of 2009 we heard every day about the dangers of swine flu. Hospitals were overstretched, governments launched major prevention initiatives and ran public information campaigns. But was this the pandemic everyone so feared?

With hindsight it is easy to accuse governments — and the media — of over-reacting. Yet the authorities could not just sit back and do nothing. They had to prepare for the worst, although it turns out that the forecasts were far from accurate.

Epidemiologists would not be surprised, however. They concede that their models for predicting the spread and virulence of diseases are over-simplified and very often flawed.

The EU-funded 'Developing the framework for an epidemic forecast infrastructure' (Epiwork) project is tackling the inefficiencies of existing modelling and simulation tools on several fronts. The idea is to develop more robust and accurate mathematical models and algorithms to describe the spread and impact of disease epidemics. These new models will better allow for real-world phenomena such as international travel. In other words, Epiwork adds social and behavioural elements into the epidemic modelling mix. 'The huge flow of quantitative social, demographic and behavioural data becoming available nowadays motivates the development of innovative technologies that can improve traditional disease-surveillance systems, providing faster and better-localised detection capabilities,' the Epiwork team comments. 'Improved ICT techniques and methodologies which link and integrate datasets can change the way epidemic processes are modelled.'

The idea is to develop more robust and accurate mathematical models and algorithms to describe the spread and impact of disease epidemics.

Epiwork is actually an extension of another project, called Influweb (www.influweb.it), which collects health information from a large sample of volunteers who respond to a weekly emailed questionnaire about their health and geographical location. This technique can predict the peak in an epidemic about a week earlier than models using data collated from doctors' reports, partly because the volunteers' answer questions in real-time and partly because 90 % of people with flu-like symptoms do not go to the doctors.

The new Epiwork models try to account for the movements of people within an area as well. For example, it is using a technique called agent-based modelling to 'follow' the movements of people between places like home, work and school and see how interactions between people could transmit a disease to healthy people and also spread it geographically. It is also modelling the effect of preventative action and vaccination on the spread of infection.

The Influweb and other large datasets or online data sources are being fed into Epiwork's models and used to run large-scale computer simulations. These simulations can be used to predict the possible spread of disease in different real-world scenarios.

'For the first time, ICT and computation enable the study of epidemics in a comprehensive fashion,' notes the Epiwork team, 'addressing the complexity inherent to the biological, social and behavioural aspects of health-related problems.'

Epiwork — Developing the framework for an epidemic forecast infrastructure
EU contribution: EUR 4 850 000
Total cost: EUR 6 323 731
Starting date: 1 February 2009
Duration: 48 months
Coordinator: Fondazione Istituto Per L'interscambio Scientifico, Italy
www.epiwork.eu

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A gesture says a thousand words

When we chat with our friends the words we says can have quite different meanings depending on who we are with, where we are and the conversation that has gone before. Meaning depends very much on non-verbal context. Now scientists are trying to give robots greater interactive abilities by coding contextual analysis into their interpretation of our words and gestures.

When a raised eyebrow or shoulder shrug can say so much it is hardly surprising that scientists have struggled to get computers and robots to interact with us beyond basic commands. If only computers could express some emotion, they dream…

So now a team of European scientists is taking on two of the biggest challenges in human-machine communication. First, they want to help computers add some emotional element to their interactions with people; second they want to focus purely on non-verbal communication — our gestures and facial expressions.

The EU-funded project 'Emotional interaction grounded in realistic context' (TANGO) thus set out to render these complex communication channels into the unemotional language of mathematics. By analysing the expressions of volunteers and how they convey emotion, the researchers want to develop theories and formulas that computers and robots can use to work out the emotions of a person (which provides them with some context) or convey emotions to them.

When a raised eyebrow... can say so much it is hardly surprising that scientists have struggled to get computers and robots to interact with us beyond basic commands.

Firstly, though, you have to detect and analyse body gestures and facial movements. The TANGO team is using some of the most sophisticated motion detectors and image processing software which allows them to explore the relationships between a person's movements and their emotions.

With this data, the project can demonstrate how computers need not be devoid of emotion. For example, the researchers asked the question: can we build an 'emotion engine' into the computer graphics?

Today, the graphics in life-like computer games are powered by 'engines' which focus on physical laws: how limbs move, gravity, the laws of inertia when two people collide. But TANGO plans to add gestures like frowns or smiles — perhaps with subtleties that express genuine happiness, sarcasm or even pain — to the faces of characters, giving them more 'human' characteristics.

The addition of contextually appropriate emotional communication helps to break down the barriers that currently exist in human-machine interactions; people feel uncomfortable and ill at ease when dealing with artificial intelligence. An emotional connection between the person and the computer can help people to trust and accept new smart technologies and be less frustrated when they do not respond appropriately.

Research like this is critical to the development of not only more life-like robots, but ultimately the sort of trusted sentient helpers and robotic friends that science-fiction is good at creating but real science has struggled to replicate.

TANGO — Emotional interaction grounded in realistic context
EU contribution: EUR 2 784 999
Total cost: EUR 3 592 890
Starting date: 1 April 2010
Duration: 36 months
Coordinator: Stichting Katholieke Universiteit Brabant Universiteit Van Tilburg, Netherlands
http://spitswww.uvt.nl/tango

Computer meets brain

The idea of uniting brains and computers has been a favourite of sci-fi writers for decades, as has the concept of being able to make things happen by thought power alone or of realising telepathy. Now the boundaries between thinking, brain activity and electronics are blurring.

We all know that, at the most fundamental level, all brain activity, including our conscious thinking, is nothing more that electrical activity in nerve cells. So we shouldn't be too surprised to discover that scientists have now developed devices that can bridge the gap between our nervous system and other digital technologies.

Perhaps one of the most fascinating future applications could be the use a computer-brain interface to effectively give people additional senses.

We are likely to witness a rapid growth in the applications of brain-computer interaction (BCI) — thought-controlled machinery and even computer-modulated thought. But most current brain-machine technologies are invasive, requiring electrodes and electronics to be inserted and hardwired into the brain or nervous system.

The EU-funded 'Hyper interaction viability experiments' (HIVE) initiative is investigating an alternative: the use of non-invasive computer-to-brain interfaces which would be worn on the head, circumventing the risks associated with surgery and the direct attachment of electronic components into nervous tissue.

Today very little is known about external brain stimulation, so HIVE is exploring the biophysics of the process and investigating non-invasive stimulation at the theoretical, computational and experimental level. The project is researching what actually happens to induced electric fields and neurons when stimulated using non-invasive techniques such as 'Transcranial current stimulation' (TCS) — a technique that uses very weak currents to alter brain function — or at the larger neuronal populations as a result.

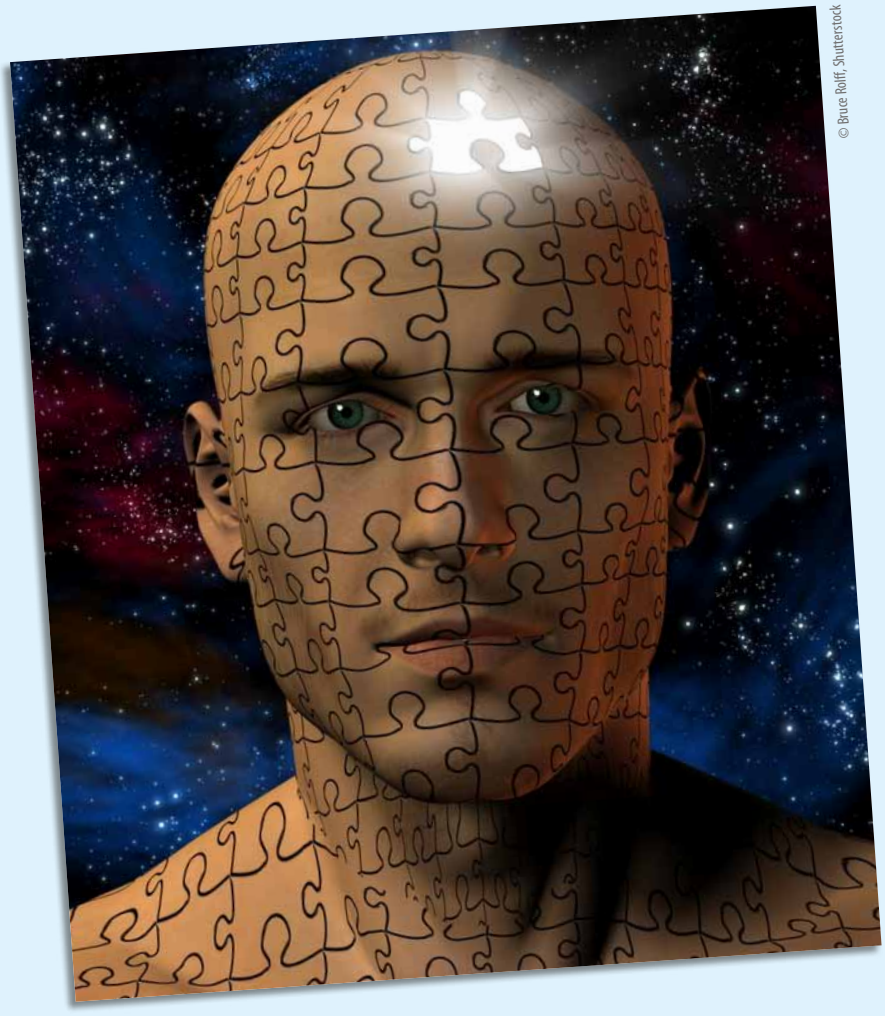
Another strand of the project is looking to refine and improve the stimulation technologies themselves, especially to make them more flexible, focused (i.e. to stimulate small, specific areas of the brain), controllable and responsive to brain activity.

The biggest challenge is finding a way to stimulate specific areas of the brain through the skin, skull and cerebrospinal fluid, which together dissipate electrical current like wifi signals weaken through walls. One of the ideas is to divide the stimulation across several different contact sites so that they are all focused on the target area; the stimulation is thus better concentrated at a specific point. The team is building a head-mounted system with 16 electrodes which can stimulate various sites in the brain but also monitor brain activity at the same time to adapt to brain changes.

In addition to providing new tools for research, the device could also be used therapeutically as TCS is used today to treat many neurological conditions such as Parkinson's disease, migraine, neuropathic pain and psychological conditions including clinical depression.

Perhaps one of the most fascinating future applications could use a computer-brain interface to effectively give people additional senses. Using external sensors, for example a temperature probe, data could be coupled directly to the human brain to transmit information and elicit particular responses. Or, as the project also seeks to explore, provide the means for brain-to-brain computer-mediated communication.

HIVE — Hyper interaction viability experiments
EU contribution: EUR 2 299 998
Total cost: EUR 3 012 576
Starting date: 1 September 2008
Duration: 48 months
Coordinator: Starlab Barcelona SL, Spain
http://hive-eu.org



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Really brainy science

Brains, nerves and cognition have been inspiring computer scientists for years. They look at the power of the human mind and cannot help but wonder: how does it work and can we copy it to create really intelligent machines?

The Neuro-ICT theme draws from the disciplines of neuroscience and information technology in an effort to transfer knowledge between these two fields and drive forward both our understanding of thought, intelligence and neuronal control and its technological application.

In this issue of *research*eu focus*, we speak with two eminent professors in the neurosciences field, Guy Orban (GO) of Belgium's Catholic University of Leuven and Sten Grillner (SG) of Sweden's Karolinska Institute, about their experience of working in Neuro-ICT research funded by the EC, in particular FET, and how it has propelled Europe's expertise and spawned innovative ideas and technologies.

Guy Orban

Q: Tell us about your early involvement in EU-backed neuro-ICT research.

GO: I've participated in neuro-ICT research at the European level from its earliest beginnings. Long before FET started, I was involved in the initial task force which explored the status of cognitive studies in Europe, which eventually led to the FET Neuro-ICT theme. I coordinated the three Insight projects — Insight was a world first because it brought together biological and computer vision scientists, long before this happened elsewhere in the world. I also coordinated the Mapawamo project and was heavily involved in Neurobotics which was funded through the FP6 FET programme.

SG: My first FET Neuro-ICT project in 2000 was quite a creative project called Microcircuits with a combined modelling and experimental approach in which we analysed the different molecular and cellular building-blocks of different microcircuits located in different parts of the brain, from the cerebral cortex to the spinal cord. Many common features were discovered and reported in a Microcircuit issue in Trends of Neuroscience from this grant. A second was Neurobotics a large integrated project which began in 2004 with a number of leading robotics and neuroscience groups. Initially we had to find a common vocabulary, and this resulted in a number of interesting projects with bio-inspired technology and robotics. This was followed up by a smaller project, Lampetra; in which swimming and walking robots were developed based on a detailed knowledge of the neural control mechanisms used in animals. These different projects have provided very important stimulus for fruitful interaction between physics/engineering and neurobiology, to the benefit of both.

In 2005, I received support from the Commission for the International Neuroinformatics Coordinating Facility, initiated by OECD, which is dedicated to promoting and facilitating international cooperation for the development of neuroinformatics in a global perspective.

Q: What have been the highlights of your Neuro-ICT projects?

GO: In the Insight projects the highlights were the annual meetings where there was such deep interdisciplinary interactions between neuroscientists, psychophysicists and computer vision scientists. We had the greatest researchers in their fields with us!

SG: My involvement with the two FET projects has been so stimulating. It has been incredibly beneficial to interact with robotics researchers, modellers and experimenters. And the transfer of knowledge between the disciplines has been mutually beneficial. We now use robots as a tool to test the output of our modelling work and theories; the roboticists can apply our knowledge because, after all, advanced robots will encounter all the same problems experienced by neurological organisms so it makes sense to use some of nature's solutions.

Q: How have the FET projects influenced and steered your research?

GO: These FET projects, especially the Insight series, had a lasting influence on my research orientation. I continued to work on the same topics for more than a decade after they finished: the existence in the visual system of primates of gradient-selective neurons. The moment I came to realise in the mid-90s we had really discovered these neurons was one of the best moments of my whole career, and it all started from discussions with colleagues working on the Insight projects. In those projects, roboticists, amongst them Olivier Faugeras, tried to calculate dense depth maps of the visual environment and I kept telling them that the brain had to have more clever ways to address this problem, by building more synthetic, higher-order depth representations. That is how the idea of gradient-selective neurons was born.

SG: FET has really broadened my horizons. I have worked closely with people who I probably would not have ever thought to consult were it not for the Neurobotics project. I would never have imagined helping to develop robots as part of my work before, so FET has been really useful in furthering my overall research aims.

Q: More generally, how important has FET funding been for the research community, in your view?

GO: For at least 10 years FET has done something unique: bringing together cognitive neuroscientists and scientists from computer and other engineering sciences to understand how knowledge of the brain can help improve ICT-based technologies. This was a wonderful achievement and could have delivered major groundbreaking findings.

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Sten Grillner

But I think that the pace of neuroscience — the lab work — was too slow for some. So gradually there was more emphasis placed on computational neuroscience (making models of brain processes in simple animals) and neuroinformatics (organising databases of neuroscience results). But we still don't really know much about the brain and are still discovering new cortical areas. So in a way Neuro-ICT was a bit ahead of its time.

I strongly believe that FET has been crucial for the survival of cognitive neuroscience in Europe, which has been somewhat neglected by other EU funding opportunities, with so much attention paid to brain diseases like Alzheimer's. But the human brain is so complex and we know so little. The FET support, at least indirectly, has been a determining factor to maintain a thriving community of cognitive or systems neuroscientists systems in Europe.

SG: FET funding has really fostered interaction between the neuroscience and computer science disciplines, including robotics. It has successfully widened our networks, broadened our horizons and we have all benefited from this wider perspective on our work. For example, roboticists are beginning to appreciate how evolution has solved a large number of problems already and are applying this knowledge in their hardware designs. And for us bio-scientists, we are now using robots to test our theories about how we think the brain processes and responds, for example, to visual stimuli.

Q: What do you think is the future for interdisciplinary Neuro-ICT research?

GO: Cognitive neuroscience is moving on especially in the EU and Japan; we now have answers to questions that computer scientists and engineers asked us 10 years ago. The brain is still a huge source of inspiration for computer and related sciences: the alliance between neuroscience and ICT must be maintained and supported.

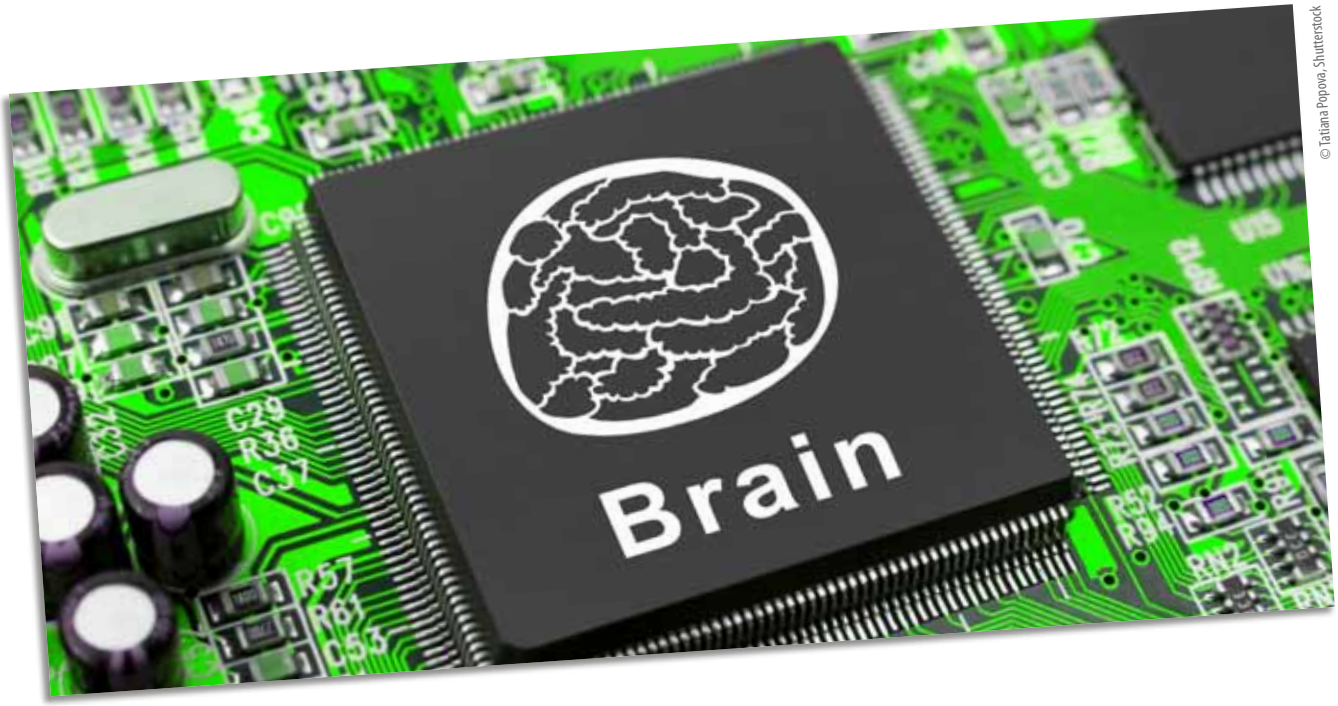
SG: The development of computer technology allows us to model millions of complex neurons that would have been unthinkable just 20 years ago. Combining this power with experimental research, we will be able to really probe and explore the way the brain works. This will help us to build intelligent and safe service robots for all kinds of tasks, especially to help people in the home as the population ages.

More info

For more information on the professors, projects and related European programmes, consult the websites:
Guy Orban: http://neuroserv.med.kuleuven.be
Sten Grillner: http://www.neuro.ki.se/grillner/cv/stencv.html
FET BIOi3 (including Neuro-IT theme): http://cordis.europa.eu/ist/fet/bioit.htm
FET BRAIN-ICT: http://cordis.europa.eu/fp7/ict/fet-proactive/brainict_en.html
FET NBIS: http://cordis.europa.eu/fp7/ict/fet-proactive/nbis_en.html
NEURO-IT network of excellence: www.neuro-it.net

'The roboticists can apply our knowledge because, after all, advanced robots will encounter all the same problems experienced by neurological organisms so it makes sense to use some of nature's solutions.'

Sten Grillner



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Publications:

Projects compendium 2007-2011
http://cordis.europa.eu/fp7/ict/programme/docs/fp7-fet-01_en.pdf

Extract WP 2011-2012
http://cordis.europa.eu/fp7/ict/fet-proactive/docs/usef-48_en.pdf

FET09 report
http://ec.europa.eu/information_society/events/fet/2009/catalogue/sciencebeyondfiction.html

Useful links:

FET Open website:
http://cordis.europa.eu/fet-open

FET Proactive website:
http://cordis.europa.eu/fet-proactive

Flagship website:
http://cordis.europa.eu/fp7/ict/programme/fet/flagship/home_en.html

FET Open on Facebook:
http://www.facebook.com/fetopen

caFETeria — Open ideas on the future of computing:
http://www.cafeteria.ning.com

Community Research and Development Information Service

http://cordis.europa.eu

CORDIS — the Community Research and Development Information Service — is an interactive information platform that keeps you up-to-date with the latest news, progress and initiatives in European research and development (R & D) activities.

CORDIS is free of charge and offers access to R & D funding programmes of the EU as well as to information on partnerships and involvement in R & D activities, and on research projects and their results. As such, it is the official entry point to the Seventh Framework Programme (FP7), its specific programmes, activities, themes and latest developments.

http://cordis.europa.eu/fp7/ict/programme/fet_en.html

The Future and Emerging Technologies (FET) is an incubator and pathfinder for new ideas and themes for long-term research in the area of information and communication technologies. Its mission is to promote high risk research, offset by potential breakthrough with high technological or societal impact.

ICT Research in FP7

http://cordis.europa.eu/fp7/ict

Information and communication technologies (ICT) have come to mean far more than the smartphones and search engines that most of us know. ICTs are also the seen and unseen things that make the internet, web TV or satellite telephones possible – the software, hardware and technical wares in between which are just as important to European industry.

How do ICTs achieve this? Well, thanks to novel technologies, Europe is more productive and innovative. ICTs can help to modernise important services and infrastructure, such as health, education and transport. ICTs also enable advances in other areas of science and technology to take place.

European Commission support for R&D, cooperation and knowledge sharing in ICT ensures that Europe remains a leading player in this fast-changing sector. ICTs are also critical to helping Europe meet its 2020 Strategy of smart, green and inclusive growth. Learn more on CORDIS about the EU's research Framework Programmes in ICT.

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