

THE EUROPEAN ASSOCIATION OF  
RESEARCH & TECHNOLOGY ORGANISATIONS

# IMPACT DELIVERED





# Foreword



Welcome to the 2012 edition of "Impact Delivered". This is the third time we take pleasure in presenting some examples of Research and Technology Organisations' work for governments and business, for the economy and society.

RTOs exist to support governments in tackling the grand challenges of the day, including helping to build and sustain the competitiveness of firms both large and small. Thus RTOs are expected to achieve tangible results, to meet targets, and indeed many RTOs operate according to medium-term (e.g. five-year) strategic plans negotiated with their sponsoring governments. "Impact Delivered" neatly sums up what RTOs do: help change society and the economy for the better.

As this brochure comes off the printing presses, the European Council, Commission and Parliament are in the midst of negotiations about the next European research and innovation programme, *Horizon 2020*. We see there a clear focus on tackling "grand societal challenges" and on "innovation": by contrast, previous programmes focussed on "research and technological development" in selected "thematic priority" areas. It is important that the change in the wording is reflected in the programmes and projects actually implemented under *Horizon 2020*. Commissioner Geoghegan-Quinn's frequent insistence that she wants to see real results on the ground is encouraging.

Public budgets practically everywhere in Europe remain tight and probably will continue to do so for some time to come. At the same time, global competition continues to grow. Europe's competitive advantage can lie only in a knowledge-based economy.

Thus we must find the resources to maintain and expand our investment in research and innovation. That is for the politicians to do. The RTO community, for its part, stands ready to continue and intensify its work with the universities, with public agencies, and with large and small firms to help turn science into technology, knowledge into value, invention into innovation - Impact Delivered!

The several case studies in this brochure give a flavour of our work. They include innovations at the leading edge of science and technology, but also clever combinations and integration of existing technologies to produce new opportunities and solutions. There are innovations for small firms and others that have benefitted large ones, and there are several examples of RTO contributions to quality of life and tackling grand challenges.

We have included, too, several examples of innovations produced with funding from EU programmes, notably the *Framework Programmes for Research and Technological Development*. As the policy debate on the final shape of Horizon 2020 continues, it is a useful reminder that RTOs are major players in EU research and innovation programmes and that they put those resources to good, practical effect.

Impact Delivered!



J.H.J. Mengelers M.Sc.  
President of the Netherlands Organisation for  
Applied Scientific Research - TNO  
President of EARTO



Industrial biotech



Drug development



3D media



Health



Fraud detection



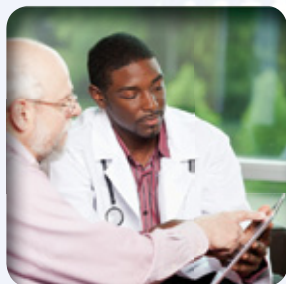
Value-added forestry



Green shipbuilding



Port security



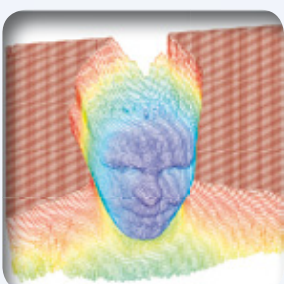
Predicting Alzheimer's



Food hygiene



Perfect chocolate



Hyper-accurate  
measurement



Green manufacturing



Educational testing



Flood prevention

# IMPACT DELIVERED



# Intelligent bio-oil system fuels new era for renewable energy



EARTO member VTT has made a breakthrough in biomass-based bio-oil production with an innovative, intelligent process that marks the beginning of a new era in the energy sector. By combining two different technologies - pyrolysis and combustion - within a power plant in such a way that each benefits from the other, VTT's totally new technology makes the commercial production of bio-oil financially viable for the first time. About to be implemented on an industrial scale, the process will enable significant bio-oil production capacity by 2020 - the year by which Europe must achieve 20% of its final energy consumption from renewable energy.

Bio-oil has long been seen as one of the most promising replacements for liquid fossil fuels. But to realise its potential as an energy source for heat production or, in an upgraded form, as traffic biofuel, it had to be made considerably cheaper to produce. It was widely believed that an initial breakthrough in its use within heat and power plants could well hinge on the use of local raw materials, such as wood, so there are no hefty transport costs, and fast pyrolysis, the long-established process for breaking down wood which, however, had yet to be used on an industrial scale.

## Mutual benefits

Capitalising on its bio-oil know-how and pyrolysis patents, VTT collaborated with energy company Fortum, technology specialist Metso Power and forestry firm UPM to take a fresh look at the problem. Their solution was to connect a state-of-the-art pyrolysis reactor, which pyrolyzes wood biomass and then compresses it into liquid form, to a conventional fluidised bed boiler for the co-generation of electricity and heat. This novel union delivers outstanding energy efficiency, as the bio-oil production process can use heat recovered from the power plant that would otherwise be wasted and uncondensed gases and char from the pyrolysis process are fed into the boiler for combustion alongside the plant's primary fuel.

The first integrated bio-oil production plant in the world will go live in 2013, providing cost-effective heat for around 24,000 apartments with only small CO<sub>2</sub> emissions

## Commercial advantage

No other bio-oil production process is able to recover the energy of pyrolysis by-products as fuel with such high efficiency, a key achievement given that they contain around 40% of the total energy content of the original biomass. In fact, using bio-oil as a replacement for heavy fuel oil in district heating applications has been found to result in reduced CO<sub>2</sub> emissions of up to 70%. Three additional factors greatly boost the commercial potential of the process: investment and utilisation costs are lower than when pyrolysis is a separate process, existing fuel logistics benefit from producing bio-oil from the same raw materials already being used at the plant and the bio-oil produce is of a quality acceptable to end users.

## Emission reductions

Following the successful two-year operation of a proof of concept pilot, the world's first commercial implementation of the integrated pyrolysis concept will go live in 2013 when Fortum connects a

bio-oil plant to its Joensuu CHP (combined heat and power) plant in Finland. This will produce 50,000 tonnes of bio-oil a year - and reduce CO<sub>2</sub> emissions by 59,000 tonnes and sulphur dioxide emissions by 320 tonnes. VTT is also involved in European standardisation work to support the innovation's entry into the market. Prime candidates for new and retrofit implementations are the 200 CHP plants within the mechanical wood and pulp and paper industries in Europe and North America, where their use could generate 14,000 jobs.

'The use of bio-oil has a significant positive environmental impact because energy produced with bio-oil reduces greenhouse emissions by more than 70% compared to fossil fuels. Also, when Nordic biomass is used as the raw material for bio-oil, we can be ensured that it has been produced sustainably. This is a key element of Fortum's strategy for sustainable development' Jouni Haikarainen, Fortum



VTT Technical Research Centre of Finland is the biggest multi-technological Research and Technology Organisation in Northern Europe. With its staff of 3000, its unique research facilities and extensive global co-operation networks, it provides leading-edge technology solutions and innovation services. VTT works to enhance its customers' competitiveness and competence, creating the prerequisites for society's sustainable development, employment and wellbeing.

[www.vtt.fi](http://www.vtt.fi)



# Dermatological tissue sampling tool gets under the skin of drug development efficiency

EARTO member JOANNEUM RESEARCH has developed a medical device which enables tissue samples giving an entire biochemical picture of the impact of a drug to be taken directly from its target site, opening up new horizons in pre-clinical and clinical drug testing. By providing continuous data on both the pharmacokinetic (PK) and pharmacodynamic (PD) effects of drug action around two years earlier in the development process than has been possible before, the dermal open-flow microperfusion (dOFM) probe enables pharmaceutical firms to focus time and money on the strongest candidates.

Dermatological drugs for conditions such as psoriasis represent a significant segment of the global pharmaceutical market, accounting for sales of over €20 billion a year. With the cost of commercialising a new drug now standing at €1 billion, capitalising on the market is demanding greater efficiency in the development process. Earlier knowledge of a drug's complete pharmacological profile is one of the most effective routes to cost savings, but existing means of generating this information were unsatisfactory. The relevance of results from blood sampling had been questioned and techniques enabling the preferred alternative, tissue sampling, had serious limitations.

The total healthcare costs of the skin disease psoriasis, which affects 125 million people worldwide and for which the dOFM probe will help find new treatments, are calculated at €9 billion annually

## Under the skin

JOANNEUM RESEARCH overcame the key problem of the membrane-based microdialysis technique, low recovery of larger molecules, by taking a novel approach to another existing method: open-flow microperfusion (OFM). The resulting dOFM probe has a mesh with macroscopic openings which provide unrestricted access to the target site's interstitial fluid, where all biochemical signalling to and from cells is present. The probe is inserted into the dermis and, coupled with a small wearable pump which allows mobility and longer periods of study, enables interstitial fluid and biomarkers to be continuously collected for more than 48 hours.

## On the case

The resulting samples are unfiltered, allowing investigation of all substances present at a target site regardless of size and other

'The dOFM probes and portable pumps are already in use in contract research for big pharmaceutical companies. It is the first time that they can get a dynamic, complete biochemical picture directly at the site of drug action. This will dramatically enhance their dermatological drug development process' Professor Dr Thomas Pieber, JOANNEUM RESEARCH

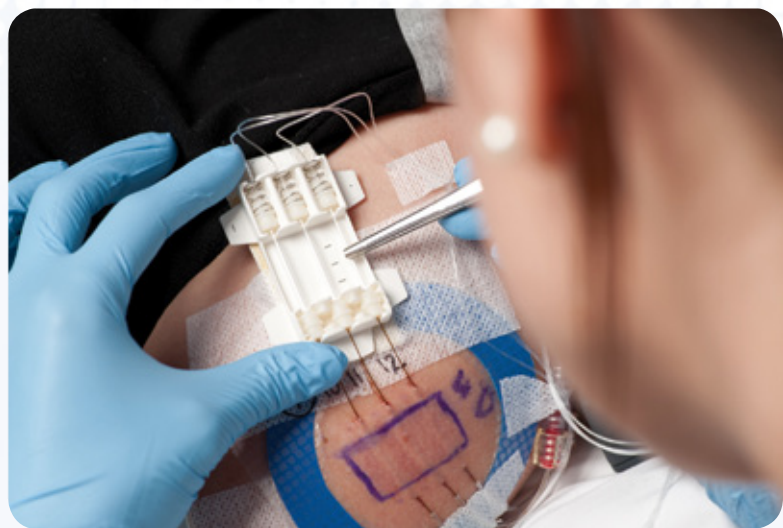
physico-chemical properties. The samples quickly reveal if a dermatological agent actually arrives in the target tissue. As the technique accelerates the collection of high volumes of highly relevant data on drug appearance and drug action, judgement on a dermatological agent's therapeutic potential can also be made much faster. By using several dOFM probes simultaneously in a single

subject, the number of study participants can be reduced as enough data is collected as early as exploratory clinical phase 1 studies - reducing the risk of having to redesign a drug after phase 3 studies.

## In global demand

JOANNEUM RESEARCH has patented and secured all relevant certifications for its dOFM device. After conducting clinical evaluation and usability tests in cooperation with the Medical University of Graz, it launched an exclusive service offering complete PK and PD investigation at the target skin site. It now serves as a one-stop-shop clinical research organisation for pharmaceutical companies around the world, offering everything from preclinical to clinical study design to analytics and scientific writing. It has already carried out two large clinical studies, one for a new topical steroid formulation and another for a new antibody for psoriasis.

'We believe that Open Flow Microperfusion can develop as an interesting and reliable technique to determine drug levels in target tissue' Senior research investigator of an international pharmaceutical company



JOANNEUM RESEARCH is a Research and Technology Organisation with a 30-year track record in cutting-edge research for business and public sectors at international level. It has a total of nine research units in Graz, Vienna and other Austrian towns, 457 employees, collaborates closely with regional universities and focuses on applied research and development and knowledge and technology transfer. Specialist areas include materials, health, digital, resources and policies.

[www.joanneum.at](http://www.joanneum.at)





# 3D audiovisual innovations recapture the excitement of the cinema - and open new opportunities for the media industry



Breakthrough media technologies enabling compelling 3D entertainment experiences developed in an FP7 project led by Barcelona Media, part of EARTO member Fedit, are fuelling the creative power and competitive advantage of Europe's entertainment industry. The advances made by 2020 3D Media to capture, code, edit, produce, distribute and display innovative stereoscopic and immersive audiovisual content are expected to boost the industry in the same way as traditional cinema did a century ago.

The film industry knows that putting spectators at the heart of the action and evoking a realistic sensory experience of being submerged in the creative imagery lies at the heart of its future success. Hollywood has already jumped on the heightened-reality bandwagon, but in its rush to release 3D films it has sometimes

3D films which enhance the illusion of depth perception have existed in some form for nearly a century but have remained a niche in the industry because of low quality imagery, costly hardware and processes and lack of a standardised format. With its R&D effort, 2020 3D Media is helping to solve these issues

used sub-optimal 3D shooting techniques and low-quality technologies such as 2D-to-3D conversion. While consumers are clearly keen on the concept - takings from 3D showings doubled to €4.8 billion in 2010 from 2009 - there is some dissatisfaction with the quality of the images and the need to wear heavy 3D glasses.

## Just in time

Set up just at the right moment to surf the wave of the cinema's rediscovery of 3D and the widespread introduction of digital technology for movie-making, 2020 3D Media set about developing engaging new audiovisual technologies to create a complete 3D-capable value chain. By its conclusion it had demonstrated a commercially viable system consisting of sound and image capture, post-production, secure network transmission and end-user customisation blocks. Key among its advances are depth-enabled high definition video capture without the need for complex twin camera mirror rigs, technology to create and display seamless panoramic and omnidirectional surround video in real time, a true 3D audio system and brighter 3D projectors for constructing immersive 'sets' even at home.

## Ready to roll

By creating a cost-effective, end-to-end solution, the project ensured the commercial viability of its innovations. Their real-world value was significantly raised by standardisation initiatives to establish an open, non-proprietary data format and enable single versions of 3D audio content to be shown in any kind of auditorium and with any speaker configuration. As more and more 3D services come on stream it is predicted that the impact of 2020 3D Media will also be felt in areas such as the future design of the internet.

## Big screen success

The project's cutting-edge prototypes were premiered at the 2012 Berlin Film Festival, as was an experimental film made using the 2020 3D Media technologies. A number of individual system components have already been commercialised, including DPL's 3D Titan projector range, a satellite distribution solution developed by DataSat, Mediapro's 3D content analyser and corrector and Doremi's 2D to 3D conversion technology.

Two start-ups have been launched to commercialise the project's breakthroughs. Camargus sells extraordinarily high resolution audiovisual solutions based on new video 'stitching' technology as well as the Maxx-Zoom multiview camera which has become a fixture of US NFL broadcasting. Imm Sound, which licensed 3D immersive sound technology developed by Barcelona Media, is already a world-leader in the field and its novel acoustic sensations play a key role in a new film, *The Impossible*, about the 2004 Asian tsunami.

Products and applications derived from the project that will be coming to the market soon include immersive, interactive cultural heritage and documentary productions from Crew and a portable version of TiME Lab's unique 180 degree 3D panoramic projection and surround sound system which Fraunhofer HHI plans to launch for events, roadshows and exhibitions.

'We are very proud that *The Impossible* should be the first film to be made using the Imm Sound system. It is an extraordinary system which enhances the power of the image and transports the viewer into the world of the film, intensifying the sensory, and therefore also the emotional, experience in the cinema' Belén Atienza, Apaches Entertainment



Santi Fort, Barcelona Media

**Barcelona Media** is a Research and Technology Organisation dedicated to boosting the competitiveness of the media and communications sector through applied research and knowledge and technology transfer. It promotes and implements research, development and innovation projects, fosters publicly-funded international collaborative projects, acts as a bridge between academic and industrial research and helps companies develop new products and services. Barcelona Media is one of the Technology Centres associated to Fedit, the Spanish Federation of Technology Centres. Fedit is the main private research, development and innovation agent in Spain.  
[www.fedit.com](http://www.fedit.com)



# Robotic rehabilitation device assists stroke patients and healthcare providers

Technologies developed by EARTO member Tecnia underpin a robotic rehabilitation system which has the potential to meet the growing global need for lower-cost, higher-quality care for stroke patients. By bringing together therapeutic computer gaming and movement measurement technologies in an easy-to-use, networked arm brace device, ArmAssist enables at-home rehabilitation training and monitoring, ensuring consistent treatment in the crucial first 90 days of recovery at a time when hospitals are facing a shortage of therapists and resources.

Every year, 15 million people around the world suffer a stroke. With the population of over 65s expected to grow nearly 40% between 2010 and 2030, this figure is set to rise significantly. Already the annual healthcare costs of stroke are substantial: €30 billion in Europe and more than €57 billion in the US, with costs in the first

In-patient rehabilitation accounts for around 5% of the direct costs of stroke, which translates to a total cost of about €1.5 billion in the US alone

90 days averaging €11,800 per patient. Despite the recommendation that patients receive at least two hours of rehabilitation a day for 12 weeks, many are currently getting in-patient support of less than two hours a week for just two weeks.

## Gaming gets serious

Tecnia believed it could find a solution by combining the concepts of robotic therapy and e-health. And it did, developing a mobile base module which holds the user's forearm, a table mat for smooth and precise motion and software drivers to allow communication between the device and a standard PC. Sensors detect and measure patients' active and passive reach shoulder and elbow movements during training sessions in game virtual environments, with real-time data feedback enabling doctors to monitor the exercises online for progress reports, clinical assessment and treatment planning.

Hospitals lack the resources to meet the rehabilitation needs of today's stroke patients - and this situation will only get worse as the population ages

## Extending its impact

ArmAssist is the first system for alleviating neuromuscular disability that takes rigorous rehabilitation programmes out of the clinical setting into the home while maintaining expert supervision and introducing valuable quantitative therapy evaluation. The resulting financial benefits on both sides are significant, with therapists able to oversee more patients at any one time and patients saving the travel costs of frequent visits to

'With this system I can move my arm! It is fun to have it at home and the rehabilitation process is faster. In addition, the games are very entertaining and as you can level up it encourages your competitiveness. Neurological rehabilitation is all about repeating and repeating, which is ideal for this robot' stroke patient

hospital. ArmAssist can also be used by patient groups other than acute phase stroke patients, including anyone with a disorder that means they need continuous training of the upper limbs.

## Forecasting the future

ArmAssist has been patented by Tecnia and successfully piloted in rehabilitation centres and at-home trials. The technology has now been licensed to ReHub Investments, initially for sales within Spain, which has established collaborations with three companies to commercialise the technology by the end of 2012. There are believed to be around 13,000 patients who would benefit from the device in Spain, where sales could reach €2.63 million by 2016. Total global sales over 15 years, from prime markets in Europe, the US, Canada, Japan, Russia, Australia and Latin America, have been estimated at €122 million.

'We are very excited to be at the forefront of new technologies for in-home tele-rehabilitation training. The growing needs in the personalised healthcare market present a great challenge to offer individualised services that improve patient participation and outcome. To this end, we believe the ArmAssist system represents a significant advance over current state-of-the-art' ReHub Investments



Tecnia Research & Innovation is an independent Research and Technology Organisation in Spain. Its mission is to transform knowledge into GDP and improve people's quality of life by generating business opportunities for companies through multidisciplinary research in the areas of sustainable development, innovation and society, ICT, healthcare, industry and transport. It has 25 worldwide offices, 1,500 employees and 3,900 clients.  
[www.tecnialia.com](http://www.tecnialia.com)

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# Fraud detection technology tackles growing threat to consumers, public funds and financial services



Two Framework 6 projects led by EARTO member Fraunhofer-Gesellschaft have developed powerful fraud detection innovations which reduce fraud losses and fraud prevention costs at the same time, heralding a revolution in the electronic payments business. By creating an advanced data-mining mechanism that can detect fraud patterns through analysis of millions of transactions, identify fraud risks and automatically convert these into new operational rules, Fraunhofer has opened the door to faster and better fraud detection in healthcare, e-government services and the financial services sector.

Fraudsters cheat credit card holders, healthcare providers and governments out of millions of Euros every year. Fraud accounts for almost 3% of the UK's €1 trillion public healthcare expenditure, for example. The worldwide cost of credit card fraud rose to more than €10 billion last year. These figures will increase as thieves continue to outwit existing fraud detection tools and non-cash payments keep on growing: numbers of e-payments are predicted to rise from 17.9 to 30.3 billion between 2010 and 2013. With the key to effective fraud management lying in the ability to analyse vast numbers of transactions to enable realistic risk assessment and evaluation of fraud trends, the overarching need was for a breakthrough in data mining and automatic analysis.

It is estimated that healthcare fraud could be reduced by around 45% with the web-based fraud detection service developed by the iWebCare project

## Protecting public services

Researchers at the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) met this need through the €2.3m iWebCare project, which focused on minimising the loss of healthcare funds. Its web service platform has embedded ICT tools to apply data mining algorithms on transactions and records, identify irregular behaviour, accurately assess if it is fraudulent and create rules for dealing with fraudulent activity. Accessible through the internet, the technology enables organisations to quickly identify potential fraud cases and establish policies to neutralise them, while also isolating cases for investigation. As part of a

complete anti-fraud policy, iWebCare tools could help losses from healthcare fraud fall by about 45%. They could also be customised for use in taxation, e-procurement and immigration security.

One particular bank using MINTify has reduced its fraud losses, saving about €150,000 a month, and cut data-analytics costs by 50%, which reflects a cost reduction of around €5 million a year

## Making trade easier

Fraunhofer went on to use its new data mining techniques in the RACWeB project (Risk assessment for customs in Western Balkans) which developed an

advanced web-based risk assessment service for customs declarations. Able to detect fraud in unexplored fields of inward processing, the service can alert other customs departments and

agencies such as tax administration to problems, improving customs efficiency and ultimately enabling faster and safer trade.

## Preventing payment fraud

Researchers at Fraunhofer then focused their attention on applying the iWebCare algorithms to a data mining engine for fraud detection in e-payment transactions. The resulting technology has been brought to market by Paymint as the MINTify fraud management service, which can interoperate with payment card processing systems. Now in use by many credit card providers to protect millions of payment cards and card holders, feedback confirms that with MINTify fraud losses drop by almost 40%. With its algorithms automating what was a very labour intensive and expensive process, MINTify also dramatically cuts the costs involved with fighting fraud.



'At a time when credit card margins are shrinking, fraud can cause losses which make the difference between a viable, or unsustainable, card portfolio. Our new algorithms will make fraud managers relax' Dr Stefan Rüping, Fraunhofer IAIS

The Fraunhofer-Gesellschaft is the leading organisation for applied research in Europe. Its research activities are conducted by 60 Fraunhofer Institutes at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 20,000, who work with an annual research budget totaling €1.8 billion. Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly-funded research projects. Branches in the USA and Asia serve to promote international cooperation.

[www.fraunhofer.de](http://www.fraunhofer.de)



# CT log scanner gives forestry industry the inside story on maximising value

A project coordinated by EARTO member SP Technical Research Institute of Sweden has developed a high-speed computed tomography (CT) scanner for seeing inside trees which heralds a new era for the forest industry, transforming it from resource intensive to value-added knowledge intensive. Yielding a detailed 3D reconstruction of the inner properties of logs, the CT-Pro scanner simulates different breakdown patterns and shows the grades and prices for the resulting boards, enabling selection of the cutting pattern that will give the highest possible value for the final products.

Faced with increased competition and adaptation to customers' needs, the wood industry needed to find more accurate production control technologies. With 70% of production costs relating to saw logs, it made sense to focus here first. Existing x-ray log scanners are fast but yield simple images showing only the most distinct internal features such as knots and heartwood, not their exact size and position. While this means sawmills can pre-sort logs into high and low-grade batches, it doesn't allow for the fact that one log can yield boards of different grades. Being able to extract some boards of high grade even from a log with serious internal defects would clearly improve recovery and value.

Studies have shown that scanning the internal characteristics of every single log before cutting would result in an increase in yield of between 10 and 50%

## First application

The CT-Pro collaborators aimed to rise to this challenge by being the first to take CT technology widely used in medicine into the sawmill. The result is a high resolution

scanner that's around eight times faster than the status quo, mainly due to the first application of a new exact reconstruction mathematical algorithm. Other innovations include an adaptation of cutting-edge automotive technology which enables wireless high power transmission and an array of antennas around the gantry for the wireless transmission of vast amounts of data to the reconstructing computer.

## Full picture

The system's revolving gantry enables a full digital reconstruction of a scanned log. Based on the scan, the log can be virtually broken down into different value-optimised cutting 'masks' until the one that gives the highest value and best suits the customer's needs in terms of appearance, quality and deformation potential is identified. By allowing the industry to move from cutting optimisation by volume or log grade to board grade and thus maximise value and minimise waste, it's estimated that the system will increase value in the sawmill-to-final product value chain by 10%. For many mills this will mean the difference between profitability and closure.

For the US hardwood sawmill industry alone, the new CT scanner could add around €1.9 billion in value a year to harvested logs

## High potential

Marketed under the name CT.Log by the project's industrial partner Microtec, the innovation has already been implemented to find optimal cutting in a hardwood plant in the US, a veneer mill in Chile and a softwood sawmill in France. CT.Log was officially launched in September 2012 and Microtec predicts that in the near future every middle-to-large sawmill and veneer mill and some smaller ones - of which there are thousands around the world - will need a CT scanner to optimise production. Based on past experience of introducing paradigm-shifting technology into the industry, the time from first installation to use in most mills is expected to be around 10 years.

'Mechanical and mathematical problems hadn't allowed the building of CT scanners able to scan at the speed needed for industrial applications before. An innovative algorithm developed in 2002 induced us to start trying to build a scanner with all the characteristics needed to be installed in the production line of a sawmill' Enrico Ursella, Microtec



SP Technical Research Institute of Sweden is a centre for research and innovation which develops, tests and evaluates technologies, materials, products and processes for national and international customers. Providing an effective link between research and commercialisation, the Institute takes a holistic approach based on interdisciplinary cooperation to innovation in its core areas of building and construction, electronics and ICT, fire, risk, safety and security, foods, materials technology and chemistry and measurement technology and calibration.

[www.sp.se](http://www.sp.se)





# Innovative catamaran heralds new wave of smart, green passenger cruisers



EARTO member Brodarski Institute has designed and built one of the world's largest and most luxurious river catamarans whose ingenious hulls, safety systems and green credentials have transformed it into a next-generation tourism vessel. Launched on the River Thames this summer to capitalise on the London Olympics, the Millennium Diamond's raft of sophisticated technical advances including automation of the ship's systems enable compliance with new regulations for tidal river vessels, maximum exploitation in unstable cruising conditions and a new level of fuel and cost efficiency.

Operating sightseeing riverboats in cities like London, which has 30 million visitors a year, has huge potential – but the investment and risks can be equally significant. The tidal Thames, for example, rises and falls by up to seven metres a day and the difficulty and danger of navigating these changeable conditions with hundreds of people on board means that ideas for improving

The Millennium Diamond cruiser avoids human error in ship operation by automating the control and regulation of the vessel's systems

ship stability and safety are highly prized. So, too, are ways of adding to the advantages of minimising down-time due to water levels and weather with lower fuel consumption and higher passenger numbers so that greater revenues can be achieved for the same operational costs.

## Challenging brief

When English tour operator City Cruises wanted to add to its fleet of Thames riverboats these were the challenges outlined in its brief to the world's top boat builders. But they didn't stop there. The new boat also had to set new standards in terms of environmental efficiency and ease of access and use for disabled passengers. Brodarski Institute won the contract with a complete turnkey package demonstrating a fast and original approach to problem solving. Its solutions included a number of step-change innovations which would ensure that the new boat complied with the latest regulations for tidal river and coastal water vessels and 'big ship' classification rules from which such sightseeing cruisers had previously been exempt.

'The design work undertaken by the Brodarski Institute was a revelation to us, particularly the hull design and tank testing' Rita Beckwith, City Cruises

## Green cruising

The Brodarski Institute designed, tested and built a 37m long steel catamaran whose innovations include novel asymmetric hulls which reduce resistance and wash and thus the power and fuel required, and automatic regulation of the ballast tanks. This makes a vital contribution to the ship's reliability and profitability, enabling uninterrupted cruising at all tide levels, keeping the ship draught and height within design requirements regardless of the number of passengers on board. Powered by energy-efficient diesel engines adjusted to the low sulphur level of biodiesel fuel, the boat also has solar panels which continuously recharge its batteries, on-board recycling facilities and software to optimise noise abatement.

## High-profile flagship

The Millennium Diamond is the most sophisticated and cost-efficient boat on the Thames and carries 600 passengers at a time between three world heritage sites – Westminster, the Tower of London and maritime Greenwich. It is the first river cruiser to provide 360 degree panoramic views from the main saloon, as well as adaptations for passengers with limited mobility including level entry and a wheelchair lift to the upper deck. Many of its innovations are expected to be taken up by the wider shipping industry, particularly its unique ballast system, which is suitable for boats operating in similar conditions in sheltered waters and harbours.

'The London 2012 Olympic Games provided a catalyst for expansion and enabled us to commit to the development of the new vessel, which will allow us to deliver an inspiring experience on the River Thames for our passengers' Gary Beckwith, City Cruises



**Brodarski Institute** is a Croatian Research and Technology Organisation that creates, transfers and applies knowledge to help organisations develop innovative, high added-value products and services for domestic and international markets. Specialising in the marine industry, control engineering, renewable energy sources and eco technologies, the Institute has more than 60 years' experience of establishing partnerships providing customers with high quality, interdisciplinary support from its scientists and engineers and access to its specialised laboratories and equipment.

[www.hrbi.hr](http://www.hrbi.hr)



BRODARSKI INSTITUT d.o.o.



# Silent underwater surveillance system secures port safety and savings

Through the world's first use of underwater passive sonar technology, an entirely new kind of waterside security solution developed by EARTO member TNO will provide protection for the most important infrastructure hubs in modern society. Able to detect both small fast vessels and silent underwater divers, SOBEK sensors bring continuous, affordable and environmentally-friendly monitoring to commercial ports as they face growing threats from terrorists, thieves and smugglers.

Ports have developed watertight landside security solutions but, on the waterside, the lack of systems that are cost- and operationally-effective in the busy, shallow underwater environment has left the way open for crime to flourish. Existing active sonar products just aren't reliable enough in shallow waters, where reflections from the sea bed, quays and debris result in false alarms. They are also prohibitively expensive. With divers stealing from port premises as well as removing smuggled drugs from ships' hulls and terrorists seeing port facilities, weirs, cargo ships and cruise liners as potential targets, a novel, affordable technological approach was vital.

Estimates of the global market for SOBEK's passive sonar technology range from a conservative €10m to about €50m if waterside security legislation becomes mandatory in civil ports

## Silent solution

When imminent EU legislation and international trade partners both demanded urgent action on waterside surveillance, TNO explored the potential of passive sonar technologies. By just listening without emitting any sound, and filtering out natural background noise, passive sonar sensors known as hydrophones can record almost inaudible sounds such as scuba diving equipment. Using these as the basis of its SOBEK solution, TNO then developed the smart signal processing methods to distinguish between relevant and non-relevant sounds. By using a number of sensors in different locations, it is possible to determine the exact location of the threat.

Just taking into account the cost of the sensors for waterside surveillance covering the full water domain area of Rotterdam Merwe harbour with active sonar sensors would cost approximately €1,250,000 - but only about €200,000 with SOBEK sensors, which also cost less to maintain and power

## Harmless operation

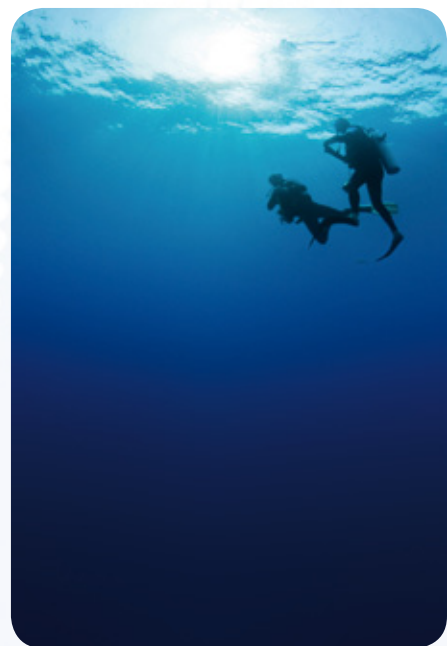
The resulting system enables remote monitoring of the underwater domain, the tracking of invisible threats and automatic alerts being sent to security personnel. Its silence is advantageous - intruders are unaware of its presence or whether they have been discovered and underwater life is not harmed in any way. SOBEK's low costs and flexible configurations make it economically feasible for use in civilian ports, yachting harbours, large coastal areas and longer shipping lanes as well as military applications where sensors could be quickly deployed, for example, around a frigate in hostile waters.

## Broad applications

SOBEK's first full prototype, developed by TNO with AVIC and supported by Dutch customs, is a basic diver detection system. The system dramatically reduces the risk for customs divers of dangerous underwater encounters with criminal divers, giving them real-time information via a smart phone or tablet to help them decide whether to enter the water to inspect ship hulls for drugs. TNO is currently working with Danish firm Brüel & Kjær which aims to produce and commercialise the technology for the port and maritime markets.

'We see SOBEK as a key technology which allows us, due to its unique passive detection principle, to differentiate ourselves from active solutions in the market. Our customers, who are required to provide solutions to increasing security threats, have expressed the view that the combination of TNO's SOBEK technology with our global organisation and data acquisition and handling solutions provides great value to the security market' Patrick Wethly, Brüel & Kjær

'SOBEK represents a breakthrough that's not just about security in ports. It concerns all areas where you don't want divers and small boats, such as coral reefs, underwater reserves, wrecks, archaeological finds, flood-control dams, water inlets or nuclear power plants' Martijn Clarijs, TNO



TNO is an independent Research and Technology Organisation in the Netherlands committed to the application of scientific knowledge with the aim of strengthening the innovative power of industry and government. TNO works in the core areas of quality of life (healthy food, good working conditions, healthcare and sports), science and industry, the built environment and geosciences and information and communication technology.  
[www.tno.nl](http://www.tno.nl)

**TNO** innovation  
for life

# Test for predicting Alzheimer's will reduce the financial and personal cost of this debilitating disease



An FP7 collective research project led by EARTO member VTT Technical Research Centre of Finland has developed an objective indicator for diagnosing Alzheimer's disease at the earliest possible stage which represents a significant step towards reducing patient suffering and healthcare costs. By bringing together a broad range of biomarkers and a new kind of computer software for combining data, the PredictAD project created a reliable early diagnosis and decision support system with the potential to play an important role in effective medical treatment of the disease particularly as the next generation of therapies becomes available.

Alzheimer's disease is the most common cause of dementia, which has been identified as a health priority in Europe and the US. It already accounts for costs equivalent to about 1% of the world's GDP and an ageing population will only increase this financial burden on society. It is widely believed that a breakthrough in early diagnosis would open the door to treatments that could target the disease before the onset of irreversible brain damage or mental decline and delay the need for hospitalisation. As early symptoms are vague, biomarkers capable of predicting the disease before signs become apparent are seen as the great white hope for improved medical understanding and care.

The estimated annual cost of Alzheimer's disease to European society today is more than €55 billion - if the onset of the disease could be delayed by five years, the costs incurred would be halved

## Biomarker breakthroughs

With no existing validated biomarkers for Alzheimer's disease, PredictAD's eight collaborators set about discovering novel biomarkers from many different sources including brain images, blood samples and clinical tests to give a holistic view of a patient's status. A number of breakthroughs by VTT feature in the selected optimal biomarker set, including a tool to measure tissue loss in the brain's hippocampus. The

accompanying decision support system compares the patient's biomarkers with a large database to give an index, which is a barometer of the disease, and a graphical representation of the individual's physical state.

There are around 100 medications currently being developed to treat Alzheimer's and earlier, more accurate diagnosis will become even more important once effective medical treatments are discovered

## Universal value

The PredictAD solution is easy for physicians to use in the clinical setting, bringing a new level of accuracy, objectivity and speed to how they assess risk,

make early diagnoses and monitor the progress of the disease and the efficacy of treatment. The new diagnostic methods and technologies developed by the project will not only lead to better quality of life for those who suffer from Alzheimer's disease. As the system is generic, the human and commercial potential of the innovation will extend far beyond this one disease.

## Revenue potential

The PredictAD system has been piloted in Finland and Denmark and is currently undergoing clinical tests in three hospitals for further validation of usability and effectiveness. The image segmentation tool, which calculates hippocampus volume, has already been licensed to one company and negotiations are currently underway with several others interested in licensing the PredictAD tool and metabolic biomarkers. Estimations of market potential are difficult given the lack of comparable tools, but even a conservative assumption of 1-2% market share indicates that revenues of up to €9 million annually may be achievable.

'The PredictAD tool gives a personalised profile of the patient's state. This is the way to go in enabling the early diagnosis of Alzheimer's disease. It can be customised to include different sets of tests for different countries and languages, which means it has great potential and can be applied widely in Europe as well as globally. I am looking forward to seeing this tool integrated into the clinical environment.' Hilikka Soininen, University of Eastern Finland



VTT Technical Research Centre of Finland is the biggest multi-technological Research and Technology Organisation in northern Europe. With its staff of 3000, its unique research facilities and extensive global co-operation networks, it provides leading-edge technology solutions and innovation services for clients in the public and private sectors. VTT works to enhance its customers' competitiveness and competence, creating the prerequisites for society's sustainable development, employment and wellbeing.  
[www.vtt.fi](http://www.vtt.fi)





# Ultrasound cleaning system washes away wasteful practices in the food industry



A completely new kind of conveyor belt cleaning rig, developed by an FP7 consortium including SinapTec, a member company of EARTO member ASRC, is helping Europe's food industry SMEs reduce their environmental impact and improve their global competitiveness. By coupling ultrasound with low water pressure delivery, the LOWTEV washing system removes bacteria, cuts energy and water use and increases productivity - and has the potential to achieve similar results in industries such as pharmaceuticals and engineering.

Stringent cleaning of conveyor belts is vital for any business involved with bakery and confectionery, salads and sandwiches, fruits and vegetables and cooked and uncooked meats. Washing equipment must prevent the spread of biofilm created by micro-organisms such as bacteria, yeast and mould, a task that has traditionally involved high volumes of water, heat and chemicals. A new approach was clearly needed to reduce the use of all three at a time when the balance between water demand and availability is reaching a critical level in many areas of Europe and 230,000 small food firms are seeking smart cost-saving solutions.

The LOWTEV system reduces the volume of water used for cleaning by 60-80% and achieves water, energy and productivity savings estimated to be worth between €10,000 and €37,000 per factory per year

## Bubble breakthrough

The LOWTEV (Low Temperature and Lean Volume Cleaning System) collaborators combined their expertise in food science and processing, system design, ultrasonics, automation and engineering to devise a system based on a novel ultrasound transducer capable of cleaning and sanitising surfaces with low pressure water, which they then integrated with an automated monitoring system. The transducer develops tiny bubbles with core

temperatures of over 1000°C which act like millions of tiny brush bristles to thoroughly clean even the greasiest of conveyor belts.

## Rapid returns

The project achieved its primary goal of reducing the amount of cleaning water needed to achieve relevant food safety and quality standards - by as much as 80%. As the water used doesn't have to be hot, energy consumption is cut too. The technology even removes the need for chemicals altogether and protects against foodstuff contamination including allergic proteins as well as biofilms. With its faster clean cycle time and lower labour costs, the system can increase productivity by 10% per line per year. The value of all the system's benefits add up to a return on investment in less than 12 months.

'We have now extended the project as a 'demonstration action' with seven partners, including four user companies who will be validators for this technology in their respective trades - fruit and vegetables, bread and sandwich fillings, cooked and fresh meat and fresh fish' Pascal Tierce, SinapTec

## Market ambitions

After testing a prototype in industrial configurations, the team has now moved on to a full-scale demonstration project, LOWTEV II. This will see the system implemented in an industrial environment for commercial validation. Once the industrialisation process is complete, SinapTec intends to take the system to market. Estimating that it could capture 3% of the European market, SinapTec believes that 500 systems could be sold within the next five years at a total cost of over €10 million.



**SinapTec** is an independent SME with over 25 years' experience in the development of innovative ultrasound solutions for use in research and industry. Approved as a private research and technology organisation by OSEO, the French innovation agency, SinapTec designs and develops solutions in collaboration with clients - and its intuitive NexTgen platform also allows them to manage the development of their own ultrasonic solutions.

[www.sinaptec.fr](http://www.sinaptec.fr)

**The Association of Contract Research Structures (ASRC)** is made up of 40 private research and technology organisations across France. It is dedicated to delivering innovative solutions for businesses and government agencies to improve efficiency, productivity and competitiveness in many sectors including health, food, energy, materials, transportation, logistics, IT, defence and security.

[www.asrc.fr](http://www.asrc.fr)





# New processes prove a recipe for success for Europe's chocolatiers



Two intractable problems that have beset chocolatiers for centuries have been solved by an FP7 collective research project<sup>1</sup> led by SIK, which is part of SP Technical Research of Sweden, an EARTO member. ProPraline developed guidance and processes to prevent the grey film known as fat bloom and the cracks that can mar pralines, enabling smaller manufacturers to produce better quality products with a longer shelf life, better flavour intensity and higher value - and capitalise on the growing interest in boutique brands.

Europe has a noble tradition of fine chocolate making. It's a tradition which, today, generates a turnover of €50 billion and exports of €4 billion. But the delicacy of chocolate and the complexity of the production process mean perfection is difficult to achieve consistently - and the reputation of luxury brands can be ruined in an instant. At the heart of the problem is a lack of understanding of the physical chemical mechanisms behind the thin crystallised layer of dull bloom caused when fat from fillings migrates to the chocolate casing and the surface cracks created when liquid content escapes and makes sugar and cocoa particles swell.

## Methodical approach

The €3.2m ProPraline project led by SIK aimed to resolve these issues once and for all so that SMEs, who account for 90% of Europe's chocolate industry, can secure - and sustain - a global reputation for premium niche products. By establishing a methodology for quality assessment, studying the role of chocolate microstructure and analysing chocolate shell and filling composition and manufacture, the project developed a broad range of improvements. These include chocolate microstructures with enhanced cracking and fat migration resistance and processing solutions, based on a new understanding of the relationship between structure, properties and process, to tailor-make these microstructures.

It's estimated that as much as 143,000 tonnes of chocolate produced in Europe are affected by fat bloom or cracking - with a cost to the European industry of €1.2 billion a year.

## Wide communication

To spread the word about the project's findings and solutions and maximise its impact, the three national SME associations involved have disseminated the results to their members, 11 demonstration lines have been set up, practical training workshops have taken place all over Europe and handbooks and course material are freely available on the project's website ([www.sik.se/propraline](http://www.sik.se/propraline)). Over 500 companies have downloaded documents from the site and the project has been presented at 90 conferences and generated 40 publications.

ProPraline is predicted to lead to a 5 to 10% increase in sales of European chocolate pralines

## Increased innovation

Armed with their new knowledge and reliable and reproducible processes, many of Europe's chocolate makers are now producing quality chocolates which are better able to withstand storage and reach the customer with their full flavour, aroma and shell intact. By reducing product recall and business risks, ProPraline is responsible for encouraging and enabling a more innovative approach to the creation of products with ever-more exotic fillings. The project has also led to the creation of start-up ChocoWinS, which offers a new energy-efficient process solution for chocolate production.

'Especially for the many small-scale chocolate producers in Europe, the project adds very important resources which will help improve the quality of their products and thus their competitiveness' Håkan Björklund, Swedish Chocolate, Confectionery & Biscuit Manufacturers' Association (Chokofa)



The Swedish Institute for Food and Biotechnology (SIK) is a Research and Technology Organisation dedicated to strengthening the competitiveness of the food industry. It conducts strategic and applied research for industry in accordance with a goal-oriented research programme and in the form of joint industrial projects.

[www.sik.se](http://www.sik.se)

SIK is owned by SP Technical Research Institute of Sweden, a centre for research and innovation which develops, tests and evaluates technologies, materials, products and processes for national and international customers. Providing an effective link between research and commercialisation, the Institute takes a holistic approach based on interdisciplinary cooperation to innovation in its core areas of building and construction, electronics and ICT, fire, risk, safety and security, foods, materials technology and chemistry and measurement technology and calibration.

[www.sp.se](http://www.sp.se)



<sup>1</sup>Research for the benefit of specific groups (in particular SMEs)

# Time-of-Flight camera marks a milestone in man-machine interfaces



Efficiency, size and quality advances made to 3D depth mapping cameras by EARTO member CSEM mark the transition to a new era of human-computer interfaces. By unlocking the potential of Time of Flight (ToF) cameras, which capture multi-dimensional images in real time by calculating distance based on the time it takes light to travel between the camera and each point in the entire field of view, CSEM has ensured that this exciting technology for tracking human movement can now realise its potential in touchless device control.

Digital images impact just about every aspect of our working and personal lives but in two dimensions key information about depth is missing. Unlike a conventional video camera, a ToF camera can plug this gap by generating 3D images containing a distance measurement based on the ToF principle at each pixel. As other 3D imaging technologies such as laser scanners are bulky, can be inaccurate and require time-consuming calculations, the speed and simplicity of ToF imaging make it the most promising platform for the gesture detection and object tracking needed to enable new interactions with phones and laptops and new healthcare applications such as remote patient monitoring.

## Multiple advances

These two fields were the focus of FP6 project ARTTS (Action Recognition and Tracking based on Time-of-flight Sensors). As one of the originators of ToF technology, consortium-member CSEM knew that realising its full potential would demand an increase in depth resolution and signal quality and a reduction in power consumption, size and cost. By improving the underlying technology and developing new algorithms - the codes that control the ToF sensors - for action recognition and object tracking, the

collaborators achieved these goals, creating an affordable and adaptable system that recognises the subtlest of gestures and has the widest of applications.

## Precise measurements

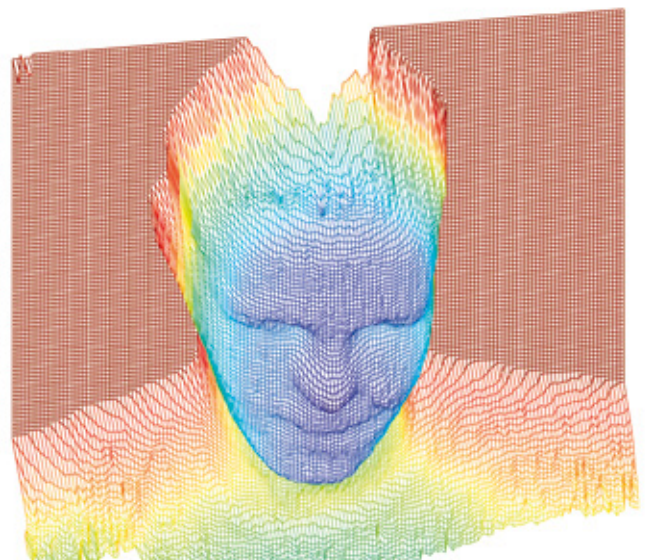
At the heart of the high expectations for the new and improved ToF technology is its outstanding accuracy and speed. The camera uses active illumination - in the form of in-built infrared diodes or lasers - so that high resolution images can be acquired in real time. More than this,

the illumination is modulated to enable the level of near-range accuracy needed for use with smart phones. As this depends on how quickly the brightness changes, the researchers built a light source that can change up to 100 million times a second. The robustness of range maps was also improved by combining distance measurements with light intensity measurements, so that each set of data can corroborate the other.

## Diverse applications

Start-up gestigon ([www.gestigon.de](http://www.gestigon.de)) is commercialising the ARTTS advances, offering gesture recognition software for gaming, healthcare and automotive applications. The ARTTS team is also working on a gesture-based aid which will give surgeons access to the images and information they need in the operating theatre. MESA Imaging ([www.mesa-imaging.ch](http://www.mesa-imaging.ch)), another start-up involved in the ARTTS project, is applying ToF sensors in a number of markets, including security and logistics. The widest application so far has come from an unexpected source, the dairy industry, where they are used to connect cows' udders to automatic milking machines.

'We had to show that you could develop sensors small enough that you can imagine people putting them into webcams, computers and even mobile devices. What makes this new camera different is that it really is a lot smaller and more power efficient than what existed before. It only requires a USB port for power and it still retains the properties of machines that are much bigger, heavier and energy consuming' Professor Erhardt Barth, University of Lübeck



Start-up gestigon, which is commercialising the skeleton tracking and gesture recognition software based on ToF technology, won a 2011 Start-up Award for ICT innovations from Germany's Federal Ministry of Economics and Technology and a WECONOMY 2012 award funded by German newspaper Handelsblatt and the Wissensfabrik consortium

CSEM is a Swiss research, development and innovation centre specialising in micro and nanotechnology, nanomedicine, robotics, packaging and information technology. The centre creates a dynamic link between research and high-tech industry, and also collaborates with other innovation centres on appropriate solutions for cutting-edge products and applications.  
[www.csem.ch](http://www.csem.ch)

**csem**



# Green textile machine brings material benefits to the European industry



A new generation knitting machine with a greatly reduced environmental impact, developed by an FP7 project coordinated by EARTO member D'Appolonia, will help secure the future of the European textile industry. By combining novel mechatronic concepts with lightweight materials and a unique carbon footprint calculator, the Nu-Wave project has woven together a winning solution that not only increases productivity and opportunities for added-value textiles but also reduces energy use by 60%.

Re-engineering traditional textile machines had become imperative if European textile machinery manufacturers and textile producers were to see off the threat posed by low-cost competitors. With the Far East filing more patents for new textile machines than anywhere else and China's textile exports rising by 24.3% in 2011, there was a clear need to reinvigorate the European industry. There was also an obvious route: focusing on growing global demand for sustainable technologies that will provide the same quality products at lower cost.

The Nu-Wave textile machine has a reduced carbon footprint of 1kg of CO<sub>2</sub> per hour compared to a traditional machine

## Knitting novelties

Nu-Wave aimed to design a completely new machine that would leapfrog existing piecemeal approaches and give customers the breakthroughs they were seeking in terms of resource efficiency, high-performance and flexibility. Research led the collaborators to a modular machine design introducing concepts such as distributed electro-mechanical actuations with sensing capability and fewer, but smarter, components with innovative surface treatments within lightweight carbon-fibre weft bars and shafts. Virtual prototyping software was also developed to help SMEs design and validate their own designs based on the new machine template.

'The type of new machines enabled by the implementation of technologies developed within Nu-Wave have the potential to be sold worldwide to both the low cost and added value markets and it is predicted that they will enable Italian textile machine manufacturers to generate an additional 10% on their current total annual turnover of €5 million' Andrea Pestarino, D'Appolonia and Nu-Wave co-ordinator

## Production advantages

The resulting demonstrator confirmed that these advanced features considerably reduce energy consumption and the cost of textile production. Not only do the smart materials give greater wear and temperature resistance, improving performance and longevity, but production speed can also be increased by 10% as the smaller size of the machines enables more to be installed in the same space. Working conditions are improved too as a result of decreased noise and vibration and there is far greater flexibility, so users can move easily from mass production to highly variable and functionalised textile products.

## Emissions evidence

The project also created a user-friendly web-tool for calculating the environmental impact of any textile machine. This Green Label tool, which produces labels detailing a machine's technical specifications and carbon footprint, will make it easy for manufacturers to highlight the low environmental impact of their equipment, purchasers to select the most eco-friendly option for their needs and textile producers to assess how technical improvements influence a machine's sustainability.

## Industrial action

All SMEs involved in Nu-Wave have access to specialised consultancy from D'Appolonia to help them make use of the project's innovations. Over 30 SME members of Italy's textile machine manufacturers association ACIMIT have so far used the Green Label as part of their sales efforts. A further FP7 initiative is now underway to develop solutions to enable Nu-Wave's innovations to be commercialised. After this, Italian textile equipment manufacturer Comez Gestioni will launch a new machine for the production of textiles for underwear and lingerie.



D'Appolonia is an Italian engineering and innovation consulting firm providing integrated services to private and public sector customers in the environment, energy, oil and gas, construction, transport, space and security sectors. With over 600 engineers and scientists, the company supports customers from conceptual design and definition of specifications up to implementation, optimisation and validation.  
[www.dappolonia.it](http://www.dappolonia.it)

**D'APPOLONIA**



# Pioneering computer-based assessment platform for educational testing gets top marks for cost, flexibility and sophistication

EARTO member CRP Henri Tudor has pioneered a powerful new kind of computer-based assessment (CBA) software which will enable e-Testing to enter the mainstream education market. The generic, open-source TAO platform puts into the hands of users for the first time a free, versatile and highly-extensible framework for creating, managing and delivering online tests customised to their exact needs. TAO's unparalleled flexibility and openness mean that it can be adapted to virtually every evaluation purpose for thousands of test takers by educational, professional and governmental organisations.

The transition from paper and pencil tests to CBA has just begun, opening the door to all kinds of new assessment modalities, widening the range of skills that can be assessed, providing educators with immediate feedback and offering greater cost-efficiency. It's estimated that there are at least 600,000 potential global customers for CBA tools, from governments wanting to measure the impact of education reforms to schools and universities wanting to introduce innovative test questions and better prepare students for the 21st century. Progress is being hindered, however, by today's proprietary products, which lock customers in with expensive and inflexible solutions.

## Pioneering combination

Convinced that e-Testing could only realise its potential if this entrenched market was challenged by an open architecture system which would reduce acquisition and operating costs and enable collaborative distributed test development and delivery, CRP Henri Tudor and the University of Luxembourg, in cooperation with DIPF, the German Institute for International Educational Research, set out to develop a platform to meet these needs. Among the critical innovations behind TAO is the pioneering integration of two disciplines: advanced knowledge technologies and psychometrics, combined with sophisticated tools to measure knowledge, ability and personality.

## Customised assessment

Built on a semantic web foundation and made up of a series of interconnected modules, TAO allows individual users to define their own data models so they can design assessments of all kinds according to both their unique needs and the latest advances in testing theory. It is suited to a wide range of assessment needs, from simple multiple-choice tests to advanced interactive simulations and collaborative tests as well as the testing of non-cognitive competencies such as social skills. By exporting TAO's results into dedicated statistical analysis tools, correlations can be made between individual test scores and behaviours to give valuable insights into the strategies used by test-takers to solve problems.

## International impact

Freely available to download from the web at [www.tao.lu](http://www.tao.lu), TAO has already been used to administer close to one million tests across more than 30 countries. In Luxembourg, it plays a key role in making the national evaluation of students moving from primary to secondary school faster and more efficient. In Sweden, medical and dentistry students take TAO-based exams. The platform has also been used successfully for the OECD's large-scale PISA (Programme for International Student Assessment) and for the PIAAC study (Programme for the International Assessment of Adult Competencies) which runs in 25 countries in 38 languages. TAO's universality makes it equally well suited to use as a tool for research in educational science, psychology, CBA-related disciplines in general, educational measurement, talent management and professional assessment, which has prompted plans for a commercial services spin-off company.

It is predicted that TAO could impact the e-Testing market just as the IT market of the late 1980s was revolutionised by open systems which led to a tremendous reduction in cost for end users, innovation and the emergence of profitable smaller providers



'In Hungary every student at grades 4, 6, 8 and 10 is assessed every year in reading and mathematics. These paper-based tests are mostly used to enable schools to improve educational processes but they are not frequent enough, and the feedback is not fast enough, to support students' everyday learning processes. A TAO-based online diagnostic system will provide students with frequent, detailed and contextualised feedback information' Beno Csapo, University of Szeged

CRP Henri Tudor is a Research and Technology Organisation in Luxembourg which provides an essential link between research and society, reinforcing the innovation capacity of businesses and public organisations and contributing to the development and transfer of knowledge and the international influence of Luxembourg's scientific community. The organisation, which has 462 employees, focuses on five areas of technology: advanced materials, environmental, healthcare, ICT and business organisation and management. Its innovation programmes target markets of the greatest importance: industry, construction, ecotechnologies, mobility, transport and logistics, health, public services, finance and human capital.

[www.tudor.lu](http://www.tudor.lu)

**tudor**  
PUBLIC RESEARCH CENTRE HENRI TUDOR

# Sensor systems generate a wave of improvements for safe, smart dykes of the future

Dyke monitoring systems developed by a project led by EARTO member TNO to reduce the risk of flooding and increase the effectiveness of water management have huge potential around the world. By integrating innovative new sensor and communication technologies, the IJkdijk project is building knowledge about failure mechanisms and design optimisation which will enable the building and maintenance of smarter, cheaper and safer sea and river defences.

A centuries-long battle against water has provided countries like the Netherlands with a great deal of knowledge about dykes, but while weak spots and their causes remain hidden, there is always the risk of catastrophic damage. With hundreds of millions of people on the planet protected by dykes, and climate change resulting in rising sea levels, a new way of predicting weakness and preventing disasters was needed that would be more accurate than existing practices and more sophisticated than simply adding clay to increase dyke height.

It is estimated that the Dutch market for IJkdijk technologies could be about €200m, the European market €2,000m and the world market up to €50,000m

## Early warning

TNO initiated the fieldlab IJkdijk ([www.ijkdijk.nl](http://www.ijkdijk.nl)), a large-scale research facility, to collaboratively develop and test sensor networks measuring water pressure, vibration and other factors inside dykes to create water barrier inspection and early warning systems. Through systematic experiments generating real-time data about the test embankment's stability, internal erosion and

response to overstress, the project brought much-needed certainty to calculation methods for embankment strengths, clarity about the reasons for dyke failure and precision to forecasts of future performance.

## Informed decisions

IJkdijk optimises the monitoring, management and maintenance of large-scale water defences, protecting citizens, homes, agriculture and industry from flooding. By bringing a new level

of understanding to the geophysical processes of failure mechanisms through the continuous, 'live' investigation of embankments up to thousands of kilometres long, its technologies enable informed decision-making in the event of imminent flooding, more efficiently scheduled maintenance work and optimised and less costly strengthening solutions - which currently cost the Netherlands alone up to €1,000m a year.

## Live projects

IJkdijk technology is now being used in Dutch water defences through 12 'livedyke' projects whose data will be made available to water authorities through a Dyke Data Service Centre. The first true sea dyke implementation will soon start monitoring the performance of 22km of sea wall along the Netherlands coast. TNO and partner AGT are installing sensor systems from Alert Solutions and TenCate Geosynthetics in China to make the Yellow River (Huang He) delta safer. These companies are among the first to benefit from the fieldlab IJkdijk's open innovation environment, launching monitoring systems first tested at IJkdijk which provide early warning of deformations in soil structures.



'By investing €100,000 in a sensor system we saved about €5m which would otherwise have had to be spent on dyke improvements. The technology generates information that we can translate directly to meet strengthening and stabilisation demands and in this way we can guarantee safety with less robust design and thus save millions of Euros' Peter Jansen, Waternet Amsterdam

TNO is an independent Research and Technology Organisation whose expertise and research make an important contribution to the sustainable competitiveness of companies and organisations, to the economy and to the quality of society as a whole. TNO's unique position is attributable to its versatility and capacity to integrate its knowledge. The organisation works in seven core areas: healthy living, defence, safety and security, industrial innovation, energy, built environment, transport and mobility and information society. TNO Innovation for Life.

[www.tno.nl](http://www.tno.nl)

**TNO** innovation  
for life

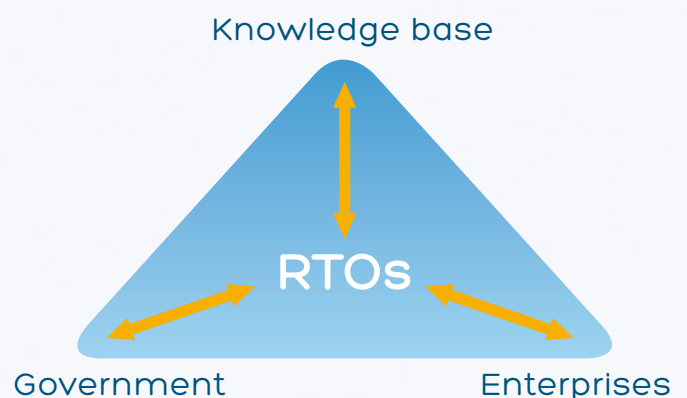
## EARTO

- ✧ is the European trade association of the Research and Technology Organisations (RTOs), a non-profit organisation founded in 1999
- ✧ promotes and defends the interests of its members towards European institutions and others
- ✧ provides its members with information and networking services to help them make the best use of European programmes relevant to research and innovation, to identify and develop joint interests, and to exchange professional experience and good practice
- ✧ groups over 350 Research and Technology Organisations with a combined staff of 150,000, an annual turnover of €15 billion, specialised equipment and facilities to a value of many € billions, and more than 100,000 customers annually

## Research and Technology Organisations

The core mission of Research and Technology Organisations is to harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness

RTOs occupy nodal positions within innovation eco-systems, bringing together key players across the whole innovation chain, from fundamental to technological research, from product and process development to prototyping and demonstration, and on to full-scale implementation in the public and private sectors









[WWW.EARTO.EU](http://WWW.EARTO.EU)