ENTERPRISE IRELAND

‘From Bench to Boardroom - Commercialising Irish Research’

The Best of 2007-08

Transforming Irish Industry

‘From Bench to Boardroom - Commercialising Irish Research’

The Best of 2007-08

Foreword

Mary Coughlan T.D
An Tánaiste and Minister for Enterprise, Trade and Employment

The Government's Strategy for Science Technology and Innovation and underpinning commitment of €8.2 billion under the NDP is designed to ensure maximum economic and social benefits for Ireland. The Government wishes to see the translation of research outputs into tangible technologies, products and services as the ultimate focus of this effort.

The transfer of knowledge, technology and intellectual property from Ireland's research institutions into the economy is critical to Ireland's economic success in the more competitive times ahead. Discoveries must be quickly translated from the research centres to the business world and the focus of that research must be on relevant areas of endeavour with the potential to have practical application.

I strongly welcome this publication which testifies to the excellent results that the Exchequer investment is facilitating. I appreciate that what is here is only a snap shot of the extensive applied research going on in Ireland's Universities and Institutes of Technology. I am delighted to see the profiling of some of Ireland's finest researchers and the application of their work to the challenges faced by companies and individuals every day in areas such as health, waste management, transport, manufacturing, telecommunications, environment, food and the marine.

The most exciting aspect of this applied research activity is that many of the researchers are producing solutions to problems that are on the horizon for many companies. It is this curiosity and vision possessed by our talented researchers that is so valuable to Irish enterprise and which will prove to be the key to our future success.

Among our European peers, Ireland's recent development is seen as a success story to emulate. This success has been achieved through our flexibility and creativity and through the development of a highly skilled and quality work force in which our high achieving educational system has played no small role.

I commend Enterprise Ireland for putting in place a strong network of talented technology transfer and commercialisation specialists all over the country. Enterprise Ireland must be an active conduit between the research sector and the enterprise community and create linkages that yield dividends for researchers, companies and the economy.

It is an intensive and time consuming process but the benefits of research commercialisation, as this publication testifies, more than outweigh the effort.
Building bridges between our educational system and business sector is critical if we are to capitalise on the potential that exists in research. I congratulate the researchers featured in this publication and the wider applied research community on their achievements to date and I look forward with interest to future developments.

Introduction

Frank Ryan
CEO Enterprise Ireland

Enterprise Ireland's role is to accelerate the development of world-class Irish companies that can achieve strong positions in global markets and increase their exports. This in turn leads to increased national and regional prosperity.

Our 2008-2010 strategy is built around the goal of achieving growth for Irish companies through innovation and strong leadership.
There are many challenges facing companies that want to increase productivity, exports and profits. Ireland is a small country with an open economy which makes it difficult to protect our economy against global factors.

However, Ireland has a number of strengths – a small, open, flexible economy and a young well educated population – that give us the competitive edge as we continue to build our economy around new ideas and knowledge.

Enterprise Ireland is at the forefront of this move and is fully committed to progressing the research and innovation agenda in this country. We have put innovation at the heart of our new corporate strategy and we are not just helping companies to build their own innovative capability but through our Commercialisation Network, we are also releasing the huge potential of the research system into the business sphere.

Since 2000, Enterprise Ireland has invested €275 million in the third level research and innovation system to drive the transfer of research from the third level sector into useful products, technologies and services for enterprise. To maximise the impact of this, Enterprise Ireland has built a strong and sophisticated commercialisation network in the Irish third level sector to make the vital connections between Irish companies and the wealth of knowledge and expertise available in third level colleges.

The Enterprise Ireland Commercialisation Experts and on-campus Technology Transfer Officers that make up this network, work closely with researchers to take their research from the bench in the lab to the company boardroom.

A further €30 million is being invested by Enterprise Ireland through the Technology Transfer Strengthening initiative. This initiative will ensure researchers have access to the right expertise on their own campus to ensure that intellectual property is identified, protected and transferred, where possible into companies in Ireland.
A customised programme for the Institutes of Technology to support their needs, which are different to those of Universities, has also begun.
The results of all of these investments are impressive – during the period 2005 – 2007 the third level sector has produced 95 licences, 26 start-up companies and hundreds of patents and invention disclosures. 2007 alone saw 136 patents filed and 264 invention disclosures by researchers.

Behind these figures are the success stories of research that has had a real impact on society, producing innovative solutions to problems like disease, waste management, climate change and energy shortages.

This publication contains 18 of these success stories. The researchers profiled here have delivered valuable solutions to real company challenges and the products and technologies they have developed can be likened to the first green shoots appearing in Spring – the investment is producing real results.

Enterprise Ireland wishes to acknowledge the hard work, talent and commitment of applied researchers all over Ireland. These selected profiles provide an insight into how solutions and technologies are brought to the marketplace where they will begin life as products and services for sale. From an Enterprise Ireland perspective, the 18 stories featured here represent the best of research commercialisation and the researchers involved are to be congratulated on their work.

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Harder surfaces

A wider beam is broadening the range of laser applications for the manufacturing industry.

Lasers are often thought of in terms of needle sharp beams, and as such they are used widely as a cutting tool in engineering. However, as Prof Gerry Byrne and Dr. Eamonn Ahearne at the Dept of Engineering in UCD explain, a wider beam can open up a range of other, surface treating, applications. Instead of burning through the material, a wider laser beam can be used to harden surfaces by inducing a sharp localised rise in temperature.

The UCD engineers first became interested when Damler Chrysler started investigating the possibility of integrating laser technology into machine tools. "We thought the laser technology itself seemed promising," said Eamonn, so they decided to concentrate on this and see if they could make improvements.

There is big potential, he said, to use lasers in hardening surfaces. The sharp rise in temperature can be applied with great precision to many different surfaces, and the effect is similar in some respects to traditional tempering. Laser hardening, said Eamonn, already existed, but only as a very specialised service, and the UCD engineers aimed to come up with something a lot less expensive and more accessible to manufacturers.

For three years Eamonn and two post grads worked under Prof Gerry Byrne on the Enterprise Ireland funded project, the results of which could bring laser hardening within reach of many industries. The laser works very well, said Eamonn, and up

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Prof. Gerry Byrne & Dr. Eamonn Ahearne
University College Dublin

to now it would have taken a much more expensive system to achieve anything like the same kind of performance.

Prof Byrne said that laser delivers a lot of power, yet the unit is smaller than a shoe box, making it suitable for inclusion in a production line. "Any company making components that require hardening," he said, "could use this system.

"It's a technology waiting to be applied," said Eamonn, and he described the range of possible applications as enormous. Hardening the surface of glass ceramics, for example, would mean that medical implants would have a much longer life, and because the beam can be directed with great precision, its is possible to be selective in hardening just one portion of a part. For example, the end of a shaft, where more wear is expected, could be toughened. Another area where laser hardening is likely to be popular is in mould making. The moulds and dies used to churn out or stamp parts into shape are expensive to make, so manufacturers want them to last as long as possible.

The technology has been licenced out to ABS Pumps a major pump manufacturer, and as Prof Byrne explained, there is a lot of interest in applying laser hardening at the micro end of manufacturing. As with the manufacture of larger components, parts often have to be sent out for hardening, but because the laser unit is so compact, it could be integrated as part of the process. Integration would also mean less reliance on robotics to guide the laser, and as Prof Byrne pointed out, these are significant savings. Not surprisingly, he remarked that manufacturers are very keen on the idea of integration.

While batch or mass producers could cut costs through integration, Eamonn said laser hardening could also be offered to manufacturers as a service. At present, he said, manufacturers are sending parts out of the country for hardening, but they could be getting the same job done here a lot faster and with less cost. Discussions are in progress now with a company interested in providing that service to industry.

Internationally the laser hardening system is likely to have a big market, and during the project the engineers worked closely with NovaUCD to ensure that developments had adequate protection. "It's a completed project at this stage," said Eamonn, and the preference at UCD is to licence out the technology rather than going into manufacturing and marketing. There is strong local interest in applying the technology, but for a world market, Eamonn said it could make sense to licence the laser system out to one of the major international players.

Output
Licensed to ABS Pumps

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Leaking information

Machines are being trained to stop the escape of sensitive documents

Home and office computers have become a window into a world of information, but all too often we end up looking at things we should not see. Ease of file transfer means that personal details are all too easy to pass on, and as we all know from recent high profile cases, the loss of a single laptop can mean a serious breach of security for thousands of people.

Prof Padraig Cunningham at the School of Computer Science and Informatics in UCD said that this kind of information leakage is a serious issue, especially in legal and financial sectors, but it can be controlled.

Prof Cunningham first became involved with the problem through an Enterprise Ireland supported project to stem the ever mounting volume of spam. "What we produced," he said, "was a text classification system that was able to detect key words in email messages." The system worked quite well, but the UCD researchers realised that a lot of other people were looking at the same problem. "At the end of the project, we commissioned a business analysis study," said Prof Cunningham, "and found that the spam market was saturated and other applications for the same technology had better prospects."

The area they identified was control of what is known as 'information leakage'. For a variety of reasons, sensitive files are turning up on laptops, and in breaching traditional security

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Prof. Padraig Cunningham
University College Dublin

barriers personal details can escape and may end up being seen by everyone on the internet.

The original spam project was based on machine learning. The researchers would give the machine a bundle of legitimate messages, and a bundle of spam, and the system would quickly learn how to spot the difference. "It's much the same with learning how to pick out sensitive documents," said Prof Cunningham, only the parameters are a bit different. "It might be names and addresses," he said, it could involve CVs from a HR department, or legal contracts, all of which have characteristic traces that can be picked out by a trained machine. "We are running tests on this now," he said, "and we are getting accuracies of about 91 per cent." This approach to screening can be a lot more effective than human supervision, because people processing data may not always realise that information is sensitive.

The system goes beyond a simple blocking response, and documents are ranked according to perceived risk. This means the system can be used as an auditing tool, and if a laptop, for example, comes up suspiciously high, it can be checked.

An Irish company is now running trials with licencing in view. The company, Pixalert, already provides an auditing service, and Prof Cunningham said this could be the way to go, or the filter could be marketed as a stand alone product. "The unique selling point," he said, is ease of set up." Once the machine has been fed a set of examples, it will continue to act as a security filter, and if necessary, the system can be retrained.

Output
Licence imminent

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Containing cancer

Better markers could help people to live with cancer and reduce the need for intensive treatment

At present, one in three people will develop cancer during their lifetime, and in ten years time the incidence could rise to one in two. The main reason for this rise, explained Prof William Gallagher from the Conway Institute at UCD, is because people are living longer.

Cancer, he said, is a disorder that occurs in a number of different forms, and with treatment it can often be eradicated, or at least held in check.

Cancer treatment in general has improved, but even so, the costs involved are very high. "A ball park figure," said Prof Gallagher, "would be €50,000 to €100,000 per patient."

Apart from wondering if this cost could be reduced, Prof Gallagher thought that containment might be a better strategy in treating many cases. "In the old way, the idea was to get rid of the tumour," he said. However, as his own research students have found, cancer cells do not always break out and spread to other sites.

Because more is now known about how cancers grow and respond to drugs, treatment has become more subtle, said Prof Gallagher. In many cases, he said, "its more like treating a chronic disease." Doctors can accept that the disease is not going to go away, but they can do something about keeping it under control.

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Lifescience & Food

Prof. William Gallagher

University College Dublin

Good monitoring is essential for this approach to work, and this is where Prof Gallagher's research into biomarkers come into play. By detecting the distinctive protein molecules produced by cancer cells, doctors have a measure of whether a tumour under treatment is active, static, or receeding.

Prof Gallagher explained that labelled antibodies, known to target these marker proteins are used to determine their quantity. The labelling is usually done with a dye, so where the antibodies 'stick' marker proteins show up as a colour. In practice, hundreds of samples are placed onto microarray slides and doctors might be looking out for several different marker proteins. Scanning slides manually can be hard work, so image processing techniques are used. "There is a big bioinformatics component in this work," explained Prof Gallagher, and apart from making it possible to scan rapidly, the results are a lot more consistent.

Funding from Enterprise Ireland is being used to refine these imaging techniques, and the aim is to produce a system that can be marketed as a commercial product. "We've had interest from national and international companies and a molecular diagnostics company, Oncomark, has been set up" said Prof Gallagher.

Looking for multiple proteins in the one sample, he explained, is a lot better than trying to detect just one marker. There are a lot of variations in these cancers, he said, and for example, one particular marker protein is an indicator of cell death. Just how important it can be to detect this particular marker is illustrated by its potential role in surgery. With some forms of cancer, treatment begins with radiation and chemotherapy. This may commence months before surgery and the idea is to bring down the size of the tumour before surgical intervention. At present, it is difficult to know that this pre-surgical treatment, which adds to the distress of patients, is actually working. With monitoring, a relatively simple test to detect tumour cell death would solve that problem. Within a few days, explained Prof Gallagher, doctors would know how the cancer is responding, and they could decide to stop the treatment and go for surgery sooner, or, if the results were good, chemo doses could be cut back.

Prof Gallagher has long experience in cancer research, but as he observed, commercialising results calls for different skills. However, as he added, "I did not have to go into business with my eyes closed." Apart from being on the advisory board of a DCU campus company, where he saw how difficult it can be to start up in business, his chartered accountant, Steve Penny has more than just a head for figures. Having worked in the financial sector for about fifteen years, Steve went back to college to study biochemistry.

According to some studies, about 70 per cent of all breast cancer patients are being overtreated with chemotherapy, so the results of this project are going to come as a great relief to many.

Output
Spin out company formed

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Paints to cover demand

Quick response gives better quality now and research continues to maintain a lead into the future

Scrubbing surfaces can help keep the germs away, but the problem is that cleaning can also remove the paint. General Paints in Celbridge knew that hygiene was a big issue with hospital, school and other customers, so they decided to initiate some research to see if they could come up with a suitably tough product incorporating novel biocide materials. The company turned to the CREST Centre at Dublin Institute of Technology for advice, and as Dr. Martha Hidalgo Ramirez there explained, this was just the sort of challenge they were set up to respond to. Being based at DIT, the Centre can give industry access to a wide range of science and technology experts, and Martha said that one of the aims is to respond quickly. In this case, she said, it was realised that the company had to respond to market demand before competitors stepped into the gap.

Initial investigations revealed that recently developed materials, containing small amounts of silver, had remarkably good biocide properties. The researchers decided that they could incorporate the silver material, but to be effective, the paint itself would have to resist wear. The researchers were able to source a tough resin, and working with the company, they developed a formulation. "We looked at what was already on the market," said Martha, and that was the benchmark against which they compared the results. As it turned out, the paint was superior to anything else

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Dr. Martha Hidalgo Ramirez

Dublin Institute of Technology

on the market, and as Martha explained, this was an excellent result from short rather than long term research, and this is exactly what the company needed.

The inclusion of silver as a biocide has opened up new possibilities, and strangely enough, this is a rediscovery of old wisdom. In ancient times there was a belief that silver gave protection against diseases, but until recently the cost alone prevented the precious metal from being considered as a biocide. However, that changed with the development of nanoparticles, and it was discovered that it only requires extremely small quanties of silver to give very effective biocide protection. The nanoparticles are released slowly, so the effect is long lasting.

Fortunately, said Martha, it was possible to source all the materials, including the nanoparticle ingredient, and while that solved the original problem, this was only the beginning for longer term research. The company now has a competitive advantage, but more research will be needed to maintain that position.

Martha's role was to act as the interface between the company and the researchers. "It was my job to manage the budget and make sure the deadlines were met," she said, and it helped a lot that the company and CREST had worked together before.

Managing these projects, Martha has a good grasp of what researchers can deliver and what industry actually needs. Originally working with DuPont in Mexico on coatings, she completed her chemical engineering PhD in Germany, before moving to CREST. Working with DuPont, she said, had made her appreciate the need to get things done quickly in industry. It is very important, she said, for researchers and industry to understand each other right from the start, and one way to resolve possible conflicts is to distinguish between short and long term aims.

The way the CREST researchers work, she said, is that they bring projects up to the stage where they are ready for commercialisation, and then it's up to the company to take over by marketing the products. As in the case of General Paints, the company, with the support of Enterprise Ireland, can get ahead with business development while the researchers get on with the next phase of research.

Output
Licensed to General Paints

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Getting away from the point

A plug-in product allows software and multimedia developers to pick and choose from a range of hardware devices

Moving the decimal point makes it a lot easier to do our sums, but for a computerised device, the floating point can mean having to do a lot more processing. As Dr. Neil Hurley from Computer Science at UCD realised, being able to move the point can be an unnecessary luxury, and in mobile devices fixed point processing, requiring a lot less power, can work just as well.

With Enterprise Ireland support, he had been working on a project to embed copyright protection in multimedia devices, but hit a problem in that the tools available for porting the fixed point software onto devices were of limited use. As he found, there are a lot of different devices on the market, and no common input language. Going from one device to another involved writing new codes.

To address that difficulty, Dr. Hurley decided to change focus, and as it turned out, solving that problem became far more important than the original project. He was far from being alone in wishing to move from floating to fixed point processing. "We realised that there was a gap in the market," said Dr. Hurley, and Enterprise Ireland backed the change in plans.

Through this research, Dr. Hurley and his post doc researcher, Keith Cullen, came up with ufxDesign, a generic tool for moving from floating point to fixed point processing. The applications for this tool went far beyond the original idea of embedding

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Dr. Neil Hurley
University College Dublin

copyright watermarks. As he explained, lots of devices can benefit from fixed point processing, and typical applications would include CD, DVD and audio players. The changeover from floating point to fixed point can influence the quality of output. With audio, for example, there might be a lot of 'wiggle room' beause listening to a recording is subjective. The final adjustments are made by running comparative tests on the hardware, and having a single piece of code with the capacity to work on all instrtuments, makes this task much easier. Not just that, but as Dr. Hurley explained, "we can generate the output before porting the code to the hardware itself, so you can test for different configurations."

Software engineers simply plug the C++ tool in and it takes care of all the fixed point issues. Not surprisingly, Dr. Hurley had high hopes when he started to talk to Irish semi-conductor companies in 2006. However, as he found, 'real-world' commercial considerations were often higher on the agenda than technical advances. For example, hardware manufacturers were often locked into existing software deals.

Then, out of the blue, a US multimedia software design company got in contact. The company was doing well, but to expand, it had to become involved in mobiles, car radio and other hardware applications. They wanted to be able to pick and choose between output devices, so the ufxDesign product was just what they were looking for.

That breakthough, said Dr. Hurley, "made us start to think about the product in a completely different way." Researchers, he commented, often see things from their own perspective, but the view from business can be quite different. "It does not mean that you have to change your research, but you learn to give some things more emphasis," he said. Marketing a new product, he added, is hard work, and it takes a lot of persistence to succeed. Finding the right kind of customer was essential, and now that they have found their niche, the aim is to continue building on licensing agreements.

Output
Licensing in progress

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Power control

As devices shrink, the demand for more precise power control will rise

The smaller electronic circuits become the bigger the problems of power control. Dr. Anthony Kelly from the University of Limerick explained that for many devices the power involved might be just 150 millivolts, and it can be as low as 30 millivolts. Traditionally, said Dr. Kelly, power control was based on analogue technology, but some years ago he realised that a digital approach would give much more precise results.

Having worked for a number of years at Analog Devices in Limerick, Anthony was familiar with the problems being faced in manufacturing electronic devices, particularly as they decreased in size. Achieving reliable power control is often an issue, so when Anthony returned to the university to finish his PhD he decided to look into digital solutions.

A previous project there, he said, provided a good foundation for this research. An integrated circuit has been developed at UL, and this gave Anthony a platform to work from. "What I did was some up with algorithms and control methods." he said. There are other digital solutions available, he said, but what made his different are those controls. Simply using a digital device to replicate analogue control, he said, had not been his aim. With a digital system it is possible to refine or add functions, and there are also other advantages. "Ours is more robust," said Anthony, "and it is more forgiving in actual use." For a manufacturer these

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Dr. Anthony Kelly
University of Limerick

are important considerations, and as Anthony pointed out, ease of use can mean significant savings in production. "Cost saving", he said, "is one of the biggest advantages."

"We were at the test stage last year," he said. By setting up a working demonstration, the company interested in commercialising the controller had something real to show international investors.

Enterprise Ireland, he commented, was very supportive, especially in guiding the hand-over of research into industry. For many projects, he added, the gap between researchers and those that can commercialise an application is quite difficult to bridge.

The next thing on the agenda is the launch of a finished commercial product. "We hope to have this by the end of the year," said Anthony, and a company has been set up to produce the digital power controllers. Like a growing number of companies involved with electronics, said Anthony, "it's a fabless operation." This means the integrated circuit chips are made elsewhere on contract, and as Anthony observed, this makes economic sense, and it gives a lot more freedom for developers to concentrate on design and innovation. Apart from astronomical set up costs, fabrication is a specialised industry in itself. So, other than placing orders, there is no real need to become directly involved in fabrication. "What's unique about our product," said Anthony, "is its design." The power controller is compact, robust, and it offers superior performance. These advantages are expected to have a strong appeal to manufacturers everywhere, and as electronics continue to shrink in size, the demand for more precise control is bound to increase.

Gas sensor

Gas from the past is back, and new discoveries have transformed traditional methods of detection.

With the phasing out of environmentally damaging chemicals, engineers are going back to ammonia as a coolant gas. Familiar in its dissolved form as a household cleaner, and used widely in making all sorts of chemicals, including fertilizer, the gas itself is quite toxic and corrosive. Leaks, said Dr. Tony Killard from the National Centre for Sensor Research at DCU, can have serious consequences, and as use of the gas is on the increase, the need for monitoring becomes more of an issue.

Cooling systems are everywhere, he said, and apart from possible contamination from ammonia, a leak might not be detected by someone working in an enclosed area.

Ammonia can be detected by differenent sensors. “We are certainly not the first people to have invented an ammonia sensor.” However, most of the existing techniques for detection have drawbacks, so Dr. Killard decided to concentrate on an electrochemical approach. “There are advantages in cost and simplicity,” he said, but at the same time, he was looking for improvements. The existing electrochemical detectors, he explained, are based on an old principal consisting of two or three electrodes suspended in an electrolyte solution. Although this works well, Dr. Killard was not too keen on having a liquid filled device, so he replaced the electrolyte solution with a gel. “That made it more like a solid state device”, he said, and a lot

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Dr. Tony Killard

Dublin City University

easier to produce for the mass market.

He then looked into using conductive polymers. Some of these, he explained, are not just conductive, they are also electrochemically active. The problem, however, was that there was no easy way to apply these polymers to a device. The only method open to him was to form the polymer on each individual device, one by one, and that would make it difficult to get any kind of consistency in mass manufacturing.

At that stage he discovered that Prof Gordon Wallace, at the Intelligent Polymers Institute at Wollongong in Australia, had managed to synthesise nanoparticles of polyaniline. This polymer had been attracting a lot of attention for its conductive properties, and the things that interested Dr. Killard most were that it is extremely sensitive to ammonia, and as a suspension of nanoparticles, it can be applied as a liquid.

"It can be sprayed on as a coating or it can be printed on," he said, and when the carrier liqud evaporates, a solid state film remains. "The ammonia ions interact with the backbone structure of the polymer, causing a change in conductivity," said Dr. Killard, and this made the nanoparticles ideal for his sensor. "The great thing," he said, "is that sensors can now be fabricated in large numbers at low cost."

As a further refinement, the sensor can be customised for different applications, and Dr. Killard explained that in going through the patenting process he deliberately kept the terms of reference broad to allow greater flexibility in commercial development. "It's going to be up to the commercial partners to decide on what they need to satisfy market needs," he said. There is a licence deal already in place with a company based in Dublin, and Dr. Killard is looking at the world market. Like many other Irish innovators, Dr. Killard believes that going after the most obvious targets is not always the best way to make an impact. "The smaller companies could have a lot more to gain by taking something like this up."

Output

Licensed to Micro Ltd.

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Clean hands

Hand washing is one of the biggest problems in hygiene control, but until now, short of personal supervision, there was no way to check if this was being done properly.

Hands on medical care is fine as long as the hands involved are clean. Unfortunately, this is not always the case, and as Dr. Gerard Lacey from the School of Computer Science at Trinity College Dublin put it, hand-washing is one of the most critical issues in hygiene control. The same applies in the food industry, where, as he noted, "more technology is being applied to getting the temperature of your pizza right than ensuring that hands are clean, yet hand-washing is way more important."

Simply asking doctors, nurses, or staff in a food plant to wash their hands properly does not work, partly because people do not know how to wash effectively, and also because one-to-one supervision is impossible. In spite of the enormous hygiene issues, no one had been able to do anything about the problem, mainly because hand washing is actually quite complex. Finding a reliable technical fix for the problem seemed impossible, but this was just the sort of challenge that got Gerard interested.

Tracking the complexities of hand movement appealed to Gerard Lacey, who remarked that he always had a fascination for robots. Having studied computer engineering at TCD he began to think about the link to mechanics, and that made him realise that the "real action" lay in how machines could sense and react to the environment. Work in factory automation soon led to design of robotic aids for the disabled, and when orders started to come

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Dr. Gerard Lacey

Trinity College Dublin

in, Gerard Lacey got some partners together to set up a company to commercialise the technology. "I learned a lot about business that way, he said, and one of the things he learned was that to survive, a company must be prepared to change. Raising finance for smart walking frames proved to be difficult, so the company identified another niche, training of doctors in keyhole surgery.

The company, Haptica, continues to make this product, but in 2005 Gerard decided to go back into academia. "In Trinity there is a great environment for sharing of ideas," he said, and links to industry are close. About forty different specialists work in one group, and two of the things they are all interested in is how sensors can take in information, and how to create artificial reality. They look at how things move, and as Gerard explained, this goes way beyond simple tracking. "It's great fun, and we get to ask some big questions," he said, "and yet at the end of the day we deliver something quite useful and practical."

Some people in the group get excited about the psychology, others enjoy doing the difficult calculations, but Gerard gets his satisfaction from applying this knowledge.

Gerard realised that tracking of hand movement might be used to solve a long standing problem in hygiene, so, in what became known as the VAMP project, the group began working out how the apparently simple and everyday actions of washing could be captured as data for monitoring and analysis.

The result was a compact camera that watches how people wash their hands. The image is taken in by a computer, trained to recognise certain movements, corresponding to a prescribed set of procedures, and as Gerard explained, the system gets it right most of the time. In fact, the system is less likely to make an error than a human inspector standing beside the sink, and is a lot less intrusive. "Its not the aim to catch people out," said Gerard, who explained that the system is simply designed to capture overall trends and reinforce individual behaviour. As someone uses the sink, a warning light comes on if some essential action, such as washing behind the thumb, has been missed, and to help people to train themselves, a set of graphics, showing the correct steps is mounted with the camera above the sink.

The Trinity team worked with the Tyndall National Institute in Cork on slimming down the hardware, and Gerard said the entire system is now a small, neat, energy efficient package. All the necessities are bundled into a camera, cheap enough to be mounted over every hospital, creche, office or factory sink. In fact, said Gerard, installing the sink would cost a lot more, and the savings from better hygiene control could be enormous.

With Tyndall's help, everything that the TCD group once had to do on a PC is now on a small piece of hardware, and this, said Gerard, is the final step before mass production. In-hospital tests of the prototype have been highly successful, so the system is ready for a world market. "Everyone, everywhere" said Gerard, "has to wash their hands."

Instant messaging

Getting the message across quickly to close time-sensitive deals

When Led Zepplin made a comeback late last year, 20,000 tickets costing £125 were snapped up in record time. According to the promotors requests for tickets came in at the rate of 80,000 a minute. The tickets were sold strictly on a first come, first served basis, so fans had to react fast.

While that kind of take-up was a record, its not unusual now for suppliers to put time sensitive offers up on the web. Typically, explained Seán Lyons from Waterford Institute of Technology, these are offers that require an instant response because they only exist for a short time.

Seán is a member of the Telecommunications and Software Services Group at WIT, which, with Enterprise Ireland support had been looking into applications for instant messaging. With text messaging on a mobile, he said, people can be alerted to offers like these, and unlike emailing, there is no time lag. Instant messaging, he said, is in real time, you know the person is there and ready to react, so its almost like a personal phone call.

However, unlike making individual phone calls, text messaging can be automated, so thousands of alerts can be sent out to database of subscribers. To make such an automated service work, the Waterford group developed a product known as Zimbie. Our idea, explained Seán, was to come up with something easy enough for non-technical people to use.

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Seán Lyons
Waterford IT

Essentially, Zimbie works by harvesting alerts from a variety of sources, such as the RSS feeds that have become a common feature on web sites. RSS feeds are often used to provide viewers with immediate access to breaking news, and they are also used to issue sports results, or in the financial sector, they are used to keep investors up to date on share prices.

Naturally, no one wants to be swamped by scores of irrelevant messages, so what the Zimbie system does is filter this information to give clients who sign on a customised text alert service. It all depends on what people want, said Seán. "You could, for example, specify that you are interested in the share prices of ten companies. You want to know about those companies now, and not when you get around to looking at your emails."

There are two sides to the business, he said, corresponding to supply and demand. Concert promotors would be typical on the supply side, but, as Seán explained, they are far from being alone. Travel agencies and tour operators often find that they suddenly have spare capacity, and provided they can get the message out quickly enough, cut price deals will bring in the bookings. The cancellation of a conference could mean that within a day or two, a big hotel would have hundreds of beds available. Although that hotel might be part of a group with excellent connections to travel agents, the time limit usually means that nothing can be done, and the beds remain empty. Most travel agencies already have plenty of people on their books asking for cut-price deals, and with an instant messaging service, all they would have to do is sign on to receive the latest up-to-the minute alerts.

Of course, said Seán, people are free to sign on to RSS alerts or to go trawling through web sites, but the search is going to be time consuming, limited in scope, and in many cases registration and downloading of some special software is required.

The software experts at WIT, explained Seán, had been working at instant messaging for some time, and he became involved because he was an engineer with business experience. He could see that what they had developed was a good tool, but it needed an application to make it succeed as a commercial product. As they discovered, filtering of information for automatic distribution to time sensitive clients proved to be just the application they needed.

Initial trials with some Irish operators, said Seán, are going very well, and the next step is to launch and go international. On-line advertising is rising rapidly, so the instant messaging product comes at a good time. At present, said Seán, plenty of last minute offers are being made, but other than sending out emails, there is no effective means of getting that message across to potential customers. Zimbie solves that problem.

Output
Possible spin out company or licence deal

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Improving local flow

To succeed in launching a novel medical device, follow the market.

One of the problems doctors everywhere have to deal with is restriction of blood flow, and a few years ago, Michael Walsh, a graduate researcher at the University of Limerick, decided to look into this problem for his doctorate thesis. Dr. Walsh, now a member of staff, concluded that intervention to improve flow is possible, but further work would be needed to develop a suitable prosthetic device. Prof Tim McGloughlin, head of UL's Centre for Applied Biomedical Engineering Research, realising the potential value of this research, decided to apply for patent protection. It meant that the UL team could continue working on the project knowing that they would retain ownership of any commercial outcome. That was back in 2001, and applying for the patent turned out to be a good move because it is projected that a new medical device, based on that research is due to be launched on the US market by 2010.

Prof McGloughlin, describing the device as a flow splitter said the stent greatly improves local circulation. In some respect it mimics the natural formation of varicose veins in response to blockages, but as he explains, the flow splitter is much more effective.

Having developed the flow splitter, Prof McGloughlin looked at where it might fit into the medical market. Originally, he had been thinking that it might be used to relieve lower limb problems,

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Prof. Tim McGloughlin

University of Limerick

but then he found that there was a specific demand relating to kidney treatment. The problem of local blood supply often becomes acute during renal dialysis. Over time, the point of puncture for extraction of blood for dialysis becomes blocked. "Normally, fifty per cent of those are reblocked at the end of year one, and seventy-five per cent in year two, so it's a significant clinical problem," he explained.

Doctors differ on how this problem should be solved, and in the US surgeons usually opt for insertion of a graft. "In North America at least fifty per cent of the treatments are vascular grafts," said Prof McGloughlin. In a procedure, known as AV (artery-vein) access, a tube of PFTE, a polymer, is introduced to overcome the blockage. This works well, but in Europe, the usual procedure involves bringing the blood vessels together to induce the formation of an artery-vein fistula.

The main reason for this difference, said Prof McGloughlin, is cost. In the US, where the procedure is often covered by health insurance, doctors generally prefer to rely on the prosthetic. In Europe, however, doctors tend to hold off on AV access until the condition is critical. The differences between Europe and the US are not always so obvious, said Prof McGloughlin, and one of the factors could be earlier detection of kidney problems on this side of the Atlantic. Even so, there are cases where the prosthesis has obvious benefits. Among the advantages of AV access is that it can be used on patients who are much further advanced with problems, and, unlike the fistula approach, dialysis can start within a couple of days.

Prof McGloughlin knew that the flow splitter device offers a significant advance in treatment, but understanding where the market pull comes from, made him decide on a US launch under the name Prolong. "We are in discussion with a number of the major players," he said, but he also thinks that the device offers one of the smaller players a chance to become big. Sometimes, he said, a smaller operator can have more to gain, so they will be more aggressive in bringing a new product onto the market.

One way or the other, the interest in taking up the product is strong, and the next stage is clinical evaluation. The animal test data is good, said Prof McGloughlin, the PTFE polymer is well established in medical procedures as safe, so final regulatory approval may be granted within a year.

The reliance on stents means that the demand for the flow splitters in the US will be high, and that track record, said Prof McGloughlin, will pave the way into Europe and the rest of the world.

Outcome
Licence imminent

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Soluble oxides

A chance discovery in the lab is about to give international industry the solution to some difficult manufacturing problems.

Some years ago, Dr. James McManus, from the Dept of Chemistry at NUI Galway, was searching around the lab for some tin oxide. Its not that common, hard to get, and messy to make, but he remembered seeing a bottle of it somewhere on the shelves. He was in luck, the bottle was still there. However, a closer look made him wonder if the search had been worth the trouble. The chemical was discoloured and grubby looking, but rather than give up, Dr. McManus decided to have a go at purifying the oxide. There was no defined procedure for this, so he improvised, putting the oxide into weak acetic acid in the hope that this could clear out the impurities. No luck, nothing happened. Then, just to see what would happen, he heated the mixture up to about 90°C. To his complete surprise, the oxide dissolved. "It didn't take the impurities out of the tin oxide, it took the tin oxide out of the impurities!"

Up to then, he explained, no one knew that it was possible to dissolve this metal oxide, and that discovery set Dr. McManus off into a very exciting area of applied chemistry. The pure oxide, he said, could then be made up with organic solvents, such as methanol, and this was just what industry needed. Tin and titanium oxides, he explains, are extremely important in industry where they are used to make such products as coated glass. The current approach for coating is to use vapour deposition involving

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Dr. James McManus

NUI Galway

toxic precursers, an expensive, difficult process, and Dr. McManus, together with the head of the Department, Prof Des Cunningham, realised that this would be a much better alternative. Prof Cunningham also had a strong interest in tin oxide, and in another project he had used this knowledge to solve a major problem for a pharmaceutical company. A troublesome tin oxide residues from a catalyic reaction had been causing problems, but when Prof Cunningham found a way to convert this into another form, company production shot up by 20 per cent.

Prof Cunningham took a keen interest in the dissolved oxide project, and after some further work, the researchers filed a joint patent in 2004.

The dissolved oxide, said Dr.. McManus is still in the active form, and as a liquid it can be sprayed on, used like an ink in printers, made into a gel, or it can be used as a dip solution. Coating glass is just one of the many possible applications, and as Dr. McManus found, one of the most significant uses is in electronics. For 'doping' circuits metal powders can be incorporated into the oxide solution, and in chip making, this could eliminate the need for volatile, surface-specific carriers. Some big international companies, said Dr. McManus, have shown a strong interest in these sort of applications, and a start-up manufacturing plant, using dissolved oxides, is being planned for Limerick.

Those oxides are now being made in a pilot plant in Ballindine, Co Mayo, and within a year said Dr. McManus the company, Theta Chemicals will be going into full production at a larger premises in Castlebar. Over the last six months, he said, conditions were being optimised with scale up in view.

Dr. McManus works as a consultant to the company, which has the licence to produce the oxide solutions. The solutions, gels, and solids are sold on to the manufacturing companies, and as Dr. Manus observed, it's a world market. One of the biggest demands is expected to come from the rising market for energy efficient coated glass. In some countries energy saving regulations are driving this demand. The international glass makers need to respond to that demand and the Castlebar plant will be ready to supply the solution.

"We tried other metals," said McManus, but the best results were with tin and titanium, and as it happens, he added, "these are the oxides most in demand."

"I always enjoyed chemistry," he said, and he recalled that his teacher, Eamon Fitzpatrick at the Marist College in Athlone, fostered that interest because he encouraged his pupils to be creative. Dr. McManus still likes the idea that messing in the lab can pay off.

Output
Licenced to Theta Chemicals

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Well fed urchins

Like the transition from hunting to farming on land, aquaculture at sea is replacing harvesting from the wild.

The distinctive hollow sea urchin shells were usually among the trophies brought back from a holiday by the sea, but in recent years they have become less common. The reason, explained Dr. Gerry Mouzakitis from the Aquaculture and Fisheries Development Centre at UCC, is that they have been eaten. Although seldom on the menu here in Ireland, there is a huge international demand for sea urchins. "They are worth about €15,000 a tonne," said Gerry, and because they have been harvested so intensely from the wild, populations everywhere have collapsed. About ten years ago the market was worth about $350 million, he said, but now it's down to about $200 million, yet the demand is as high as ever.

Although various attempts had been made to farm sea urchins, no one had yet been able to succeed in developing a system, and this made Gerry wonder if there was some way around that problem. He concluded that feeding was one of the main difficulties, not because sea urchins are particularly fussy eaters, but the tanks used in previous attempts were of poor design. As he discovered, tanks did not allow enough circulation to bring in air and wash away waste, and because there was no separation of feed from sea urchins, they clung together in clumps.

With Marine Institute support, Gerry had already started to look into aquaculture, and convinced that he could come up with a better tank system for sea urchins he approached Enterprise

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Dr. Gerry Mouzakitis

National University of Ireland, Cork

Ireland with the idea of developing a commercial system. "I had the concept," he said, "but I am not an engineer", so he needed people to put the various bits and pieces together. With backing from Enterprise Ireland, Gerry could put his ideas into action, and about a year later the cages were ready, and the sea urchins are thriving. "We now have a good commercial system," he said.

Having considered ways to market the system, Gerry thought the best approach would be to provide a complete package. "We are not just selling some equipment," he said, "we are selling a farming method." The plan is to bring the technology to other countries, and back this up with on-site training. Unlike most other types of aquaculture, this is a system that can fit in anywhere. The tanks, said Gerry, are stand alone, they are on shore, so everything can be controlled. Sea water can be filtered, to avoid any problems such as the 'red tides' that can wipe out shell fisheries at sea, and because the tanks are isolated, there is no danger of farmed stock escaping into the wild.

The export potential is huge, with Japan leading the world in demand. 80 to 90 per cent of the world's supply goes into Japan, said Gerry, but sea urchins are also important in France and around the Mediterranean. Ireland is also likely to benefit as a producer, and Gerry, who grew up with seafoods in Greece, believes that this is the way to go because harvesting from the wild is simply unsustainable.

Ireland is already involved, with Europe's only sea urchin hatchery based in west Cork at Durrus. Breeding, he said, was not the big problem, but providing suitable growing conditions was, and now that difficulty has been overcome. So, instead of trying to rely on boosting wild stocks, Gerry argues that farming is the best option.

As is often the case, one solution led to another, and although it's not that difficult to collect seaweed as feed, Gerry realised that this is just another case of harvesting from the wild with all the attendant limitations. He talked to some of the food scientists at UCC, and as he recalled, "in just ten or fifteen minutes we had come up with a completely new way of making feeds. Next day, one of my students, and one of his got together, and they made up some feed." The result was a lot better than expected. "The animals absolutly went mad for it," said Gerry.

The big advantage, he explained, is that the new feed technology binder works at low temperature, and for marine animals, this is critical. Sea urchins like their food raw, and they are not alone in this preference. Octopi are also in demand, as are tuna and cod, but no one had yet been able to come up with a suitable feed.

The sea urchin cages turned out to be a breakthrough in more ways than one, and Gerry said that feed for acquaculture is likely to be the bigger commercial development. A pilot scale production line has been set up at UCC, producing about 70 tonnes of feed a year. "This is enough to demonstrate to ourselves, to investors, and to everyone else how the feed works," said Gerry. "All we need to do now is scale up."

Output
Spin out company expected

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Gaining from a material change

Wind is renewable and turbine blades can be recycled

Wind farms have grown in size, and so have the turbine blades. Single blades can be about 20 tonnes in weight and what interests Dr. Conchúr Ó Brádaigh from NUI Galway is that they are among the largest objects made from plastic composites.

Since 1990, Dr. Ó Brádaigh had been collaborating with Prof Pat Mallon from the University of Limerick on plastic composites, and one of their objectives in Enterprise Ireland supported research was to develop materials that could be used in large structures. Those enormous blades, said Dr. Ó Brádaigh, represented just the sort of challenge they were looking for.

In making large objects, designers can choose to use thermoplastics or thermosets, and as Dr. Ó Brádaigh explained, there are significant differences. Objects made from a thermoset cannot be altered or repaired, and there is no end-of-life use for them. In manufacturing, if something goes wrong, the object has to be scrapped, and any factory offcuts have to be dumped. Thermoplastics, on the other hand, can be reworked, and when the time comes for scrapping, the material can be recycled.

At the time, turbine blades were being made with rigid thermosets, and the researchers argued that a change over to thermoplastics could represent a big advance. However, they first had to work out how to make this change, and one of the problems, explained Dr. Ó Brádaigh, was that molten composites

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Dr. Conchúr Ó Brádaigh
NUI Galway

being used at that time were viscous, so they could not be drawn in between supporting fibres in the same way as free-flowing thermosets. New materials solved that problem, and the researchers discovered that precurser fluids could be injected to form a thermocomposite within the structure.

By 2003 research had advanced to the stage where scale up could be considered and Dr. Ó Brádaigh began to work with Eire Composites in Galway. "From the beginning", said Dr. Ó Brádaigh, "we were thinking of how we would get this out onto the market." This meant scaling up from the lab, and in a Green Blade project supported by industrial partners and Sustainable Energy Ireland the company began working on the development of a 12.6 metre blade.

At this stage, said Dr. Ó Brádaigh, one of the problems associated with scale up became apparent. The process involved heating to about 200°C, and while this might not be a problem with small objects, expansion of the metal tools being used in manufacturing made them useless. "This was unexpected," said Dr. Ó Brádaigh, but once again, solving the problem worked out to be a double advantage. The company was able to patent the MechTool system, and as Dr. Ó Brádaigh remarked, this gave a high degree of protection to the entire process.

Commercially, the project has been a great success, and apart from the licensing rights, the Galway company has a stake in a German manufacturer of big blades. The demand for blades is high, and the wind energy sector is expanding at up to 20,000 MW a year. According to Dr. Ó Brádaigh we could assume it takes 20 tonnes of composite for every.

Manufacturers who choose to stay with thermosets do have some options, said Dr. Ó Brádaigh, but compared to thermoplastics, these are fairly limited, and costs are higher. Compared to the 36 or so hours that it takes to form and cure a thermoset blade, the thermoplastic equivalent can be made in just 8 hours.

Blades last about 20 years, and the good thing about thermoplastics is that a lot more of them can be made without any of them having to end up in a tip.

Supporting repair

Collaboration on solving one problem resulted in a medical breakthrough of greater significance

Our body has a remarkable ability to patch up minor scrapes and scratches, but major injuries are often beyond repair. The main reason for this is that tissues need something solid to grow on. If we can provide a suitable base, many of the tissues making up our various organs have the capacity to regenerate.

Wound recovery has always fascinated Abhay Pandit, Professor of Biomedical Engineering Science at NUIG. As a small child he became aware of non-healing ulcers, and his curiosity about them eventally turned into a life-long research career.

As he explained, although the concept of providing a scaffold is straightforward, achieving success in practice is actually quite difficult. Cells will only grow on surfaces that they accept as natural. For some years he had been searching for materials that the body would accept, and eventually, in collaboration with a veterinary surgeon, he discovered that the solution lay in borrowing from nature.

Mechanical supports are widespread in our body, often in the form of collagen and elastin proteins. Collagen, the most abundant protein in the body, keeps our skin firm, yet elastic, and elastin, as the name suggests, are long fibres that enable our organs to bounce back into shape. These proteins, explained, Prof Pandit, can be harvested from animals, and, unlike synthetic materials, there is no problem with rejection.

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Prof. Abhay Pandit,

National University of Ireland, Galway

With Enterprise Ireland support Prof Pandit's group began working out how this novel biomaterial could be brought to the market. Initially, Prof Pandit was thinking only of mechanical support, but as the research progressed, he realised that the follow-on benefits might prove to have even greater significance. Not alone was the harvested material ideal for the original job, it was also a breakthrough for tissue culturing.

Prof Pandit has found that a whole range of human cells, including blood, skin, and even nerve cells, can be cultured on this material, and when a layer of cells has grown, it can be transplanted complete with its support to the wound site. This was a major advance, but as yet it has to be put into practice in humans. The research group have had great success with animal transplants, and eventually this technique will be used to culture a variety of tissues for grafting back into the body.

The project is certainly heading in that direction, and Prof Pandit said that the biggest issue now is getting regulatory approval. The underlying research has been done, the approach works on animals, but to get through to the next, human trial stage, Prof Pandid will work with a commercial partner. "We have been talking to a number of companies, and it will not be long before a deal is made," he said.

Growing tissue for transplanting, is Prof Pandit's aim, but he is realistic about distinguishing between long and short term objectives. After cleaning and preparation, the collagen and elastin materials are completely cell free, so the rules covering insertion of the support alone are a lot easier to comply with than the regulations governing transplantation of living tissue. For this reason, Prof Pandid said that it will take a bit longer for this to be achieved, but we can expect to see the biocompatable scaffolding being used for hernia and lung repair in the not too distant future. Extra support can be given where the body is weak, and in cases where part of an organ has been surgically removed, as in lung cancer, the material can be used as a plug. This in itself is a big advance, and as Prof Pandit observes, it would not have been possible to achieve these results without a lot of collaboration.

Prof Pandit's group has been able to draw on a range of expertise available at NUI Galway, and collaboration often results in research branching off into different strands. One of these involves development of biodegradable nanoparticles that can be used for delivery to targeted sites within the body. Collaboration, said Prof Pandit, is essential for research. "If we all work in our own little castles, it's just not going to happen."

Output
Licence imminent

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Biofilms

A deeper understanding of an old process has paid off in a fresh approach to treating wastewater.

The discovery that microorganisms could be harnessed to digest and treat large volumes of municipal wastewater had a huge impact on society. Being able to channel wastewater into treatment works meant that small villages could grow into big cities, and in more recent years the same approach means that villages no longer have to pollute local streams.

The microorganisms that perform this transformation are a mixed bunch of different species, that can live together in highly adaptable biofilms that stick to stone, plastic, peat, sand and soil media. The mixed population, explained Dr Michael Rodgers from NUI Galway, is the reason why biofilms are so adaptable. Over time, biofilm populations adjust to the prevailing diet and environmental conditions, and this is one of the reasons why Dr Rodgers believes that natural digestion using biofilms has a great future. Biofilms, he said, can be produced to digest all kinds of substrate, but for the present, his main concern is with improving the treatment of wastewater. Although there is a long tradition, most of the current treatment systems have reached a peak of efficiency because many designers did not fully appreciate that microorganisms can be very effective when clinging to fixed surfaces under changing environmental conditions.

Dr Rodgers was convinced that the existing systems could be improved to eliminate a number of contaminants including, carbon, nitrogen and phosphorus by exposing the biofilms in controlled sequences to oxygen-rich and oxygen-poor environments. Results in the lab supported these views, and with backing from Enterprise Ireland, Dr Rodgers has been able to put this research into practice. Getting an innovation grant

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Dr. Michael Rodgers

NUI Galway

from Enterprise Ireland, he said, made it possible to build a research team that includes engineers, microbiologists and mathematical modellers. To maximise the performance of microorganisms, Dr Rodgers set up a laboratory scale plant to operate under controlled conditions. A sample of wastewater from a municipal treatment plant was used to 'seed' the biofilm, as a starter, and because the wastewater 'substrate' was made up in the laboratory, it was a lot more consistent than the 'real' thing, so its performance could be better defined and accurately assessed. In addition, the temperature of the wastewater was deliberately kept down to 10°C, and the reason for this, said Dr Rodgers, was that he wanted to get a biofilm that will work well under normal Irish ambient conditions. This approach, explained Dr Rodgers, means that a treatment plant can be matched quite well to less than ideal conditions at an actual site.

Optimising the biofilm population is just one aspect of fine tuning the process. As Dr Rodgers observed, the biofilm works economically when it is static, and efficiently when it is exposed to different controlled environmental conditions. So, a fundamental change was made in design. The microorganisms that digest ordinary wastewater in municipal treatment plants are mainly aerobic, they need air, and in many systems this is bubbled up through dispersed and moving microorganism flocs in activated sludge, or is supplied to a biofilm as it dips in and out of the liquid on a rotating drum. These methods work very well, but Dr Rodgers and his team have come up with a more efficient alternative. Rather than move the biofilm, his approach is to move the wastewater by pumps in a two-tank system, while the biofilm remains fixed on static plastic honeycombed media. One of the advantages of this, he pointed out, is that there is less mechanical wear involved and not much energy is required to drive the system.

As digestion slows down in one tank, the wastewater is moved into the second tank, allowing the biofilm in the first tank to become aerated. The flow from one tank to the other can continue for as long as needed, and as Dr Rodgers explained, this approach has led to additional options. Normally, we are only concerned with the aerobic side of digestion in removing carbon, but the microorganisms under anaerobic conditions can also play a vital role in removing other contaminants. Simply leaving the liquid stand in one of the tanks can be enough to spark off growth under anaerobic conditions leading to the removal of nitrates and phosphates - nutrients that cause eutrophication in lakes. Dr Rodgers says that the pumped flow biofilm system is particularly suitable for treating wastewater from villages and towns.

A major player from the construction industry was interested in the pumped flow biofilm technology, so a full-scale research wastewater plant was built and installed to service a small town in Co Mayo. The plant has been performing very well, paving the way for the launch onto a very receptive market. Treatment of wastewater is a big problem everywhere, and as Dr Rodgers observed, this system has proven to be a significant advance in efficiency.

Dr Rodgers and his team have also devised a different technology for small wastewater volumes such as from single houses. Licensing negotiations on this technology are at an advanced stage with a multinational Irish company.

Biofilms, he said, can be very adaptable, and we are only beginning to realise their potential. So having solved the challenge of getting biofilms to work more efficiently on wastewater, Dr Rodgers and his team, with the support of Enterprise Ireland, are keen to move on now in developing a range of industrial applications.

Self-destructing tumours

With better targetting, cancer cells can be sent a fatal message.

A number of substances in our body act like messengers, carrying signals and instructions from one place to another. One particular group of proteins, known as the cytokines, can trigger self-destruction by latching onto specific sites on a cell surface. Alarming as that might seem, programmed cell death is a perfectly normal process that helps keep the body in good shape. Back in the 1970s the idea that cells could self-destruct was new, but as Prof Afshin Samali, Director of the Cell Stress and Apoptosis Research Programme at NUI Galway, remarked, it is now one of the hottest topics among scientists working on degenerative diseases. His own experience in this field goes back to his student days in NUI Maynooth, where he did a PhD on programmed cell death under Prof Tom Cotter. Now, as Professor of Biochemistry at NUI Galway, he continues to work in this area, and the way in which cytokines can act as triggers of cell death is of particular interest to him.

There are many different types of cytokine, but the one that Prof Samali has been paying most attention to is known by the acronym TRAIL. The reason for this is that while the TRAIL cytokine is otherwise inactive, it induces death in cancer cells.

Because of this characteristic, TRAIL could have a significant role to play treating cancers but as Prof Afshin found, the binding of TRAIL to surface sites is not completely precise. The cytokine

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Prof Afshin Samali

NUI Galway

could recognise up to five different receptor sites on a cell surfaces, but only two of these actually trigger self destruction. If you give wild type TRAIL to a patient, said Prof Samali, most of it gets mopped up by the wrong receptors and not enough of it kills the cancer cells, so he wanted to see if there was some way around this problem.

In collaboration with researchers in the Netherlands and Germany, Prof Samali began to examine the detailed molecular structure of this cytokine. Computer modelling helped to reveal points where they could consider introducing changes through mutation. Through this approach, the researchers were able to produce a recombinant form of TRAIL with a point of attachment for just one particular cancer cell death receptor. This receptor is known as 'death receptor 5' which is present in many different types of cancer cell.

This was a significant development, and to bring it further, Prof Samali secured support from Enterprise Ireland to find out if the genetically modified TRAIL would reduce tumour size in animals. These tests, he said, are progressing well, and what he has also found is that a synergy between existing therapies and TRAIL can be used to fine tune treatment.

A commercial campus company partner is now looking at how this knowledge could be applied, and clinical trials are planned for the Netherlands. Interest in the project among pharmaceutical companies is high, and as Prof Samali explained, other related developments are likely to follow. The same approach that led to such good results with with TRAIL can now be applied to other cytokines.

"A lot of things move on and improve," he said, and one of the ways he stays ahead is to keep in contact with other researchers, wherever they are. One of the experts who worked on the protein modelling back in 2003 has since moved from Germany to Spain, but Prof Samali still draws on his expertise. When it comes to research, Europe has become a lot smaller, he said, and in projects such as this going to the experts can be a lot more effective than trying to develop expertise in everything here.

All in the box

Simple, low-cost technology could give the elderly more independence and cut down on the need to go into care.

About one in every five people who go into nursing homes are there simply because they cannot manage their medication. "If you are over 65," said Dr. Michael Schukat at the Dept of Information Technology in NUI Galway, "there is a good chance that you are on some form of medication." At any age it can be hard to remember how many pills to take and when, but with the elderly the consequences can include loss of freedom.

Dr. Schukat first became interested in this problem when his own parents were getting on in years. Knowing that elderly relatives are being looked after well in most respects is reassuring, but it's not so easy to check if they are taking their tablets.

Packaging can help, and blister packs, giving a clear visual indication of what has been taken, can be a lot better than a bottle filled with pills. Another approach, said Dr. Schukat, is to attach a timer which starts bleeping when the next dose of medication is due. However, while the costs are not prohibitive, someone has to set the timer, and there is no way of checking that the patient has actually followed the carefully worked out programme.

What was needed, said Dr. Schukat, was something foolproof and simple, so having secured proof of concept funding from Enterprise Ireland, he brought a team of five together to develop an all-in-one box. Each of the team had something different

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Dr. Michael Schukat

NUI Galway

to add, and Dr. Schukat chose them carefully, for results had to be delivered within a year. With a tight time frame, he said, there is no plan B, so if things go wrong, he knew that there was not going to be a second chance.

As it transpired, the DigiSpense box came up to expectations, and it gave Dr. Schukat something to show potential commercial partners. The patent protected design incorporates a sealed tray containing a week's supply of medication, and when a dose is due, the box gives an alert signal and the tray opens. In picking out the medication, the patient breaks a seal, which in turn provides the box with evidence that the prescription is being followed correctly.

"At first I thought the one box would solve all problems," said Dr. Schukat, but talking to companies convinced him that the system could be adapted to suit a range of different groups, and that it might even be enhanced by the inclusion of diagnostic functions. "At the end of the day," he said, "we could have a number of boxes."

Simplicity is the key, and as far as the patient is concerned, the technology is invisible. Every week the box is refilled by the pharmacist, who, at the same time, resets the program. "That's not an issue," said Dr. Schukat, "because pharmacists already have to enter patient records into an IT system."

At the moment, explained Dr. Schukat, the box is stand alone, but the plan is to provide a remote link using basic mobile technology. As Dr. Schukat observes, you don't need broadband to send out simple alerts, and this opens up an opportunity to link up with health care professionals. For example, if a patient missed taking a tablet, the box could automatically send out an alarm, so that someone could intervene.

Peace of mind, said Dr. Schukat is very important, and with the all in one box, the quality of care for a lot of people on medication could be improved.

Over the next few months the box will be on trial with post-operation patients in a nursing home in Kilkenny, and the full commercial launch of DigiSpense is set to follow. With the age profile going up, the product is going into a growing market, and for many it will mean retaining independence. "Anecdotal evidence from pharmacists," said Dr. Schukat, "suggests that if people are getting good care, they can stay at home for another three to five years."

Code for the highway

Sensing the centre of gravity would cut down on roll-over accidents.

People buy big cars because they believe they are safer. Not necessarily so, said Dr.Selim Solmaz, a researcher at NUI Maynooth's Hamilton Institute. With Sports Utility Vehicles, usually known as SUVs, the centre of gravity is high, so over-confident drivers regularly lose control on corners. In situations where an ordinary saloon will stay on track, the SUV could pitch over.

According to statistics, explained Selim, SUVs are involved in just 2.6 per cent of the road accidents in the US, yet they account for something like 20 per cent of the passenger fatalities.

Tighter standards might help, but as Selim pointed out, regulations alone are never going to solve that particular problem. Unlike many other parameters, centre of gravity is a variable. A lot depends on how the SUV is loaded, and of course driver over-confidence is always going to be a factor if a car looks safer than it is.

Selim has always been fascinated by the control of movement, and before completing his PhD at Maynooth, he studied aerospace engineering at the Technical University in Ankara where he was one of the top graduates in 2001. His interest in mathematical modelling of dynamic systems brought him to the Hamilton Institute at Maynooth. There, he immediately began working on possible improvements to existing control systems,

Area
Informatics

Dr. Selim Solmaz
NUI Maynooth

particularly in cars. Most cars now have computer processing units, CPUs, and ABS brakes, which incorporate anti-locking sensors, come as standard. This means that cars are already equipped to accept further refinements, such as Selim's centre of gravity sensor which could slash the number of roll-over fatalities.

As yet, sensors for lateral, side-slip, movement are not fitted as standard. They do exist, and in some cars they are being offered as 'anti-spin' systems for increased stability. What they can do, explained Selim, is stop a car from drifting out of lanes on corners. Those sensors, he added, could also be used to prevent roll over.

Although that potential exists, the only manufacturer to have made progress in roll over control is Volvo in the top of the range XC90. However, this is a special case, and Selim explains that not alone could an anti-roll over system be installed in all SUVs, but it could be sophisticated enough not to detract from driving experience.

The unique selling point of this system, said Selim, is that it it compensates for changing centre of gravity and is only activated when the situation is critical. Detecting lateral movement is of limited use if the centre of gravity is taken as a fixed point, and experienced drivers would have concerns about a system kicking in while the car is still under control.

A good roll over prevention system is not that difficult to install, said Selim. Basically, it's a matter of adding some lines of code, he said, and this is, in effect, his product. Enterprise Ireland and the university looked after patenting the innovation, and they helped to introduce Selim to interested companies. The next step, he said involves putting the system to the test, and that will involve a commercial partner. This could be a component supplier, or the auto manufacturer, because the code can be put in when the CPU is being installed or programmed.

"We are in discussion with a number of companies," said Selim, who added that selling something new to the auto industry is not always easy, even if it's a significant improvement. "No one likes to add anything unless there is a financial gain," he said. While Selim's solution to roll over only requires a small change to existing technology, the gains both in safety, and added value, would be quite high.

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