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GMIT Research & Innovation

Galway-Mayo Institute of Technology
Institute of Technology of the Year



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GMIT research and innovation

an overview



*Andrew D'Arcy
Head of Development*

GMIT has taken a major step over the past few years to increase its level of activity and profile on the research landscape. In 1997/'98 the Institute had six postgraduate students studying for their Masters degrees. Today GMIT has almost 90 postgraduate students, seven of whom are studying for their PhDs.

Research is one of four strategic drivers of the GMIT strategic plan. In its drive to encourage and promote research, the Institute is conscious of its national priorities and regional remit as outlined in the National Development Plan and in reports from agencies such as Forfás, SFI, Enterprise Ireland, the Marine Institute, Sustainable Energy Ireland, Environmental Protection Agency, Coford and government departments.

In developing its research profile GMIT is informed by the areas highlighted for national and regional development. In particular it is influenced by the key government decision to double the numbers of PhDs available in the country over the life of the NDP. At regional level, the BMW Regional Assembly sets the scene for what is required to address the needs in the GMIT catchment region.

In 2005, GMIT was awarded extended delegated authority to confer awards up to and including PhD level in the areas of Marine Science and Mechanical Engineering - two areas of greatest research strength within the Institute, having world-renowned researchers of the

highest calibre with numerous published papers to their credit in both fields.

Marine Science is still the strongest area in the GMIT research profile and continues to enhance its reputation year after year by procuring significant programmes and funding – some in collaboration with other major players in this field. The range of expertise available addresses topics that include: Commercial Fisheries, Marine Biodiversity, Marine Food, and Molecular Ecology.

New EU regulations recently introduced are going to severely curtail the volume of fish takes in our waters. As a result the search to establish non-traditional fish species becomes an important economic issue. This topic is currently being addressed by one of our research teams.

GMIT, in a competitive bid, secured funding under the very first round of the Applied Research Enhancement scheme (ARE) operated by Enterprise Ireland. As a result, the Shellfish Technology Research Centre (SHELLTEC) was established. This centre carries out research on shellfish species and supports the industry in maintaining

Introduction



the freshness and quality of its produce to the point of delivery to market.

Our second major research area is Mechanical Engineering. The particular focus here is on medical devices. Many of the funded projects address specific aspects of stent design and performance. Again a major boost was given through the procurement of a second ARE award for this area from Enterprise Ireland. As a result the GMedTech Centre was established. It carries out applied research in the medical device areas and has strong links with industry. The greatest cluster of medical device companies outside the US is located in the environs of Galway and GMedTech is poised to take advantage of its proximity to this cluster by exploiting innovation and product development for this industry.

Other research areas in GMIT on the technology front are: Furniture and Wood Products; Automation and Control; Software Systems and Multimedia and Portable and Wireless Devices. A very strong unit is emerging in the area of Energy and includes diverse aspects such

as: The Built Environment; Forest Health and Protection; and Sustainable Energy.

A particular vibrancy is palpable in our Business and Humanities areas. The well-established West of Ireland Centre for Tourism and Hospitality Research continues to expand and is well recognised as the foremost centre of tourism research in the west. Its learning network delivers programmes throughout Galway, Mayo and Roscommon. The Irish Culture and Heritage Research group has procured funding under a number of programmes over the last few years and continues to expand its profile.

The Business School has a strong tradition developing entrepreneurship and was recently enhanced by its delivery of a new Rural Entrepreneurship programme that was researched and developed under the auspices of Lónra, the BMW Regional Higher Education Network.

The Institute has greatly boosted entrepreneurial activity in the region with the establishment of two Innovation in Business Centres – at the Castlebar

and Galway campuses, supported by Enterprise Ireland. The centres support knowledge and technology-based start-ups by providing incubation space and business development supports for the nurturing of new ideas and the commercialisation of applied research.

We have travelled quite a long way since the late 1980s and early 1990s when the only programme that was easily available to us was the Fobairt-funded Applied Research Programme that allocated, in relative terms, paltry sums of money.

We look forward to continuing our work with development agencies, industry and cultural organisations to further develop our research and innovation capacity. And we also look forward with confidence to seeing the benefits it will bring to the region.

Andrew D'Arcy

Research and innovation: infrastructure for a sustainable future



Marion Coy
President

As we watch the emergence of the new vibrant economies in what are now referred to as the BRIC economies – Brazil, Russia, India and China, for once an acronym makes some sense. Bricks are an appropriate metaphor for research activity because research essentially provides the infrastructure for a sustainable future.

Much discussion takes place around the conventional view of research as falling into two distinct categories: basic research and applied research. This approach is flawed and outdated and it belongs to a time when research was the pursuit of individual interest and academic research the preserve of the few - those few generally regarded anything of an 'applied' nature as sully the purity of their endeavours.

The past is indeed a foreign country. They did things differently then and any vestiges of the highly elitist and narrow approach to research should be consigned to the dust-bins of history.

Research is essentially concerned with the development of human capacity and such development spans a continuum of activity, approaches and disciplines. The integration of knowledge requires that we approach research by simultaneously promoting depth of expertise and breadth of context.

The Government's Strategy for Science, Technology and Innovation (DETE, 2006)

suggests that in Ireland we now need to take a leap forward. It identifies the need for increased numbers of people with advanced qualifications, for an enhanced contribution by research to economic and social development, for transformational change in the quality and quantity of research, and for greater coherence in our approach to the development of research and innovation.

Recently, the OECD reviewed the role of higher education in relation to regional development and it urges those involved in higher education "to adapt a wide agenda." The report suggests that the emergence of a well-functioning human capital system in the region, as distinct from a number of disconnected components, requires some degree of co-ordination and steering.

In a global context, Ireland needs to focus on a one-region approach to human capital development that seeks to integrate the work of all stakeholders in the process. The work of GMIT in research and innovation is and will continue to be allied with the National Development Plan, the Strategy for

Science, Technology and Innovation and the National Spatial Strategy.

In 2005, Ireland was ranked first in the EU for entrepreneurial activity and private capital investment and first in the OECD for attracting new greenfield foreign direct investment. Even in a short period of two years, it is possible to see the clouds on the horizon in relation to our future performance and it is now timely to review the effectiveness of our national innovation system.

By 2015, it is estimated that one in every four people will be employed in knowledge intensive industries and the capacity of the state to deliver on this requirement for highly skilled individuals is and will be heavily dependent on the success of the Institutes of Technology.

Despite significant investment in research since 1998, Ireland remains below the European average for spending on research in the higher education sector and we were ranked 14th of 30 countries in 2004. The situation in the Institutes of Technology sector is particularly critical, as it is likely to be the

Opinion

“While we do and should concentrate on future economic growth, we should not neglect the human, social and cultural dimensions that underpin research and innovation.

main source of growth and development in relation to use-inspired research, technology transfer and the development of much closer strategic alliances with business and industry.

In the region served by GMIT, almost 28% of the workforce hold a third level qualification. Employment in the medical and precision instruments sector has shown strong growth over the last ten years as has the performance of companies engaged in software and computer related services. Maintaining growth will require a substantial increase in workforce development programmes if the research and innovation pipeline is to be maintained.

Most of the students who go on to do post-graduate study will need to find an alignment between their research interests and those required by companies in the region. In addition, those at work today will need opportunities to upskill. The development of research in GMIT will have to respond to these national requirements and our strategy for research will be realigned and refined in line with emerging areas of

national economic development.

The balanced regional development of gateways and hubs – as envisaged in the National Spatial Strategy – remains a part of Government policy. The realisation of this objective cannot be achieved without a concerted programme of action with defined outcomes and targets. Such a programme needs to utilise and build on the capacity of the Institutes of Technology.

Recent comments about the need to divert resources to the Eastern conurbation should be vigorously challenged in the west of Ireland. Our innovation and research system requires a whole island focus because our size does not allow for any other approach if we are to compete in global markets.

While we do and should concentrate on future economic growth, we should not neglect the human, social and cultural dimensions that underpin research and innovation. Creativity is at the heart of innovation and the climate in which creativity flourishes is multi-layered.

A climate that encourages risk-taking,

blue-skies thinking, the ability to collaborate and a willingness to learn from failure is a necessary pre-requisite for the development of an innovation system. So too is the development of flexibility in our education system and the encouragement of multi-disciplinary approaches to research.

This journal showcases some of the research and innovation work underway in GMIT. The Institute is not an island. What we do and what we achieve in the future will be heavily influenced by the demands of our funding partners and the expectations of our stakeholders. An Institute of Technology needs to be the lighthouse of its region and I hope that our endeavours in the future will ensure that this is the case.

Marion Coy

Research development on track

GMIT has an ambitious research agenda that incorporates research development and growth within the Institute's strategic plan. Dr Barry O'Mahony, Associate Professor at Victoria University, Melbourne, and former Head of Research at GMIT, believes that the Institute is on track in its goal of developing a critical mass of research strength within the institute.



Dr Barry O'Mahony, Associate Professor at Victoria University, Melbourne, and former Head of Research at GMIT

The research being conducted at GMIT is as impressive as the professional approach adopted by its researchers. Several key research areas are performing at a very high level and the Institute is making great progress in its efforts to improve research capability and performance.

With 88 students studying at masters or doctoral level contributing to a growing research culture, the Institute can be justifiably proud of its achievements. Internal research support initiatives have contributed to GMIT's research success and I believe that this investment has been a catalyst for the development of research capability.

Having attended a number of government seminars on the future of research in Ireland, the major challenge for GMIT in the future will be securing prestigious grants from major Government funding bodies such as the Irish Research Council for Science, Engineering and Technology and the Irish Research Council for the Humanities and Social Sciences.

To achieve success in these areas the internal capability of the Institute needs to match stringent research criteria and I believe that GMIT will soon be in a position to contest these opportunities.

Further development in the Institute's key areas will place GMIT in a position

to capitalise on major externally-funded research opportunities and to achieve national and international recognition as research leaders in several research areas.

The key to achieving world-class research standing involves connecting with international research leaders and developing cross-national research collaboration, a priority now within GMIT.

Dr Barry O'Mahony

Reading messages from space: cosmic radiation

A major collaborative research project exploring cosmic radiation and outer space is underway in the US and GMIT is playing an active role, writes GMIT's Dr Patrick Moriarty, a project scientist on the VERITAS project.



Dr Patrick Moriarty, Senior Lecturer in Physics & Instrumentation, GMIT, and a project scientist on the Veritas project

You can't see it, but the skies above us teem with messages from the depths of outer space.

In fact, Earth's atmosphere is bombarded by a constant rain of charged particles known as cosmic radiation. Much of this comes from our own Sun, but some has travelled further – a lot further – to bring us tidings of distant stars and galaxies

and even more exotic objects. We have known about cosmic radiation for nearly a century, since Victor Hess detected it during balloon flights in 1912. But technology has moved on and now some of the world's most powerful telescopes are starting to track down the high-energy cosmic radiation that comes from outside our own solar system.

It's not an easy job. Because cosmic ray particles are electrically charged, their paths are scrambled by magnetic fields as they speed through the galaxy, so when they reach the Earth it is impossible to tell where they originated from. Enter gamma radiation: gamma-ray photons are electrically neutral and are not affected by magnetic fields, so we can project their paths back to the source. If we can find gamma-ray sources where the radiation is being produced by protons and other nuclei, this will identify such objects as cosmic ray sources, and will allow us to study the mechanisms by which cosmic rays can be accelerated to the enormous energies some of them possess on reaching the Earth.

That's why the Administrative Complex of the F.L. Whipple Observatory in southern Arizona is a veritable hive of activity these days (and nights!). Work is afoot to use giant and powerful telescopes to

pick up bursts of gamma radiation from structures in outer space like black holes and exploding stars. And excitingly, GMIT is playing an active role in the project – this writer is a Project Scientist with VERITAS and a member of the VERITAS Executive Committee.

At the heart of the operation are four massive 12-metre telescopes. Distributed among the buildings and car parks at the Arizona station, the four telescopes make up the Very Energetic Radiation Imaging Telescope Array System (VERITAS), which saw first light in April 2007.

Each telescope uses 350 hexagonal mirrors, carefully aligned to bring light to a common focus on a 499-pixel camera. This is no ordinary camera, though: each "pixel" in the camera is a photomultiplier tube that can respond to single photons of light within a few billionths of a second. The large mirror area coupled with the extreme speed and sensitivity of the photomultipliers means we can detect and image the tiny blue flashes of light produced in the upper atmosphere by gamma-ray photons (and charged cosmic rays) that have travelled from the depths of space. In fact, each telescope is sensitive enough to detect the light from a birthday candle ten miles away – even if it was lit for just two hundred-millionths of a second!



Veritas T.3 wide angle telescope



So what can we learn with all this sensitivity? Where do these cosmic gamma rays come from? At present, much of the activity at VERITAS is directed towards the observation of sources and potential sources of very high energy gamma radiation coming from extreme environments. One of the current aims is to look at blazars – active galaxies with a rotating supermassive black hole at their core. Jets of high-energy electrons streaming out of the structure interact with magnetic fields in the jets to emit X-rays, which are then boosted to gamma-ray energies.

Studying this gamma radiation allows us to probe the structure of the jet and begin to unravel the processes at work in the vicinity of the black hole.

Another objective for VERITAS is to investigate supernova remnants, or sites of exploding stars, where the gamma radiation may arise when electrons are accelerated by shock waves and interact with magnetic fields – this is certainly the case for the emission from the Crab Nebula. However, in other supernova remnants, it is possible that the gamma rays come from interaction of protons

and heavier nuclei, a tantalising prospect in the search for the origin of cosmic radiation.

Other key projects for VERITAS project include a survey of the Milky Way galaxy and a search for the elusive “dark matter” which makes up a quarter of the Universe. Whilst the key projects are still a considerable way from completion, some early results from VERITAS have been released. The telescopes have been cutting their teeth on the Crab Nebula in the constellation Taurus, long a standard candle for ground-based gamma-ray astronomy. In addition, the instruments have picked up radiation from blazars up to 500 million light years away. And closer to home, within our own galaxy we have seen emissions from the high-mass X-ray binary system LS I +61 303 in which a compact object – either a neutron star or a black hole – orbits a very massive “ordinary” star, and from the supernova remnant IC443, which lies about 5000 light-years from Earth.

So VERITAS is up and running, and performing the job for which it was built. Almost 100 faculty, post-docs and graduate students contribute to the

effort. GMIT is one of 23 institutes in four countries which make up the VERITAS Collaboration. The other Irish institutes involved are CIT, UCD and NUIG. One of GMIT’s postgraduate students is Victor Acciari, now based in Arizona, who is working with VERITAS and with the Whipple Observatory 10-metre telescope on multiwavelength investigation of blazars. This work will form the basis of a PhD project.

Already, several papers have been accepted for publication in the *Astrophysical Journal*, and many more are at an advanced stage. But there is still much to do, particularly in the search for new sources of high-energy gamma rays. In April-May, this writer will once again be in Arizona to carry out observations with VERITAS as part of this search. I forward to having new and exciting results to share in the near future.

GMedTech: serving the medical devices industry

by Jo Lavelle

The Galway Medical Technologies Centre (GMedTech) was established at GMIT's Dublin Road campus in 2006 as a testing centre for non-invasive medical devices and a resource to support the medical technologies cluster in Galway city and surrounding area.



John Kelly, Centre Director, GMedTech

Funded by Enterprise Ireland, the GMedTech Centre's research is based on the development of in-vitro simulation test systems that mimic human anatomical systems. The Centre also offers a range of engineering design and development support to the developers of medical devices.

John Kelly was appointed Centre Director in 2006 and brings a wealth of experience from the research and development sector, having worked for a number of years leading R&D teams in Medtronic, developing devices to treat cardiovascular disease and investigating new technologies to treat a range of

cardiovascular diseases. He moved onto Biocompatibles where he set up and ran their R&D group, and then worked on a consultancy basis before joining GMIT.

"GMedTech was set up in response to the lack of simulation testing in the medical devices industry in the Galway area," explains Kelly.

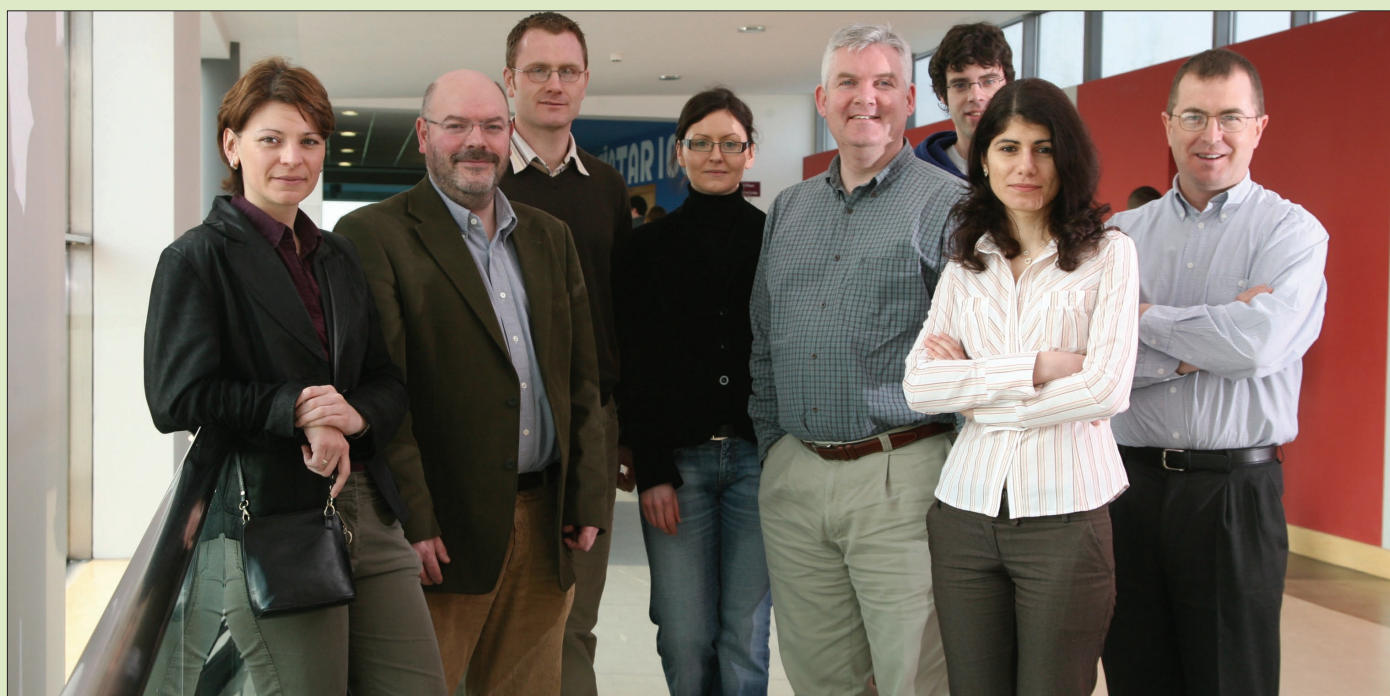
"The products that are developed in medical device companies can sometimes be tested in very rudimentary replicas of the body. The use of these rudimentary systems has occasionally led to situations where products, which appeared to perform well when tested in the rudimentary systems, proved problematic when first used in humans. So we're providing a simulation test system development Centre to develop higher fidelity test systems than those that already exist. We chose to work first on the development of a simulation test system that replicated abdominal aortic aneurysms (AAAs)."

The Galway area has the second or third largest cluster of medical device companies in the world. Serving

one of the top three medical device clusters in the world is no small feat, particularly from a small team of six academic members and eight full time researchers. The four major research topics are abdominal aortic aneurysms, cranial aneurysms, coronary artery disease and the venous system. Their main customers are product and R&D engineers in the device companies to whom they sell their test services.

"We are here to develop and build simulation test systems for specific customers to meet their specific product needs. To do this well, we're developing a series of background skills that can be applied to any vessel in the body. These skills include material selection; how to form the vessel; and how to measure what's happening in the model. We're building up strong skills in these areas and they can be applied to most of the anatomical systems in the body."

"For example, we have an Innovation Partnership programme with a company here in Galway where we're developing a simulation capability for them. The expectation is that down the road, we'll



Members of GMedTech research team: Dr Carine Gachon, Dr Patrick Delassus, Dr PJ McAllen, Dr Magdalena Tyndyk, John Kelly (Centre Director), Dr Liam Morris, Florie Eni and Gerard O'Donnell.

be able to use our expanding knowledge base to work with more and more device companies to support their product development and product test activities."

"From the point of view of GMIT, post-grads working in the Centre gain invaluable experience, not only through their particular research activities, but also due to the high level of interaction with experienced engineers in the device companies."

"It's a very good experience in that they have a protected environment in which they get their post graduate qualifications. They are also incredibly well positioned to understand the goings-on in product development groups in industry because all the students will talk to R&D engineers in the local device companies about how they do things, what the products are, where mistakes were made and so on. It gives them a great understanding of the commercial world as they're working with professional engineers on real development projects."

"People in industry are often of the

opinion that researchers in academic environments don't have a sufficient understanding of the dynamics of industry and where their work fits into it. But in this environment, you have a situation where students can see that their work is contributing to a test system, which is contributing to the development of a better product – that's a very tangible pathway from the research to a real product. My view is that the links we're establishing with industry are of great benefit to both industry and our technical researchers here in GMIT."

It's anticipated that GMedTech will become self-sufficient in another few years, when the funding from Enterprise Ireland funding will wind up.

"For that to happen, we have to engage very strongly with industry. We're putting in place the building blocks. We're working with multinational and indigenous companies and with companies outside of Ireland on the testing of AAA devices. The expectation is that we will have a number of companies working with us on the

testing side. Through the testing, we will be in a position to tell them what's right and what's wrong with their devices and to suggest improvements, providing continual support throughout its development."

Although business is at the core of the GMedTech Centre, Kelly and his team never lose sight of the end result. "Companies obviously want to make profits, but it's also rewarding to actually help save and extend people's lives."

The GMedTech team is comprised of Dr Magdalena Tyndyk, post-doc, and six academic advisers to the Centre: Dr Patrick Delassus, Mr. Gerard O'Donnell, Dr Liam Morris, Dr PJ McAllen, Dr Oliver Mulryan and Dr Carine Gachon (pictured).

In addition, there are seven post-grads in the Centre: Florie Ene (second year of PhD), Ronan Carroll (second year of MSc), Paul Cahill (second year of MSc), Ronan Finn (first year of MSc), Paul Fahy (first year of MSc), Tomas Murray (first year of MSc) and Kevin O'Connor (part time MSc and technician in the Mechanical & Industrial Engineering Dept).

liBCs: supporting knowledge and technology based start-ups

Two innovation centres set up by GMIT, supported by Enterprise Ireland (EI), in 2006 are flourishing. One centre is based at the Castlebar campus in Mayo and the other at the Dublin Road campus in Galway city.



Picture, L-R: Gerard MacMichael, Head of the GMIT School of Engineering, Des Foley, Head of the GMIT School of Science, George McCourt, Manager of the GMIT Innovation in Business Centre, John Clancy, Head of Business Development, eFast (client company), and Seamus Bree, Regional Director of Enterprise Ireland.

The Innovation in Business Centres (liBC) support the development of knowledge and technology-based start-ups in the region by providing incubation space and business development supports for the nurturing of new ideas and the commercialisation of applied research.

The liBC in Galway is now fully occupied with 16 enterprises (11 client companies and five at concept desk stage)

representing sectors from Software & Services, ICT, and Renewable Energy to Medical Devices and Biotechnology. The newer and smaller Castlebar liBC has 80% occupancy with high growth companies working primarily in IT, Medical and Environmental sectors.

One of the successful High Potential Start ups in the Galway campus is eFast, an Irish company founded in 2006 by Mr Padraic Burke. eFast is investing heavily

in research and development, marketing and developing innovative fixed asset RFID solutions. The company recently secured over €300,000 in funding through Enterprise Ireland and GMIT to continue developing its innovative "a-track" asset management software over the next 18 months. "a-track" manages assets for companies by providing 'on-demand' and in 'real-time' financial, utilisation, compliance, logistical and security information. One of eFast's



Maria Staunton, Manager, Innovation in Business Centre, GMIT Castlebar.



liBC Castlebar client company InTime Media : Peter Hayden, Mark Smith, Julian Ellison and Ian Little.

clients, Elan Corporation, recently installed eFast's proprietary Fixed Asset Tracking and Management Solutions at their state of the art facility in Athlone.

A successful company at the Castlebar campus is InTime Media, an interactive media start-up focused on delivering new functionality to the latest mobile phones so that users can interact directly, via their phones, with TV. Founded by Julian Ellison, the company is building up its technical team on the back of on-going developments with the BBC and conducting cutting edge work with mobile phones that have never been tried before. It was recently awarded an Innovation Partnership Programme from Enterprise Ireland.

The success of the Incubation Strategy at GMIT over a two-year period has resulted in six high potential start ups: eFast, ATFM Solutions, Novate Medical, Trade Cert, Veryan Medical and Chipright; 53 new jobs in Galway and 25 in Castlebar; €740,000 research funding (mostly Innovation Partnerships with Enterprise Ireland) and greater integration between

GMIT students working with client companies on projects such as product testing, market research, development of marketing materials; and the placement of GMIT graduates and post-graduate students with client companies.

In addition, the liBC at Castlebar introduced a Student Innovation Award for current students and graduates at the Castlebar campus, to encourage them to set up their own businesses. The competition gives students a chance to learn about the entrepreneurial process and to experience at first hand some of the issues that accompany the development of an idea into a viable business.

The range of services and business development supports for GMIT liBC client companies include financial, legal, sales, marketing and export development as well as mentoring and networking facilities.

The liBCs are managed by Maria Staunton in Mayo and George McCourt in Galway, both under the direction of Dr John Kennedy, Commercial Services Manager.

Bridging the old and the new

Design for manufacture in furniture and wood products

Many furniture manufacturers in Ireland face a dilemma: how do you best combine the traditional skills of manufacture alongside modern design processes? The area of design for manufacture (DFM) is a critical junction, and one where GMIT is coming up with innovative planning solutions.



A student using a CNC machine in the Letterfrack workshop

It's a topic that has exercised Dr Patrick Tobin, programme coordinator of the BSc in Furniture Technology at GMIT Letterfrack, since he took a career break in 2000/01 to research operations strategy in the furniture and wood products industry in the USA.

This sparked his interest in the related areas of design for manufacture (DFM), product engineering and process planning in the furniture and wood products sector. Dr Tobin has now teamed up with Paul Leamy, a lecturer and graduate of the BSc in Furniture Technology who is completing his MSc based on research in the area.

Their main goal is to come up with a process plan that runs from design right through to manufacture, outlining the operations, routes, machines, jigs, tools and parameters required to transform the materials and/or parts into finished products. At present there is little data on

the application of DFM techniques in the wood products industry. When this gap in DFM research is viewed in the context of the major changes in production technology that have overtaken the industry in the last 20 years, a very interesting picture emerges.

"Any small manufacturing company could be using production technology that includes hand tools, versions of machines that have not fundamentally changed in the last 70 to 80 years, highly automated equipment and the very latest in flexible computer numerical controlled (CNC) machining centres. So initial research work at GMIT led the project to investigate process planning methods to help furniture companies to take best advantage of new technologies, and essentially design products for CNC manufacture," explains Dr Tobin.

"But another confounding factor is that in the 1980s and 1990s many Irish

...GMIT is working to create a process planning methodology that spans the design-to-manufacture cycle for today's manufacturing environment.

furniture and wood products companies invested in 3-axis machining centres. They did this without fully understanding the technology, how to adapt their products to best use this new technology, the capabilities, the process planning requirements, and also without understanding the scale of the parallel investment required in training, personnel and software. On top of this, in the last ten years many of these companies have also been developing new capabilities and have implemented CAD design tools and CAM systems to help them design and manufacture on CNCs."

"This has made for a difficult transition for these companies, which has been hampered by a lack of understanding of the effect of process capability on design parameters. To make the situation even more complex, we are currently looking at growth in the uptake of 5-axis CNC machining technology in the Irish wood products industry. These machines can manufacture 3D components that remove many restrictions on product design. They can also allow companies to by-pass expensive jig manufacture in the production of 2-D components."

"That's why GMIT is working to create a process planning methodology that spans the design-to-manufacture cycle for today's manufacturing environment. Research work has

The potential of alder and eucalyptus in woods products



Broadleaf forestry and timber production have played a minor role in the forestry industry in Ireland. However, in recent years there have been more concerted efforts to redress this imbalance.

A new research project "Utilisation of Alder and Eucalyptus in the Wood Products Industry" by GMIT lecturer Dermot O'Donovan focuses on two species of trees which demonstrate considerable potential in terms of growth and timber production. The relevance of this research is evidenced from the strong dependence in Ireland on imported construction materials and fossil fuels.

Common alder is a native species to Ireland and although of relatively low density, it has proven to be remarkably versatile in terms of timber utilisation. Eucalyptus, on the other hand, is an extremely fast growing and dense timber and is used elsewhere around the world for timber production, biomass and as a source of short fibre pulp.

This research project specifically examines Irish-grown specimens of these two species in terms of:

- physical and mechanical properties
- utilisation potential as wood products
- potential in the Irish wood products industry
- utilisation and experiences overseas
- standards applicable in terms of silviculture and timber production

The project will be completed in April 2008. Project supervisor is Dr Patrick Walsh, Forestry Management, GMIT.

New Frontiers



Staff and students from GMIT Letterfrack visit the CMS plant in Zogno, Italy.

included trials and tests on several products using a variety of processing options at the Letterfrack workshops.”

“The main challenge in this research project has been to develop DFM techniques that create a bridge between the traditional manufacturing approaches and the new technologies. The focus of research efforts has been drawn to process planning, which has been traditionally regarded as a manual operation, usually carried out by qualified and experienced tradesmen with minimal additional training. It depended on individual skill and aptitude for the planning task, knowledge of manufacturing processes, equipment, materials and methods in general, and those available in the individual’s own production facility in particular. Thus, in the past process planning has been biased to individual manufacturing

preferences.”

“Currently, in theory, process planning decisions should be effectively made at the CAD workstation, before the product goes to the shop floor. However, in practice there are no techniques available to support such decisions at this point in the design-to-manufacture cycle. Process planning has become very complicated as more processing options are available in the modern flexible manufacturing environment”, adds Dr Tobin.

Work will be completed on the process planning methodology in the coming months. It will result in a technique that will support DFM and product engineering efforts, and guide design and production decisions involving the transition from traditional to modern manufacturing technology.

This project entitled “Design For Manufacture in Furniture and Wood Products” has benefited from the involvement of industry on several levels. GMIT Letterfrack has a high level of contact with industry through undergraduate placements and projects. This provided context data to support initial research into DFM, product engineering and process planning in the sector. This was followed by more specific research, funded from the IRDP, with an industrial partner, David Crowley Furniture (Waterford).

The research was also cross-linked with related work on a funded Inter-Trade Ireland ‘Fusion’ project with Hegarty Fitted Furniture (Tyrone). Also, some final year undergraduate projects, based in companies such as Andrew Ryan Furniture (Wexford), were structured to feed results into the project.

Virtual campus

GMIT School of Business, in collaboration with seven other third-level EU colleges, has been involved in the development of a virtual campus, the EU-funded e-learning project "Erasmus Virtual Economics and Management Studies Exchange (EVENE)."



Kevin Heffernan
School of Business

Co-ordinated by Kevin Heffernan, School of Business, it involved the development of a Virtual Campus for the purpose of delivering web-based courses to exchange students under the Erasmus Student Exchange framework.

The EVENE project involved each of the eight participating colleges offering five modules of five or ten ECTS credits to students of the other participating colleges. The GMIT partners were Tomas Bata University in Zlín, Czech Republic; University of Huddersfield, UK; Savonia University of Applied Sciences, Finland; Riga International School of Economics and Business Administration, Latvia; University of Genoa, Italy; University of Hradec Králové, Czech Republic; and University of West Bohemia in Plzen, also in the Czech Republic.

Over the last two semesters, several GMIT lecturers delivered a number of online modules in the virtual student exchange. Modules included Internet Technology, Entrepreneurship and Innovation, Computer Business Applications and Celtic Studies. Some 60 students studied these modules.

Initial feedbacks from students undertaking virtual mobility

studies at GMIT were positive. "They were very satisfied and considered the experience and the learning outcomes very beneficial. The value to lecturers was two fold - an incentive to embrace e-learning technologies and a rewarding experience of working with students from diverse cultural backgrounds."

From a project coordinator's perspective, Kevin Heffernan says "the experience offers valuable insights into the logistics involved in delivering a project of this nature across a variety of cultures and disparate structures, procedures and work practices."

"As an innovative process there were substantial uncertainties involved, and a lot of valuable lessons to be learnt. The value will be realized in follow up projects, which will inevitably arise," he adds.

Undergraduate student Barry Fahy, who is studying towards a BBS (Hons) in GMIT, undertook a 'Stock Exchange and Financial Markets' module hosted by the University of Hradec Králové as part of this project.

New approach to maths

Over the past five years, numerous software packages have been developed to assist Mathematics lecturers and teachers in the classroom. However, most of these packages have been either purely simulation based or have focused on aspects of lesson design and planning.



Dr Robert J Loughnane
GMIT Maths & Computing Lecturer

The modern lecturer of Mathematics requires more sophisticated tools that allow for both simulation and parameter variation together with code generation, in particular C and/or JavaScript.

While these tools are available in MAPLE, which allows the lecturer total flexibility when presenting the more complex areas of Mathematics to students, further software tools were required.

GMIT Maths & Computing lecturer, Dr Robert J Loughnane, has developed a number of portable algorithms within the MAPLE framework that can be used with students to enhance their understanding of mathematics. These algorithms can be used at both second and third level and are such that the mathematics under investigation is brought to life.

The GMIT Maths & Computing Department has had significant success with specific groups of third-level students over the past five years. Secondary school students have also benefited by completing intensive 'taster' programmes in the Institute. Students who were weak at mathematics found that the

algorithms helped them to understand the theory behind Maxima/Minima problems as well as Differential Equations.

Dr Loughnane is currently working on the development of new algorithms to help students understand the mathematics underpinning Computer Voice Control and Image Processing.

His research findings have been published in the prestigious *International Journal of Mathematical Education in Science and Technology* and in the *Irish Scientist*.

Nursing school seeks to improve global healthcare

GMIT's Department of Nursing and Health Science is involved in collaborative research involving some twelve countries. The department hosted an international meeting of the Caring International Research Collaborative (CIRC) at the Castlebar campus this year.

The Castlebar gathering represented academic and clinical leaders and consultants in healthcare from the Bahamas, Belgium, Brazil, Cameroon, England, Ireland, Italy, Philippians, Serbia, Switzerland, Tanzania and the United States.

The ultimate goal of CIRC is to create a model that will display how the many aspects of healthcare interact to impact results of patient care globally, nationally and locally. Much is anticipated from the dedicated work of this international interdisciplinary group whose ultimate aim is to improve healthcare globally.

CIRC was set up two years ago to use research as the vehicle for discussion. Geraldine Murray, Head of Nursing and Health Sciences at GMIT Castlebar, is one of four founding members of this group: the others are John Nelson, Jayne Felgen and ChrysMarie Suby, from the US.

The group has 126 members with 18 subgroups of researchers called "Sharing Groups". Each group is intensely focused on one aspect of the healthcare work environment, for example staffing, retention, and patient safety. The Sharing Groups are also working together to see if their findings are connected.

Geraldine Murray, Head of Dept of Nursing & Health Sciences, says "The research

objective is to establish an evidence-based model of process improvement for healthcare providers - a standard of care that will be applicable in the countries of our strategic research partners."

"Development of a best-practices standard for health care in all cultures will lead to improved patient outcomes"

"Development of a best-practices standard for health care in all cultures will lead to improved patient outcomes"

The first year begins with a seven country study of identified factors in nursing work



Members of CIRC. Front row, L-R; Chrys Suby, US; Geraldine Murray, Head of Dept of Nursing & Health Science, GMIT Castlebar, John Nelson, US; Jayne Felgen, US; Dr Susan Smith, UK. Back row, L-R: Jennifer Guild, US; Lily Raposa Correa De Azevedo, Brazil; Dr Sheryl Horowitz, US; Geraldine Shaw, Castlebar; Julie Silke, Director of Nursing, Sacred Heart Hospital, Roscommon; Donna Wright, representing Africa; Patti Legler, US; Relindis Moffor, US and Maria Romana, US.

sites: "It will examine predictors of the following: nurse autonomy within their work, professional patient care, pride in the organisation; profile of effective caring nurses; interaction effect of nurse-patient ratios and competence on patient falls; interaction effect of nurse-patient ratios and competence on medication errors," says Ms Murray.

"All partners will seek to understand similarities in the nursing work environment, and the unique inter-relationships between nurses and patients by continent and country. No previous global research has been identified that examines the work of nurses, and its effect on the selected patient outcomes."

The first year of the research programme will begin with nursing staff, as the largest human resource within health care. Subsequent years will examine

the work environment(s) of physicians, followed by all other health care workers. Interventional planning will be taking place to address strengths and vulnerabilities identified in each year of results.

"Human resource planning and decision-making in nursing services, and eventually other disciplines, will be facilitated by the research data/findings as it will allow examination of the work environment globally, nationally and per participating organisation," explains Ms Murray.

"For the research measures, the Healthcare Environment Survey (HES) was used as an instrument to measure the work environmental factors – it has been psychometrically tested for ten years at international level. To measure the patients' perception of care, the Caring Factor Survey (CFS)

was selected for the sound theoretical bases in Watson's Theory of Caring and psychometric testing internationally."

"To track and measure staffing and patient outcomes, the Labour Management Institute's Survey of Hours® software was selected as it has over 25 years of experience in staffing, workforce management and patient outcomes in healthcare and provides the most valid and reliable database for labour management in the United States.

Finally, to track and measure competence, staffing and patient outcomes, AcuStaf™ software was selected. It has over 20 years of experience in data mining procedures in healthcare and provides the most valid and reliable databases for staffing and scheduling in the US," adds Ms Murray.

Creating energy efficient homes



Dr Tom Roche and Dr John Lohan, principal investigators on the GMIT-Oysterhomes energy project

GMIT has teamed up with Galway-based development company Oysterhomes Ltd in an innovative research partnership on the design and development of ultra energy efficient 'A' rated dwellings.

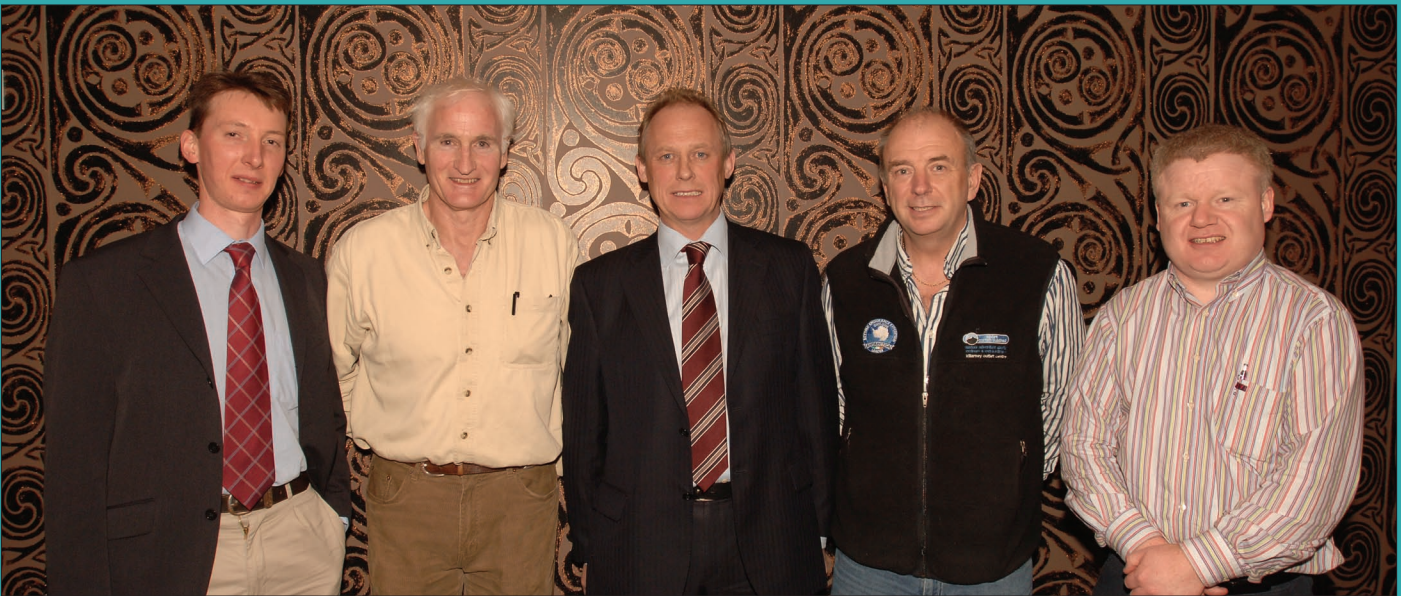
Ireland's energy sector has an exceptionally high dependency on imported fuels and has significant obligations arising from the Kyoto protocol and relevant EU directives. The State's dependency on imported energy in the form of oil and gas, and the likely increase in the cost of these, has the potential to deliver far-reaching negative impacts on our economy in the medium term.

Ireland has the highest CO₂ emissions per inhabitant of any other country in Europe and has been mandated by the EU to reduce its CO₂ emissions significantly over the next 12 years. Failure to do so will result in penalties and thus potential carbon taxes for energy users in Ireland. With 33% of

the State's CO₂ emissions coming from dwellings, energy efficiency of dwellings is becoming increasingly important for Ireland's economic future and in particular for individual householders. As a result, new building standards have been developed which will be implemented in July 2008.

These building standards require:

- 40% improvement in energy efficiency and a 31% reduction in CO₂ emissions for new homes in 2008
- significant improvements in wall, roof and floor insulation levels
- leak testing to minimise unwanted heat loss through air leaks in the building
- each individual dwelling to have a



Dr John Lohan, GMIT; Duncan Stewart, Environmentalist and Broadcaster; Eamon Conneely, CEO Oyster Homes Ltd; Pat Falvey, Explorer, and Dr Thomas Roche, GMIT, at the recent launch of the Parkway Avenue Development (Athlone) and the GMIT-Oysterhomes project.

minimum of 10kWhr/m²/annum to be supplied from renewable technologies (such as solar panels and heat pumps).

Importantly, there is a stated commitment in the standards to review and improve regulations to 60% above current levels in 2010, with the ultimate aim of achieving a zero carbon standard for new houses in the medium to long term.

Oysterhomes Ltd has taken a very proactive approach, with GMIT as its research partner, to designing ultra energy efficient low CO₂ homes in their new developments just launched in Parkway Avenue in Athlone, Co. Westmeath and Millers Glade in Clara, Co. Offaly.

“The company approached GMIT with

the idea to collaborate over the next two years on a cutting-edge research project to design and develop cost effective ultra energy efficient homes for these developments.” says Eamon Conneely, CEO, Oysterhomes Ltd.

“The project will develop a combination of insulations, structural and fabric details and renewable technologies to give ‘A’ rated ultra energy efficient homes,” he adds.

The research is conducted by GMIT’s Dr Tom Roche and Dr John Lohan, Principal Investigators on this project.

“Once constructed we will carry out tests on the buildings to ensure appropriate build quality standards and then correlate the expected energy efficiencies with real life energy data coming from living dwellings over a period of two years,” explains Dr Roche.

“The project builds on energy expertise developed in the Centre for Sustainable Energy Research at GMIT and on the expertise acquired in training over 400 building energy assessors in GMIT over the last year. It is extremely important not just for the owners of homes in these developments but also nationally, for the furthering of Ireland’s mission to cut CO₂ and its dependence on imported fossil fuels.”

“It is planned that the information from this research project will be made available to the general public and indeed the students in GMIT via a specially prepared website,” adds Dr Roche.

*For full details visit
www.gmit.ie/research/nrs/seg*

New energy solutions for sustainable aquaculture

As oil prices once again shoot past the landmark rate of \$100 per barrel, the knock-on effects will soon trickle down to increased petrol and diesel fuel prices, putting pressure on electricity and gas prices in the medium term.

These developments are of particular interest to industries such as power generation and transportation that depend heavily on energy. However, they are of equal interest to other sectors, none more so than the Irish aquaculture industry, where energy cost ranks alongside labour and feed.

Researchers from GMIT's Research for Alternative Culture Enterprises (RACE) Group recognised that energy cost has long been a key constraint to growth in the aquaculture sector and have teamed up with GMIT colleagues from the Sustainable Energy Research Group (SERG) in 2006 to help address this issue.

Both groups sought to establish lower-cost "Total Energy Solutions for Sustainable Aquaculture" (TESSA) and a three-year project started in June 2007.

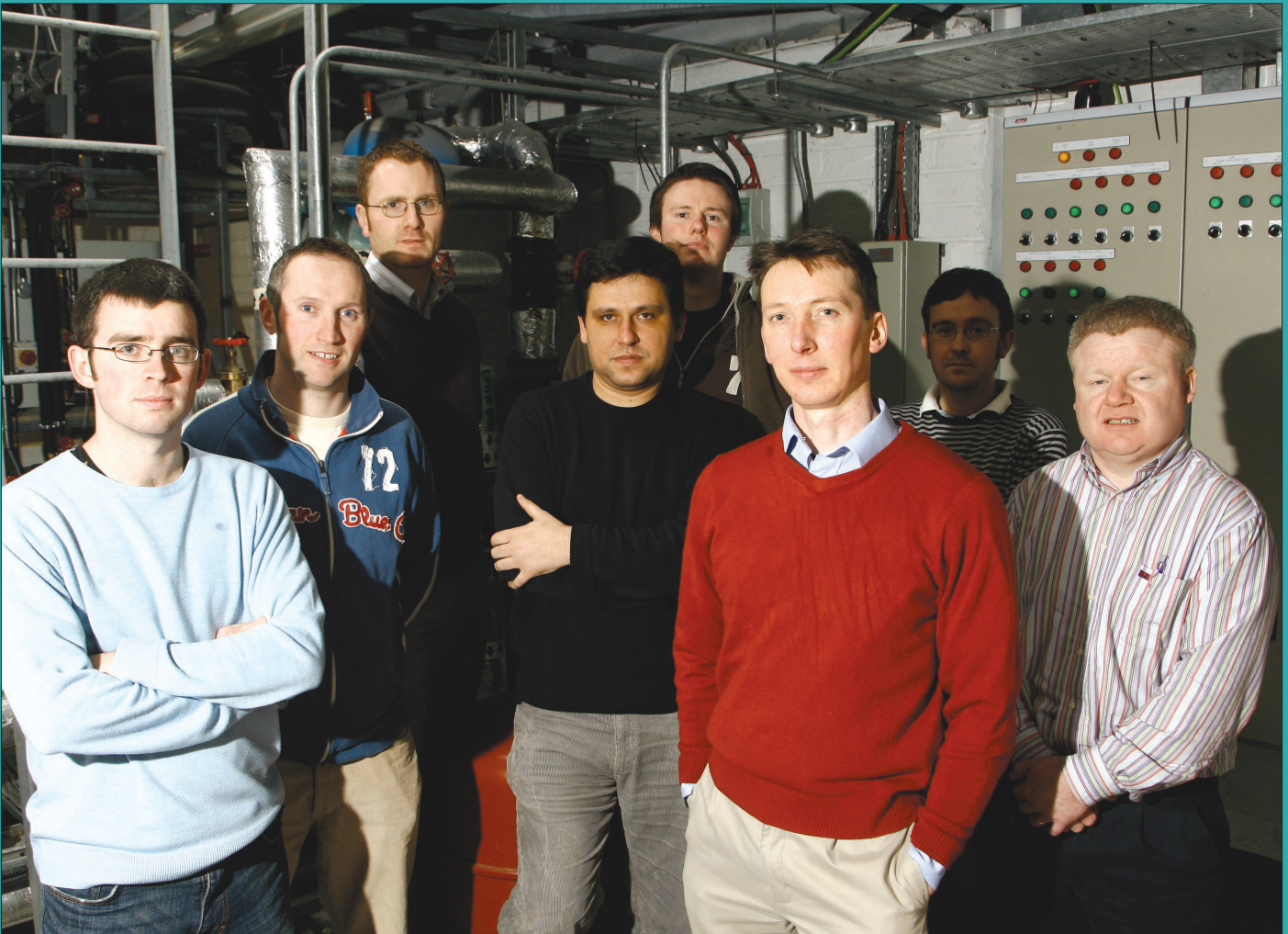
The key aims are to establish a profile for the year-round energy consumption in Irish-based aquaculture farms and then use this information to investigate

"One important development in the sector is that an increasing number of Irish aquaculture production facilities are considering a move from "flow-through" to more controllable "re-circulation" systems, where pumps are used to circulate water through a closed loop system."

alternative means of meeting energy requirements. This would be achieved by using a combination of sustainable energy technologies (energy supply) and energy efficiency measures (energy reduction). The research combines desk study, site visits nationally and internationally, and the construction and operation of a demonstrator facility and system simulation at GMIT.

"We carried out sector analysis to establish the species of fish cultured in Ireland, finding that mussels, oysters and salmon make up the bulk of the total weight of fish cultured here. We also looked the optimum farming conditions for growing a range of species in Ireland, including cod, turbot and abalone," explains Laurentiu Dimache, Project Manager.

"Balancing energy consumption with profitability is central to sustaining aquaculture, so in addition to desk studies we carried out site visits in Ireland and the Czech Republic and audited energy consumption."



Researchers, L-R: Francis Fitzgerald, Ray Clarke, Dr PJ McAllen, Laurentiu Dimanche, Michael Greene, Dr John Lohan, Niall Burke, Dr Tom Roche

"Any effective energy usage approach needs to take current trends into account. One important development in the sector is that an increasing number of Irish aquaculture production facilities are considering a move from "flow-through" to more controllable "re-circulation" systems, where pumps are used to circulate water through a closed loop system. Water temperature is controlled using either heaters or chillers and water quality is maintained through a series of biological and mechanical filters."

"All these components combine to generate high energy consumption, and profitability is therefore heavily dependent on the energy management and protocols and unit cost. At GMIT we are looking at energy sources such as geothermal, wind and solar as options

to power a re-circulation system. We are also developing a demonstrator experimental facility that will embody many of these concepts in a recirculating system.

"Work will start on the site this year and we envisage a full integration of energy systems by mid-2009," adds Dimache

Since this project has been developed to support the entire aquaculture industry in Ireland, the project team established a cross sectoral Steering Group to advise on the research direction and scope. The members are Bill Carty, Cool Springs Arctic Charr Ltd; Ken Maher, MRI Carna; Joe McElwee, IFA Aquaculture; Dr Mark Norman, Taighde Mara Teo; Cindy O'Brien, Abalone Chonamara Teo; Damien Toner, Aquaculture Initiative; Dr

Terence O'Carroll, Bord Iascaigh Mhara; and Dr Paul Sikora, Dunstar Ltd. The project is funded by the Department of Education and Science's STRAND III Programme.

The project is supervised by Dr John Lohan (SERG) and both Brendan Allen and Dr Ian O'Connor (RACE). Laurentiu Dimache has been recruited as project manager and Michael Greene as PhD researcher.

For further information on this project contact Laurentiu Dimache or Michael Greene: tessa@aquaculture.ie or +353 (0)91 74 2370 or +353 (0)91 74 2379.

Commercial fisheries research group: an invaluable resource

The Commercial Fisheries Research Group (CFRG) at GMIT has been carrying out research in support of sustainable fisheries management and aquaculture since 1999, and is proving to be an invaluable resource and support to the fishing, aquaculture and angling tourism industries in the BMW region.



Researchers at CFRG have established collaborative partnerships with industry in the region and with state bodies with the ultimate aim to sustain the economic development of the BMW region. Projects have involved industry partners such as BIM, the Marine Institute, Taighde Mara Teo, and the Irish Commercial Fishing Industry.

The CFRG is involved with several National Advisory Councils and maintains regular contact with the changing needs of industry, and also collaborates with researchers at international third level and research institutes in Europe and the US.

“We primarily undertake leading-edge applied research that provides critical new knowledge for the commercial fisheries sector,” says Dr Pauline King, Commercial Fisheries Research Group Team Leader.

“We recognise the importance of incorporating an ecosystem approach into the management of commercial fisheries to ensure their sustainable management. And we also conduct research to address current knowledge gaps pertinent to commercially exploited species within marine ecosystems.”

“In the current climate of dwindling fish stocks the seafood industry is faced with the challenge of maintaining a level of exploitation that minimises the impact on the fisheries ecosystem while ensuring that the industry remains economically viable. Our group responds to this need through a range of industry focused research projects examining commercial fish and shellfish stocks and the ecosystem components with which they interact,” explains Dr King.

CFRG research activities focus on the dynamics of commercial fish and shellfish species and the biotic and abiotic interactions driving their spatial and temporal variability. Specific research projects address the ecology, population dynamics and stock structure of commercially exploited species throughout the organism’s life cycle, from adult spawning grounds, to juvenile nursery areas, via larval drift pathways.

Current projects also examine the

interactions between commercial fisheries and key predators (cetaceans and sea birds) within marine ecosystems. A principal research interest of the group is how available biological information on fish stocks can be used to best advantage in the formulation of stock projections that inform management decisions.

“Our group has attracted over €5million in funding since 2000 and succeeded in establishing two key marine laboratories at GMIT. When integrated with existing facilities, the equipment and expertise provided by the funding combines to provide a greater technical support base with extensive capabilities, helping the Institute to play a more significant role in research, consultancy and training services to the fisheries sector.”

“The funding also ensures sustained growth in commercial fisheries research at GMIT and establishes the Institute as a national leader in fisheries research,” adds Dr Pauline King.

The CFRG has five research active lecturing staff, five fulltime researchers (at principal investigator, postdoctoral and research officer/scientist level) and nineteen post-graduate researchers at MSc and PhD level, making it one of the largest such groups in the Irish third-level sector. The CFRG has produced three PhD and seven M.Sc. graduates in the past five years.

The group has now reached a critical mass of research activity and contributes to cutting-edge research at an internationally renowned level. This is demonstrated by an extensive record of peer-reviewed publications, conference presentations, international and national collaborations and appointments of members of the CFRG to expert advisory groups.

Dr Pauline King



Dr Pauline King, Commercial Fisheries Research Group Team Leader.

Dr Pauline King is a senior lecturer at the Department of Life and Physical Sciences and Team Leader of the Commercial Fisheries Research Group (CFRG) at GMIT, which she set up in 1999. She is Lead Scientist on a number of externally funded research projects and is an experienced research supervisor at MSc and PhD level.

Her professional research interests are in the area of fisheries biology and the sustainable management and development of commercial fish stocks.

Specific interests centre around the age, growth, reproductive biology and fishery dynamics of commercial fish and shellfish species, while other research interests include marine ecology, rocky shore ecology, ichthyoplankton studies, and alternative food products for the Irish Seafood Industry. She has a substantial record of peer-reviewed literature, with over 40 publications in international scientific journals.

Dr King is a regular participant at international conferences and has been a lecturing visitor at the University of Algarve (Portugal). She is a member of the Marine Institute Implementation Team for ‘Sea Change’. Internationally she is an active participant at the International Council for the Exploration of the Sea (ICES), and North Atlantic Fisheries Organisation (NAFO), a member of NAFO’s Working Group on Reproductive Potential, a member of the EU COST Management Committee for Action concerning fish reproduction and fisheries, an Advisory Partner to International Aquatic TNET, and a member of the Council of Directors of IRCSET since 2006.



Dr Martin Robinson, Dr Grant Stentiford (CEFAS) & Jennifer Walsh (MSc)



Shellfish holding system

SHELLTEC boosts shellfish industry

Applied research and development for the shellfish industry continues to gain momentum in the Enterprise Ireland funded SHELLTEC Applied Research Centre at GMIT.

A collaborative project with the Inis Oírr Fishermen's Co-operative has been heralded as an excellent example of how GMIT-lead research can generate significant new diversification projects for communities in the region.

The project involved the installation of a large commercial lobster holding system at the co-op premises and the training of co-op staff by GMIT researchers. It attracted national interest and was profiled on national television, radio and in the *Irish Times* during December 2007.

A number of other projects are currently running at the centre: SHELLTEC was successful in obtaining €90,000 in funding from Enterprise Ireland for capital equipment to support new research themes in the area of biomarkers for animal stress and pollution. This award assisted in a collaborative venture that secured a major award from the EPA

under the Strive Programme. The project entitled "The assessment and potential for human impact of exposure to environmental contaminants on marine and freshwater bivalves" has a value of €783,000 over five years. The funding was awarded to Dr Brian Quinn to join SHELLTEC and bring with him two PhD students.

"As methods of assessing water quality issues are of global interest SHELLTEC worked with Brian to develop this proposal", SHELLTEC Principal Investigator Dr Martin Robinson explains.

"Marine and freshwater mussels will be used to assess the potential for build-up of pharmaceutical and other chemical wastes in our aquatic environments this giving us some idea of how to progress to assessing associated human health risks"

A formal collaboration with the Shellfisheries Pathology Laboratory of the Centre for Environmental, Fisheries and Aquaculture Science (CEFAS) UK has also recently been formed, with a new PhD student being jointly supervised by Dr Robinson and a member of CEFAS staff, Dr Grant Stentiford, who visited GMIT to discuss further EU-level collaboration with the Institute, and to view some of the shellfish pathogens that are impacting on Irish industry currently.

SHELLTEC is working with industry to provide management advice to minimize or eradicate these infections and increase economic viability.

Profile: Dr Martin Robinson

Principal Investigator, SHELLTEC

by Deirdre O'Shaughnessy

Originally from Poole in England, Dr Martin Robinson came to Galway in 2005 to head up GMIT's Enterprise Ireland funded SHELLTEC shellfisheries technology research centre. He lives in Renmore with his wife Mary, also a marine biologist.



Martin does not have the demeanour of a stereotypical academic, nor the schedule of one. He travels abroad on research work three or four times a year, and within Ireland, to visit companies around the coast with which he conducts development projects.

Martin left school at 15 and trained as a carpenter. After a few years working he returned to college, completing his A levels at night school and going on to do a degree in marine biology, becoming

a poster boy for the notion of 'lifelong learning'. He describes how important changes in the third level education sector in recent years have presented people from all walks of life with chances to access skills and knowledge re-training throughout their life. This has not only resulted in the enrichment of the quality of life of the students, but also contributed enormously to Ireland's robust economy.

Although he was the first in his family to obtain a doctorate, it was no surprise he

decided to study marine science. "My grandfather had a little wooden boat. He used to row out with me and my brother into Poole Harbour and tell us all about seagulls and crabs on the bottom of the sea, and I think that's what got me into it."

His interest in all things aquatic resurfaced when he took up scuba diving as a teenager, and he says that "when everyone else was seeing how deep they could go and how long they could stay down, I was happy to splash around in the shallows where all the best wildlife is."

After completing his degree in marine biology at the University of Wales in Bangor in 1996, Martin moved to Ireland and began a doctorate in Trinity College. His doctorate, completed under Dr Oliver Tully, who now also works in Galway for Bord Iascaigh Mhara, centred mainly around the early life history ecology of crabs and lobsters. This involved a heavy load of diving in the Saltee area of Wexford and introduced Martin to the Irish fishing industry. After this was completed he continued to work in Trinity

Natural Resources & Sustainability

“We work with industries to define their specific needs and then build partnerships that access the resources and assistance of the various development agencies.”

for a number of years, first with Oliver and then heading up his own research team.

The move to Galway came when GMIT was looking for a scientist to manage its new SHELLTEC Centre. This is an Enterprise Ireland 'Applied Research Enhancement' funded initiative which provides innovative commercial support for the shellfishing industry. The group has recently helped with the installation of a GMIT-owned one tonne shellfish holding system on Inis Oírr, which enables the local fishermen to better control their market by storing their catch for longer.

“We try to help optimise things overall by helping to apply the correct research and development”, says Martin, adding that the SHELLTEC team “never do things unless it is useful to the local communities. Regional and national development are key to our strategy”, he adds.

The SHELLTEC group are at present

working on over 12 different projects with a combined value exceeding €2m. Such is the level of interaction with industry enjoyed with the group that some of Martin's postgraduate students are partly or fully funded by Irish companies.

“Although I have been working with some industry groups for nearly 10 years now, we are contacted regularly by new ones looking to establish research and development links with the academic research environment”, Martin explains.

“We work with these industries to define their specific needs and then build partnerships that access the resources and assistance of the various development agencies. Successful projects result in increased competitive ability within the industry, while we increase knowledge and train our research staff.”

The everyday management of his extended research team, which currently numbers 18 postdoctoral scientists, assistants and postgrads, also adds

significantly to the hectic schedule.

According to Martin, “Marine science has become much more centralised”, with many of Ireland's major centres now based in Galway. NUIG also has a marine science function, the Martin Ryan Institute, while the Marine Institute and BIM are also based in or near the city.

“The HEA/Forfás Review in 2006 highlighted the potential for developing Galway and the western seaboard as a leading centre for marine research within Europe”, Martin states.

“Although it is rare that I manage to get out to work on boats with the industry these days, and even rarer that my scuba gear gets dusted off, I hope that I can continue to live by and work in the marine environment and in doing so bring benefit to coastal communities”.

© Galway Independent, “Me and the Sea” series.

Marine mammals: enhancing our knowledge

Irish waters provide a diverse range of habitats for whales, dolphin and porpoises with 24 species recorded to date. In 1991, in recognition of the importance of Ireland for cetaceans, the Irish government declared all Irish waters to be a whale and dolphin sanctuary. GMIT is playing its part in this mission, writes Dr Simon Berrow.

Marine mammals represent almost 50% of the native mammal fauna of Ireland and thus Ireland has a significant conservation obligation to all cetaceans and their habitats. This great species diversity reflects the range of marine habitats in Irish waters, from shallow continental shelf waters to shelf slopes, deep-water canyons, offshore banks and abyssal waters. Conservation initiatives and policies are constrained by lack of basic knowledge on most

species ecology including their distribution, abundance, diet and habitat requirements. A new cetacean research team has been established at GMIT, which is trying to address many of these issues.

In 2005, Dr David McGrath of the School of Life and Physical Sciences in GMIT and I, as Project Manager of the Shannon Dolphin and Wildlife Foundation (SDWF), put together a joint tender to the National Parks and Wildlife Service (NPWS) for

a study of dolphins and porpoises in Galway Bay and North Connemara. The tender was successful and GMIT were awarded their first whale and dolphin research project. This project was advertised as an MSc and the successful applicant, Joanne O'Brien, has achieved so much that the project has been upgraded to a PhD with additional funding from the NPWS. (Continued on next page)



Natural Resources & Sustainability

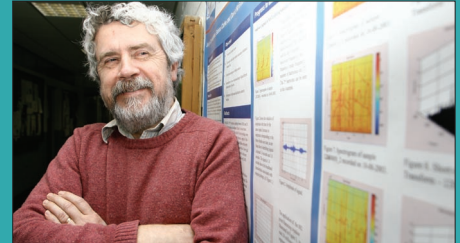


Dr Simon Berrow, Project Manager of the joint GMIT/IWDG PReCAST project

The Shannon Dolphin and Wildlife Foundation is based in Kilrush, Co Clare and operates a field station on the shore of the Shannon estuary, which is the only protected site in Ireland for bottlenose dolphins. One of its main research interests is the development of passive acoustic monitoring. One aspect of Joanne's PhD is the deployment of passive acoustic devices to recognize and log the echolocation clicks of bottlenose dolphins and porpoises using TPODs. In addition to these TPODs, the SDWF also deploy a static hydrophone in the estuary each year to record dolphin whistles and other vocalizations.

Cetaceans live in a world dominated by sound and if we are to understand their ecology, identify threats and

monitor their status effectively, we need to tap into their primary sense, which is acoustic. This field attracted the interest of John Cunningham in the Department of Physics at GMIT. John is involved in voice recognition software and wondered if it could be applied to the recognition and extraction of dolphin whistles from sound files. It is thought that all bottlenose dolphins have their own unique whistle (a signature whistle), which they use to communicate with each other. This interest has led to an MSc project being carried out by Sam Clarke, a technician in John's department. Sam is using MATLAB to identify and match whistle types, which can then be associated with dolphin behaviour, group size and maybe even individual dolphins.



Dr John Cunningham, Dept. of Physics, GMIT

This new development of research into passive acoustics quickly led to Dr David McGrath and this writer being asked by the Irish Sea Fisheries Board (BIM) to assist them in testing their new acoustic deterrent devices. These devices had been developed to deter dolphins from pelagic trawl nets, which occasionally capture dolphins, especially when fishing for albacore tuna. Although BIM have these acoustic deterrents or "pingers" deployed on commercial trawlers they could not evaluate their effectiveness. A field protocol for testing the devices on the dolphins in the Shannon estuary was devised. The team invited Dr Ruth Leeney from University College, Dublin to assist with these trials as she had worked on harbour porpoise acoustics. The trials were very successful and showed an evasive reaction by bottlenose dolphins to these deterrents.

However, as the most frequently caught dolphin species in pelagic trawls in Ireland is the common dolphin, BIM requested GMIT/SDWF to carry out additional trials on this species. The Irish Whale and Dolphin Group (IWDG), of which I am Co-ordinator, is an NGO, which co-ordinates an All-Ireland stranding and sighting scheme as well as undertaking many research and awareness initiatives. Using the data collected by the IWDG we could identify the best site and season for encountering common dolphins and therefore increased the probability of encountering enough dolphin groups to produce robust results.

In the winter of 2006 a series of tests were carried out off County Cork and

to everybody's surprise we obtained completely different results to those from the Shannon estuary. Common dolphins completely ignored the acoustic deterrent signal, even when it was modified to be of a greater frequency range and for a longer duration. The funding for these trials was obtained from a EU-wide research project called NECESSITY and some collaborators had successfully deterred common dolphins with some of their acoustic deterrent devices. Colleagues from Denmark and France were invited to test these devices in controlled exposure trials on Irish common dolphins.

These were conducted in winter 2007 and once again the common dolphins off County Cork showed very little reaction to these devices. These results have made a significant contribution to the development of acoustic deterrents in European fisheries by showing that different species, and even different populations of the same species, may react very differently. They also showed that controlled exposure trials on dolphins are possible in the field with proper preparation and planning. These trials led to the development of an application for funding under Strand One to increase our knowledge of dolphin vocalizations. This proposal was successful and a new MSc student will be starting on this project in GMIT in March 2008.

In summer 2007 a joint tender to the NPWS led GMIT and the IWDG to carry out a survey of harbour porpoises in the Blasket Islands, Co Kerry Special Area of Conservation (cSAC). Using line transect methodology and passive acoustic, the team derived abundance estimates for the SAC and showed important seasonal variation. GIS was carried out by Dr Ian O'Connor of GMIT who is now a member of the cetacean research team. Three more similar surveys in Counties Cork and Dublin have recently been advertised for which GMIT and the IWDG will be tendering.

Supporting and guiding conservation policy

GMIT has recently won a major research project, worth over €500,000. This project is called "Policy and Recommendations from Cetacean Acoustics, Surveying and Tracking (PReCAST)" and is a collaboration between GMIT and the IWDG. The aim of the project is to provide robust scientific data to support conservation policy and provide guidance to state agencies in implementing national and international obligations and in so doing to build national capacity in the area of automated assessment and monitoring of wildlife populations. It will contribute very significantly towards fulfilling the requirements of the EU Habitats Directive, which required that Ireland must "put in place a comprehensive, adequate, ongoing monitoring programme for cetaceans that could enable a system of strict protection for those species to be devised". Two Research Scientists will be employed on three-year contracts to deliver this work.

The commitments under PReCAST will be delivered in four main work packages. We will carry out offshore cetacean surveys of the entire Irish Exclusive Economic Zone (up to 200 nmls offshore). These will be carried out on platforms of opportunity including Irish and foreign research vessels, navy ships and even the onboard the Irish Maritime Squadrons' aircraft. We intend to acquire two year's passive acoustic monitoring data of dolphins and porpoises in Galway Bay, Shannon estuary and off the Blasket Islands cSAC. These data will be used to develop monitoring protocols in order to achieve "Favourable Conservation Status" of protected species. The flagship project will be an attempt to deploy satellite tags on fin whales.

Fin whales are the second largest whale after the blue whale and are now frequently observed off the south coast of Ireland where a whale-watching

industry is starting to expand. Photo-identification studies carried out by the IWDG have shown that the same whales are returning each year and may be found in inshore waters for up to nine to ten months. Where they go outside his period is not known and we have invited Danish scientist Dr Mads Peter Heide-Jørgensen, who builds and deploys satellite tags to assist us with this work. This will increase our capacity to carry out similar studies in the future. We hope to bring together a lot of these tasks to explore the ecosystem links between whales and dolphins and the food chain in the Celtic Sea. An ecosystem approach to managing marine resources is an aspiration of the EU and we hope to make a significant contribution to this vision by using the Celtic Sea as a pilot study.

PReCAST is funded by the Marine Institute through their SeaChange programme and the NPWS. As part of this project we will have an extensive outreach with public lectures, lunchtime seminars and fantastic opportunities for students and staff at GMIT to participate in cutting edge whale and dolphin research. We are entering into exciting times as Ireland's largest cetacean research team explores one of the most fascinating and enigmatic group of animals on our planet.

Dr Simon Berrow is Project Manager of the joint GMIT/IWDG PReCAST project, Project Manager of the Shannon Dolphin and Wildlife Foundation based in Kilrush, Co Clare, and Co-ordinator of the Irish Whale and Dolphin Group. He is co-supervising two MSc and one PhD students at GMIT with Dr David McGrath, GMIT.

Marine biodiversity research group

At GMIT we have been looking at the diversity of marine species around us and with some 90% of Ireland's territories lying under seawater there's plenty to explore, from microscopic plankton to large mammals, writes Dr Ian O'Connor, Marine Biodiversity Research Group (MBRG).



Heads of the Marine Biodiversity Research Group, Dr Ian O'Connor and Dr David McGrath

Our Marine Biodiversity Research Group has expertise in the systematics, biology and ecology of marine invertebrates, sea birds and cetaceans (including whales and dolphins). Formally set up in 2004, our multidisciplinary group of experts currently includes three full-time academic staff, two postdoctoral researchers and eight graduate students.

To date we have received significant funding from state agencies such as IRCSET, the Marine Institute, Bord Iascaigh Mhara, National Parks and Wildlife Service, the Environmental Protection Agency, the Dept of Education Core Research Enhancement Programme and GMIT Research Development Fund.

The breadth of expertise within the MBRG, which includes biologists, physicists and bio-acoustic engineers, has resulted in the group becoming recognised as a national leader in the

area of remote sensing and assessment of marine wildlife populations.

In partnership with the Irish Whale and Dolphin Group, we have received funding for conservation surveys of cetaceans in Irish waters, and for an ambitious, three-year project to look at the distribution and ecology of cetacean species in Ireland's territorial waters.

In 2005, BIM commissioned the Marine Biodiversity Research Group to research the efficacy of continuous and responsive pingers as acoustic devices to keep cetaceans away from the vicinity of fishing gear. The success of these initial trials led to two additional projects on the effect of acoustic deterrents on the behaviour of common dolphins.

Our postgraduate students in MBRG frequently participate in research cruises with scientists from the Fisheries Science Services and the Advanced

Mapping Services of the Marine Institute, and we are currently looking at the use of habitat mapping as a tool in ocean management.

Working with National Parks and Wildlife Service we are also contributing to the development of rapid assessment techniques for soft sediment biodiversity and habitat use by cetaceans.

Through continued successful bids for research funding the group has plans to further extend its expertise in the areas of remote monitoring and assessment of wildlife populations and continue to develop and validate rapid assessment techniques for biodiversity.

The Marine Biodiversity Research Group, (MBRG), is jointly led by Dr Ian O'Connor and Dr Dave McGrath.

Managing fish based on early life data

Research into larvae and juveniles of commercial fish species provides important information for their management, writes Dr Deirdre Brophy, CFRG researcher.



Dr Deirdre Brophy, CFRG researcher

When a fish arrives at the mouth of a net it marks the end of a remarkable journey which most of its siblings will never complete. A female fish produces thousands to millions of eggs, depending on the species, during one spawning event. Once released, these minute developing organisms must fend for themselves, and their chance of survival is extremely slim.

Those that endure until hatching start the precarious larval phase, which lasts from a few weeks to several months. Larval mortality is huge. And while they can control their fate to some extent by moving up and down the water column, these tiny fish are very much at the mercy of winds and water currents. Some are transported to favourable nursery grounds, often hundreds of kilometres from where they hatched. Many more drift to unsuitable habitats where food is scarce and further survival impossible. Others end their short lives as food for larger fish. For the few that

survive, the battle is not over: at juvenile nursery areas competition for food, weather conditions and the impact of pollution all influence survival of the young recruits.

On reaching maturity, the adults of many marine fish species undertake long migrations to feeding and spawning areas where they are targeted by commercial fisheries. The incredible journey from hatching to maturation takes anything from one year in fast growing fish, to over 15 years for some slower growing, deep-water species.

Fluctuations in commercial fish stocks are often attributed to events that impact on populations during this time, long before fishing mortality takes effect. Fisheries scientists need information not just on abundance, age, growth and reproduction of adult fish, but also on the processes that influence the distribution and survival of larvae and juveniles. This can help us understand and predict

of trends in adult fisheries, allowing management to respond to ensure that exploitation does not lead to over-fishing and stock depletion.

Many of our research projects at the Commercial Fisheries Research Group (CFRG) deal with the early life stages of commercially important fish stocks. For example, we have carried out surveys of juvenile flatfish (e.g. plaice, turbot and flounder) since 2000, in collaboration with Bord Iascaigh Mhara (BIM) and Taighde Mara Teo.

Our ultimate aim is to monitor patterns in juvenile abundance to inform how adult stocks can best be managed. We use fish otoliths to reconstruct the first few weeks of life, before the fish arrived at the coastal nursery grounds. Otoliths are part of the auditory system and grow continuously throughout a fish's life. Their calcium carbonate and protein constituents are deposited sequentially at a daily rate. This produces microscopic

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growth lines. Like tree rings, their number corresponds to age and widths are proportional to growth rate.

Adult otoliths also hold details about early life, which are revealed by slicing or polishing. We use these approaches to determine hatching dates and larval growth rates in juvenile flatfish. In flatfish, changes associated with the shift from pelagic larva (found in mid water) to demersal juvenile (living on the sea bed) are recorded in the otolith as irregularly shaped increments. We can use these reference points to determine settlement dates and the length of larval life.

With funding from the GMIT IRDP, Strand I and IRCSET/Embark, the CFRG has initiated a larval sampling programme to look at issues such as the effect of larval supply on juvenile densities, the influence of environmental variables and oceanographic features on growth and the consequences for larval survival. Meanwhile research funded by the EPA/STRIVE seeks to identify habitat features that promote optimal growth and survival for juveniles. To do this we plan to use field observations and also to manipulate conditions within a controlled aquarium facility, purchased with funding from the Marine Institute/RTDI.

Investigations of coastal fish communities must consider all interactions within the ecosystem, including multiple human uses of coastal habitats. With recently secured Strand III funding, the CFRG is now embarking on a programme of research to examine species interactions within coastal ecosystems with reference to the impacts of human activities. A steering committee with stakeholder involvement forms an important part of this project, which will contribute to the development of ecosystem focused management of the coastal zone.

CFRG activities are not restricted to flatfish. Other species that warrant our attention include herring, blue

whiting and albacore tuna. This research provides information on movements and connectivity of populations which is crucial for their management.

For example, we have used geographic variation in the microstructure and shape of otoliths to trace Atlantic herring populations from hatching areas to nursery grounds and back to natal spawning areas as adults.

“With recently secured Strand III funding, the CFRG is now embarking on a programme of research to examine species interactions within coastal ecosystems with reference to the impacts of human activities.”

This work, funded under Strand III and GMIT IRDP, is helping to solve a problem that has for decades perplexed the management of herring fisheries in the Irish and Celtic Seas. Juveniles from these two stocks mix during the first year of life, so their abundance can not be used to predict the subsequent strength of the adult fisheries. The two stocks can be distinguished using measurements of larval otolith increments. We used the proportion of each otolith type in archived otolith collections (1993 - 2003), to

correct estimates of juvenile abundance used in previous stock assessments. This adjustment revealed a strong correlation between the abundance of Irish Sea juveniles and the catches of adult herring of the same cohort three years later.

And now, several years of management-focused herring research at GMIT recently attracted additional funding from the Marine Institute/Sea Change/NDP to examine long-term dynamics of Irish herring populations using fisheries datasets dating back to the 1950's.

The chemical composition of otoliths and other hard parts may reflect the surrounding water chemistry and can also help to elucidate where a fish has spent its early life. This is the rationale behind an analysis of trace elements in the otoliths and fin rays of albacore tuna, which is being conducted as part of a larger investigation into the stock structure of this valuable species in collaboration with the MERG and with the support of BIM/NDP.

The common goal of these diverse research activities is to provide credible scientific information on the entire life cycle in order to assist the sustainable management of the fisheries ecosystem, on which the economies of coastal communities so heavily depend. This is especially pertinent in the current climate of depleted fish stocks and the changing marine environment.

The people involved in this research project entitled “Lessons from early life: research into larvae and juveniles of commercial fish species” are academic staff: Dr Deirdre Brophy, Dr David McGrath, Dr Pauline King, Dr Ian O'Connor (MBRG) and Dr Elizabeth Gosling (MERG), researcher Dr Luca Mirimin, postgraduate researchers Noirín Burke, Carys Ann Davies, Roisin O'Callaghan, Stephen Comerford, Paula Haynes, Fien De Raedemaecker and Bernadette O'Neill.

Understanding how marine species develop will aid conservation and management

Since we were set up in 2002, our focus at The Molecular Ecology Research Group (MERG) has been to examine the evolutionary and ecological forces that shape genetic structure in a range of marine shellfish and fish species, writes Dr Elizabeth Gosling, team leader, MERG.



Dr Elizabeth Gosling, team leader of the MERG group.

Using primarily DNA-based tools we look at the role of gene flow, selection and the environment on how species develop, and we also examine whether these molecular tools can help direct the management and conservation of commercially important aquatic fish species in the North East Atlantic.

Knowing about population structure is an essential prerequisite for the conservation and rational management of marine fisheries. Different stock may have their own unique demographic properties and respond differently to exploitation or rebuilding strategies. An understanding of stock structure is particularly useful for mixed fisheries that contain several stocks. For example where stocks are mixed, less productive stocks may be seriously depleted or

eliminated if they are fished at a rate that is appropriate for the more productive stocks. So in order to be effective, each stock must be managed separately to optimise yield while ensuring sustainability.

Outward features of the animals may be of some use to discriminate populations or stocks, but most of these traits are heavily influenced by environmental factors. In contrast, the inheritance of genetic markers, such as various types of DNA, is for the most part clearly understood.

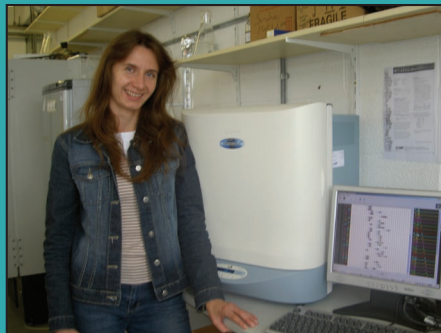
Most members of our group use microsatellite DNA markers to investigate the genetic structure of stock populations. These stretches of DNA are scattered randomly across the genetic material of each species, and

because they are highly variable they can reveal population structures that are undetectable using other types of markers. Another plus is that only small amounts of DNA are required, so it is possible to do non-lethal sampling of fish, for instance by fin clipping, and to analyse old archival samples, such as scales and otoliths (bony structures) from reference collections.

A list of current projects will give a flavour of the scope of our research and the range of organisms being investigated. Many of these projects involve collaboration, in terms of funding and supervision, with CFRG and ShellTec in the School of Science.

- Defining spatial boundaries in commercial brown crab stocks: evolving an effective management

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MERG researchers, clockwise; Carys Davies, Dr Anna Was, Carmel O'Connor, Bruce Moran and Sandra Doherty.

framework which includes: genetic stock identification of brown crab fished around the coast of Ireland and neighbouring countries, assessing current national and international management regimes for commercially exploited crab species and eventually making recommendations to relevant governmental authorities on appropriate spatial scales for management regimes.

- A spatio-temporal, genetic structure of blue whiting from the North East Atlantic
- Population structure of plaice in Irish coastal waters.
- Feasibility study to test whether DNA can be extracted and amplified from archived otoliths (calcareous structures in fish heads)
- An investigation of the reproductive cycle of mussels (*Mytilus*)
- Genetic characterisation of hybrid mussels on Irish coasts
- Genetic structure in bottom and raft-grown mussels from aquaculture sites
- Investigation of shell ligament as a new source of DNA for historical studies
- An investigation of stock structure and migration patterns in albacore tuna fisheries of the North East Atlantic
- The molecular ecology of *Phytophthora ramorum* and *Phytophthora kernoviae* (Fungi: Oomycota) pathogens of forest trees in Europe

Funding for molecular research has come primarily from Strand I, Strand III, Enterprise Ireland, BIM and EU programmes. Over the past ten years we have obtained €2.5m funding as either stand-alone MERG funding, or in collaboration with CFRG.

A prime focus of MERG is dissemination of our research findings. Since 2002, when the group was formalised, we have published 11 peer-reviewed papers, four articles and one book, and have made 33 oral and poster presentations at national and international conferences.

Nutritional value of deep sea fish, orange roughy

The findings of a research study on the nutritional composition and storage stability of Orange Roughy, a deep sea fish, will be of interest to food producers in the fishing industry.



Researcher Maureen Mannion

Orange Roughy from the Rockall Trough were collected seasonally over a one-year period, ranging in size from 45 to 62 cm in length, proving to be as big as those recorded in the Southern hemisphere off New Zealand.

Their protein, fat and moisture content were determined. Protein was 16 to 17% comparable to most common fish. The fillets contained about 2 to 6% fat, significantly above lean fish like cod but much lower than salmon and mackerel. The fat was primarily composed of fatty acids with one double bond, similar to olive oil and Jojoba oil. It was rich in fatty acids with chain lengths of 18, 20 and 22 carbons.

The fish was found to be a poor source of omega 3 fatty acids, which are particularly good for concentration, flexibility, and keeping arthritis or heart attacks at bay. It has only trace levels of EPA, DHA and DPA, and the major

fat type is wax esters that are poorly digested.

The fish obtained were extremely fresh and were assessed for quality by:

- (i) the TVBN method - a measure of protein deterioration and trimethylamine oxide breakdown;
- (ii) the TMA assay - a measure of trimethylamine oxide decay;
- (iii) by the thiobarbituric acid test - a measure of lipid oxidation.

Researcher Maureen Mannion said some of the findings were surprising: "The same tests were used to assess aging/spoilage and as expected, vacuum packing increased refrigerated shelf life significantly"

"Storage at -5°C had an even more significant effect on increasing shelf life. But surprisingly, fish that had been stored at -20°C (vacuum packed) had a shelf life when thawed and aged at refrigeration

temperature both aerobically and vacuum packed that depended on the length of the frozen storage time."

This research was conducted by MSC student and full-time technician at GMIT Maureen Mannion, under the supervision of Dr Mary O'Muircheartaigh, Dept of Life & Physical Sciences, GMIT. The project is in its final stages and is in the process of presentation for the award of MSc to HETEC.

Defrosting solutions for improved performance

Transport refrigeration systems form a crucial part of the “Cold Chain” providing a temperature-controlled environment to transport produce such as fruits, vegetables and meats from refrigerated warehouses to wholesalers. However, as on all refrigeration systems, domestic and industrial, the build-up of frost decreases performance. GMIT & Thermo King, Galway have found a solution.



Thermo Kings SL200e transport refrigeration system mounted to a refrigerated trailer.

Thermo King Corporation, founded in 1938, is a world leader in the manufacturer of transport refrigeration systems. To better understand the complexities of the defrosting process on transport refrigeration systems Thermo King Europe, Galway, and GMIT joined forces on a research project titled “Investigation and Optimisation of Demand Defrost Strategies for Transport Refrigeration Systems”. The PhD study was conducted by GMIT postgraduate student Wayne Donnellan and co-funded by Thermo King Europe, Galway, and Enterprise Ireland.

Transport refrigeration systems can maintain temperatures ranging from -29°C to +27°C, which facilitates the transportation of a wide variety of fresh and frozen produce. However when these systems operate at temperatures

below 0°C frost forms on the surface of the evaporator coil similar to frost that forms in domestic freezers.

As frost accumulates the performance of the refrigeration system decreases to such an extent that a defrost cycle is required to remove accumulated frost.

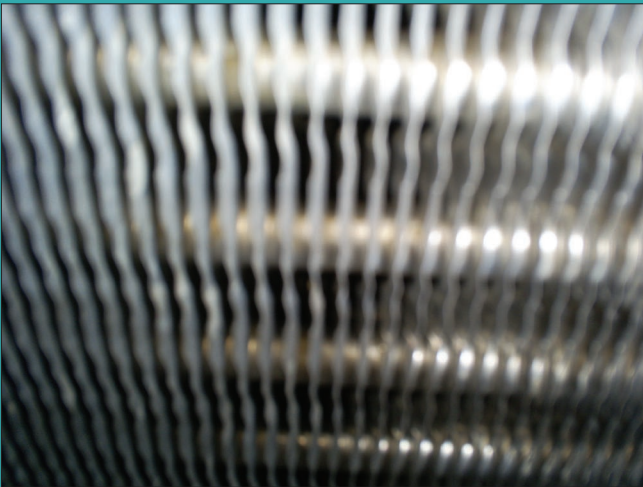
“On transport refrigeration systems this is typically accomplished by supplying high-pressure hot gas refrigerant directly from the compressor discharge to the evaporator coil and is referred to as “hot gas defrost”. However, until recently very little information existed in relation to the effectiveness of the defrost strategies employed to initiate and terminate defrost cycles”, explains Wayne Donnellan.

The four main objectives of this research

project were to:

1. design and build an experimental test facility capable of generating a wide range of typical operating conditions and provide continual monitoring of refrigeration system performance
2. investigate the impact of evaporator frosting on refrigeration system performance
3. characterise for the first time the dynamic behaviour of a transport refrigeration system during a hot gas defrost cycles
4. assess the performance of the current defrost control strategies and develop enhanced defrost control strategies to optimise defrost performance.

The experimental test facility consisted of the SL200e transport refrigeration system, refrigerated compartment,



Close-up view of a frost-free area of an evaporator coil



Frost melting from the evaporator coil surface during defrosting.

instrumentation and data acquisition and control system. Instrumentation employed to monitor refrigeration system performance during testing ranged from temperature, pressure, velocity, and flow rate sensors.

Through extensive testing and a thorough analysis of test data, several significant findings emerged from this study.

“The first key finding was a detailed description outlining the effects of evaporator frosting on the dynamic performance of a transport refrigeration system. As frost accumulates on the evaporator coil the volumetric airflow, refrigeration system, refrigerant temperatures and pressures and air temperatures within the refrigerated compartment all decrease while the refrigeration system functions on cool

mode. The study also describes for the first time the dynamic behaviour of a transport refrigeration system during hot gas defrost cycles.”

“A critical evaluation on the performance of the defrost control strategies employed by the SL200e was conducted. To improve the defrost performance four new defrost control strategies were developed and tested. The introduction of these new defrost strategies led to consistently thorough defrost cycles, which resulted in sustained time intervals between successive defrosts, fewer defrost cycles and superior defrost efficiencies. Furthermore unnecessary timed defrost cycles were eliminated thereby improving the overall performance of the refrigeration system.”

“ Overall the project was a complete

success accomplishing all the objectives set out and further enhancing the defrost performance of the SL200e transport refrigeration system”, concludes the newly graduated Dr Donnellan.

The PhD research project was supervised by Dr John Lohan, GMIT, and Ken Gleeson, Industrial Supervisor, Thermo King Europe, Galway. Support was also provided by the engineering and technical staff in the R&D department, Thermo King Europe, and staff from the Mechanical and Industrial Engineering Department and GMIT. Barry Brophy from University College Dublin (UCD) assisted in the development of the data acquisition program.

Genealogy tourism: can we tackle the decline?

by **Gráinne McMahon**

For years a beautiful landscape, rich culture and friendly people have meant hundreds of thousands of tourists have flocked to Galway. However, could we become too complacent and take for granted the millions that are pumped into the local and regional economy from the industry? Gráinne McMahon talks to researcher Marta Gergelyova about her research in this area, in GMIT.

Has Ireland's tourism product become tired and lacking in verve or "bounce" for many tourists, as stated in the National Development Plan 2007–2013? Looking specifically at genealogy tourism, what are the reasons behind the fifty percent decline in the overall number of genealogy tourists to Ireland between 2000 and 2005? What are the profiles, needs and expectations of genealogy tourists to Ireland and how do they differ from those of general tourists? Can the genealogy tourism market be recovered and – if yes – how can this be achieved?

These were the most challenging questions in a thesis entitled *An Investigation of the Potential of Genealogy Tourism as a Catalyst for Regional Development in County Galway* carried out by Marta Gergelyova, Cultural Heritage Consultant and a former postgraduate researcher at GMIT.

A fifty percent decline in the overall number of genealogy tourists who came to Ireland to trace their roots between the years 2000 and 2005 led Marta to carry out the qualitative and quantitative research, which is one of the only recent large scale academic studies on present day genealogy tourism in County Galway.

The result of the thesis is not only an

One of Marta's key recommendations in this thesis is the need to increase access to genealogical research institutions and their services while also promoting genealogy as an integral part of our cultural heritage.

eye opener but Marta's recommended marketing mix for the promotion of genealogy tourism could well be used not only to tackle the problem of dwindling numbers of genealogy tourists coming to Ireland, but also to identify and target a larger market that is closely connected to genealogy tourism.

According to various media reports, the main reasons for the fall in the numbers of such tourists coming to Ireland is the growing popularity of internet based genealogical research which enables Americans, for example, to research and trace their Irish roots. However, according to Marta's research, the reason is in fact due to the gradual decline in the numbers of American citizens who claim Irish ancestry.

What then should those in the tourism industry and the genealogy area do to promote 'real life' research over internet-based root tracing, and can an expensive genealogy holiday in 'rip-off Ireland' ever win out over a broadband internet connection? Through focus group and one-to-one interviews, participant observation, diaries and a questionnaire survey with hundreds of participants Marta found that while genealogical research on the internet is very important and provides a good grounding basis for further research, it is mainly constructing

family trees, stories about ancestors and visiting ancestral homes and land plots that truly excite genealogy researchers and stir expatriates' hearts.

"It is also the contact with people – newly-found cousins or descendants of the community from which the ancestor came, that was perceived as one of the ultimate rewards of often long and tedious genealogical research," says Marta, explaining that while such testimonies were revealed by genealogy researchers themselves during the course of her research, this message also echoed from official circles of heritage and tourism organisations: "Not everything is readily available online. Genealogical research requires a high motivation, lots of time, dedication, persistence, patience and a sense of humour as well."

One of Marta's key recommendations in this thesis is the need to increase access to genealogical research institutions and their services while also promoting genealogy as an integral part of our cultural heritage. The former could be improved if the Central Signposting Index, which is the first point of call for genealogy researchers providing records for all the counties in Ireland, was completed and fully accessible online.

"It is also important to make the services of the Irish Family History Foundation societies more consistent, transparent, time efficient and better value for money – simply more accessible," explains Marta pointing out that the fees for such a service should be standardised, reflecting various degrees of difficulty and time involved in the search.

The services of the Irish Family History Foundation societies could also be extended: "Their staff should be not only well briefed on their local heritage but it is desirable that they actually develop interpretative means to present and market their local heritage to the visitor, including genealogy as an integral part of Ireland's cultural heritage. Those societies who will be proactive and will find the financial and human resources for these new services may become sustainable on a long-term basis."

"However, genealogy tourism must not be marketed separately," explains Marta, "or it will never survive due to an aging genealogy market and growing competition from other Western-European countries". The development of a Diaspora Centre in the West of Ireland could have the potential to significantly enhance regional development through a rapid increase in tourist numbers and their spending. (Continued next page).



Dr Gavin Murphy, Lecturer in Art History and Critical Theory

An examination of reactions to contemporary art in Ireland

Dr Gavin Murphy, Lecturer in Art History and Critical Theory, is currently undertaking research into the critical reception of contemporary art in Ireland from the early 1970s to the present. Dr Murphy is investigating the emergence of conceptual and post conceptual art in local and international circumstance and the tensions arising when these visual art discourses encountered traditional forms of criticism within Irish cultural circles.

This work will be published in October 2008 as part of the Irish Museum of Modern Art forthcoming programme of events.

Tourism, Culture & Humanities

“Such development can then become the number one state-of-the-art tourist attraction in the West of Ireland, closely related to genealogy tourism,” she says, pointing to her marketing mix where Marta has suggested package tours like ‘Peopling the Past: Castles in County Galway’ and ‘Re-tracing the steps of the great Irish literati in the West of Ireland’ as well as possible exhibitions at Galway City Museum focusing on the famine, emigration and the Connaught Rangers as some of six possible marketing products for the wider tourist market.

“It may tremendously support the revenue generated by the heritage and the hospitality sectors in the region,” she adds.

Marketing campaigns promoting the themes of ancestral visits, constructing family trees and stories about ancestors could go some way to tackling the decline in genealogy tourists coming to County Galway. However, Marta points out that “a high-degree of co-ordination, co-operation, team work and joint funding’ is needed among the principal stakeholders involved before we can rejuvenate and revitalise genealogy tourism here.

The thesis entitled *An Investigation of the Potential of Genealogy Tourism as a Catalyst for Regional Development in County Galway* was carried out by Marta Gergelyova, and co-supervised by GMIT lecturers, Dr Mark McCarthy, Lecturer

and Programme Coordinator in Heritage Studies and Monica Nielsen, Lecturer in Tourism and Marketing, School of Business. It was funded over two years by GMIT’s Internal Research Fund.

A study of Anglo-Norman Hall-houses in Mayo

Within the spectrum of Irish castles, Hall-houses are a type of castle that are often mistakenly identified as Tower-houses. Both structures share a similar appearance but it is only after careful examination that classification can be attributed, a new GMIT research project finds.

The form and structure of a building is often disregarded in its truest sense. Castlecarra in Mayo, for instance, is popularly referred to as a manor but closer inspection reveals that the earliest part of this structure was a Hall-house. These factors have led to the conclusion that the identification of Hall-houses needed to be re-examined.

The West of Ireland has been identified as an area where Hall-houses are most prolific and Mayo-based researcher Rebecca Etchels-Dobson is currently completing a Masters by Research on “Hall Houses of Mayo” at GMIT, Castlebar. Her supervisors are Fiona White and Margaret O’Riordan, both lecturers in Heritage Studies at the Mayo campus.

“This research project will contribute to an understanding of the Hall-house relationship with the later Tower-houses and may also provide clues towards the social, political and economic structure of Connaught at that time,” says lecturer Fiona White.

“It will re-examine the number of sites that can be identified as Hall-houses. A key part of the research will consider the morphology (form) of medieval structures therefore identifying the true number of Hall-houses within the county. An inventory will be compiled which will record a synopsis of the history and their architectural features and dimensions.”

Margaret O’Riordan says the research will not only result in a revised inventory of Hall-houses but will also seek to investigate the roles of Hall-houses within medieval society. “It will ultimately contribute to our understanding of the history of castle building in Ireland.”

History of human settlement at Lough Carra, Co Mayo

Lough Carra is one of the five great western lakes of Ireland - the others being Corrib, Conn, Cullen and Mask. The lake has a long history of human settlement stretching back almost 10,000 years and is currently the subject of a PhD research project undertaken by Fiona White, lecturer in Heritage Studies at GMIT Castlebar.



*Fiona White,
Lecturer in Heritage Studies at GMIT Castlebar*

Lough Carra was of strategic importance for early human settlement and was rich in the vital resources needed by the hunter-gatherer population: The location of megalithic tombs and cairns near the Carra region indicate the existence of a prehistoric farming community. An important Bronze Age site has been identified consisting of a series of massive oak causeways dating back to the Late Bronze Age 1500-1000 BC. These structures are among the largest yet found near European lakes and may be interpreted as ancient bridges or ritual causeways.

The promontory fort and numerous lake dwellings indicate Carra's strategic importance during the Iron Age and Early Medieval Period. The Early Christians left their mark on this region as demonstrated by Church Island with its early church and graveyard. And the Anglo-Normans were quick to exploit the strategic significance and built numerous majestic castles in the Carra region. The post-medieval and modern built environment is also well represented with numerous examples of mills, famine and vernacular cottages, villages, demesnes and landlord houses. Such examples make it an ideal region for the study of human settlement history.

"Research on the history of human settlement in this area will lead to the development of a taxonomic index of images for aerial photography and remote sensing that will allow quick identification and mapping of sites that may otherwise be overlooked or take an inordinate amount of time to find", explains Fiona White.

"Mapping of these sites with Geographical Information Systems (GIS) and ground-truthing will produce a resource that is readily accessible and understandable. In this way a novel and rapid approach to surveying may be implemented during a period when many of our heritage sites are yet unidentified and potentially threatened."

"In recent years the unprecedented growth in housing, farming, forestry and infrastructural developments has led to increased pressure on the countryside and the underlying cultural resources contained within the landscape. So there has been a sense of urgency that techniques be developed to optimize the identification of sites of special heritage interest."

"The use of GIS has been successfully applied as a multidisciplinary tool for identification and mapping of many aspects of our environment from agriculture to forestry and waterways - GIS is the ideal tool for the integration of cartographically-based datasets -widely used in development planning."

"The research project will also test the potential of integrating cultural resource management and forestry development in the fragile lake-district."

"This project will provide an extensive record of heritages sites in the district using a more non-intrusive surveying method", concludes Fiona White.

Mapping the history of Loughrea



The history of the growth and development of Loughrea is to be the focus of a study led by GMIT Heritage lecturer, Paul Gosling. The project was initiated in January 2008 as part of the Royal Irish Academy's (RIA) Irish Historic Towns Atlas (IHTA) project.

Heritage Lecturer Paul Gosling, GMIT School of Humanities.

Loughrea was established shortly after 1236 by the Anglo-Normans. It developed around a castle they built on the north shore of the lake of the same name. The new town was laid out on an east-west axis, the two principal streets now represented by Dunkellin St – Main St and the eastern part of the present Barrack St. (Fig. 1). A series of cross-streets linked these two main thoroughfares, their lines preserved in Castle St., Kelly's St., King's St., Church St. and Pigott's St.

The settlement was a defended one, comprising a wall, external moat and four gates only one of which survives (Fig. 2). Unique amongst the 50 or so towns of Anglo-Norman origin in Ireland, the medieval moat of Loughrea remains fully functional and is still a major topographical feature in the modern townscape, especially along the linear park known as The Walks. The enclosed area covered c.15 hectares (37.5 acres). The moat was supplemented by a mortared stone wall described in 1574 as 'fair walls begun, but not finished.' In 1305 the Carmelite Order established a friary just outside these defences. Though it was suppressed in 1539, the community still provides pastoral and community services from the same site.

The other major landmarks of the medieval town were the parish church (now occupied by the early 19th century Church of Ireland) and the castle. Though the latter no longer exist, its approximate location is indicated by the position of Castle St. The 18th century saw the dismantling of the medieval defences,

the addition of a military barracks - now the 'Temperance Hall' (Fig. 1) - the growth of an eastern suburb, the construction of a Catholic chapel (see Fig. 1), as well as the creation of the park called The Walks.

The aim of the Irish Historic Towns Atlas (IHTA) is to provide in-depth source material and assessments of the topographical development of a selection of Irish towns. Each town is published separately as a fascicule, or folder, which contains a series of large-scale maps. These are supplemented by inventories of the principal structural remains and a review of each town's topographical development. The IHTA is part of a European scheme. The maps are prepared in association with Ordnance Surveys of Ireland and Northern Ireland and in-house editorial expertise in the Academy is provided by Sarah Gearty, cartographic editor and Angela Murphy, editorial assistant.

A total of eighteen towns and cities have been published to date (Fig. 3). The Loughrea project will form part of, and inform, the continuous assessment work for a number of modules in the BA in Heritage Studies programme in GMIT. It will take approximately eighteen months to complete and it is envisaged that it will be published in 2010.

"Studying the evolution of Urban Space: compiling the Irish Historic Towns Atlas for Loughrea, Co. Galway" is led by Heritage lecturer, Paul Gosling, GMIT Dept. of Humanities.



Figure 1: Clanrickarde estate map of Loughrea, dated 1791. Each of the numbered properties is cross-referenced to a rental list. Amongst them are some landmarks which are still familiar today: No. 310 - the Carmelite 'Abbey' on The Walks; No. 145 - The Church of Ireland Church, now the Branch Library, in Church St.; No. 134 - R.C. Chapel, now a funeral home; and No. 72 - the 'Barracks', now the Temperance Hall in Barrack St. (Source: Egan JGAHS 1951).

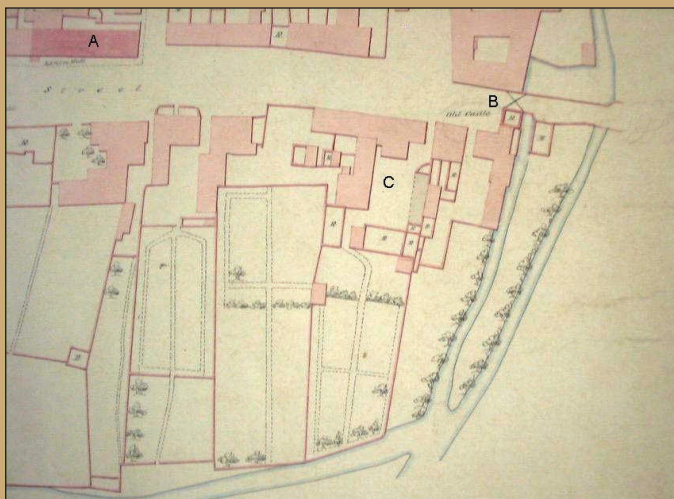


Figure 2: The east end of Barrack Street, Loughrea in 1840 showing the following: A - the town hall; B - the sole surviving medieval town gate, 'Latimer Gate'; and C - the site of the present gothic-revival Cathedral of Brendan (begun 1898). The extract is from the 1:1056 scale, 'Manuscript Town Plan' of Loughrea by the Ordnance Survey of Ireland. (Source: National Archives of Ireland).

No. 1	Kildare	(1986)
No. 2	Carrickfergus	(1986)
No. 3	Bandon	(1988)
No. 4	Kells	(1990)
No. 5	Mullingar	(1992)
No. 6	Athlone	(1994)
No. 7	Maynooth	(1995)
No. 8	Downpatrick	(1997)
No. 9	Bray	(1998)
No. 10	Kilkenny	(2000)
No. 11	Dublin, Part 1, to 1610	(2002)
No. 12	Belfast, Part 1, to 1840	(2003)
No. 13	Fethard	(2003)
No. 14	Trim	(2004)
No. 15	Derry/Londonderry	(2005)
No. 16	Dundalk	(2006)
No. 17	Belfast, part 11, 1840 to 1900	(2007)
No. 18	Armagh	(2007)

Figure 3: Towns and cities published to date by the Royal Irish Academy's Irish Historic Towns Atlas (IHTA) Project (Source: <http://www.ria.ie/projects/ihta/published.html> [last accessed 15-2-2008])

Uncovering historical communities in Co Mayo

Researchers at GMIT Castlebar's Heritage Studies Department are breaking new ground by uncovering the secrets of historical communities in a remote area of Mayo.



Heritage lecturer Seán Lysaght

The study focuses on a wild tract of blanket bog in the Owenduff catchment area, between Mulranny and Bangor. Farmers and herders settled in the river valleys here and managed to survive the harsh conditions. Although these communities are now either extinct or in decline, there remains a large visible heritage of field systems, house sites and other built structures.

Heritage lecturers Seán Lysaght and Fiona White, based at the Castlebar campus, are currently directing a two-year masters research project on the history of settlement and land use around Owenduff, with fieldwork being conducted by Rosemarie Kiely, a graduate of the Heritage Programme at GMIT Castlebar. The National Parks and Wildlife Service (NPWS) is supporting her

work as part of developments towards a new National Park And Visitors' Centre at Ballycroy, due to open in September 2008.

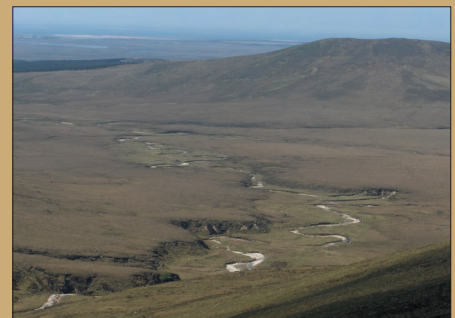
Now in its second year, the project involves mapping the field systems and river catchment of the Tarsaghaunmore River and a number of adjacent sites. GPS readings are used for mapping, then the data is compiled on a mapping programme to produce overviews of the field systems, arable plots, buildings and drainage channels. Pearse Mc Donnell of the Electronic Engineering, Dept of Business and Technology at Castlebar, is providing technical assistance with the mapping component of the research.

According to Seán Lysaght: "This is a pioneering project in a little-known area of Mayo. The National Parks and Wildlife Service are supporting our work in the human history of the national park area and will be using some of this work in the exhibition at the visitors' centre. This is a first, because NPWS has traditionally been mostly interested in flora and fauna in the scientific features of the landscape. Here we have a recognition that these places had a community as well. There's also a rich body of folklore from this area, a lot of it in the journal *Béaloideas*, which has never been looked at from the point of view of geography and settlement."

Lysaght's own research in the area looks at place names. Many of the names still used by the sheep farmers have never been recorded and are now being compiled for the first time. "The place is



Tarsaghaunmore, Co. Mayo



Slieve Carr, Co. Mayo

so remote that few researchers have ever walked this ground – before Castlebar students arrived!" he says.

The historical project is the latest in a continuing relationship between the GMIT Castlebar Heritage Studies programme and the NPWS in the area. There have already been final year BA dissertations on the dragonflies of the Tarsaghaunmore area and on the vegetation of the Bangor trail. All the data provided by these projects will be available to visitors to the new National Park Centre at Ballycroy when it opens later this year.

Challenges facing rural enterprise

A post-graduate research study on the characteristics of, and challenges facing, small rural enterprise in the West of Ireland is being conducted by the GMIT School of Business, with the support of the Western Development Commission (WDC).

The GMIT School of Business sought the support of the WDC to carry out this important study in order that it would be in a position to inform the Commission and other enterprise development agencies of the current activity around the development and assistance of rural entrepreneurs.

Conducted by postgraduate researcher Kieran O'Malley BBs(Hons), a graduate of the school, and led by GMIT lecturer Ivan McPhillips, the study will identify possible effective interventions, suitable to the role of the WDC and other enterprise development agencies, which would fit in an Irish context.

This research will provide enterprise development agencies in the region with an opportunity to focus on some practical issues relating to rural enterprise and enterprise development needs of rural communities, and will add to its understanding of the types of successful economic activity and the changes taking place in other rural areas."

The study will explore the following:

- What are the defining characteristics of rural enterprise?
- Is reliance on the natural resource base a defining characteristic of rural enterprises?
- Are there other characteristics that distinguish them from urban counterparts?
- Is there significant variation in enterprise type in different rural area types?

"The study will identify possible effective interventions, suitable to the role of the WDC and other enterprise development agencies, which would fit an Irish context."

Mr Ivan McPhillips, lecturer in Entrepreneurship & Business Management, GMIT, says: "The study also involves an audit of rural entrepreneurial activity within the region, international comparisons between the West of Ireland and similarly disadvantaged areas within the European Union and an analysis of the role played by the developmental agencies in inculcating a culture of enterprise within the region. In particular the research is examining the rural enterprise support initiatives by agencies and governments in other countries, especially those dealing with rural peripheral areas. Recommendations will be made for interventions or initiatives that the Western Development Commission and other enterprise development agencies could offer to rural communities."

A small management team consisting of representatives of the School of Business, GMIT and the Western Development Commission is managing this research project.

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