

**McNamara Centre for Construction Innovation and Sustainability**

**Progress Report  
April – September 2008**

**Professor Mark Dyer,  
Michael McNamara Chair in Construction Innovation**

**TRINITY•HAUS**

**TRINITY•HAUS** is the McNamara Centre for Construction Innovation and Sustainability at Trinity College with joint research projects planned or underway with Business School, Moyne Institute of Preventive Medicine Department of Applied Microbiology and Immunology, School of Medicine, Department of Manufacturing, Department of Civil Engineering and National College of Art and Design. It is housed in refurbished offices in 15/16 Westland Row.

Over the last six months a research and innovation theme has evolved embracing systematic innovation, building energy, universal design, biotechnology and advanced manufacturing techniques. This has given rise to two major research initiatives **GREENprint** and **Design Dublin** with a series of high profile innovation events to be held in the Trinity College's Science Gallery. A team of seven staff have been recruited with on-going advertisements placed in Engineer's Ireland for high quality PhD students and project engineers. An advisory group is being established comprising initially of John McGowan of Michael McNamara and Co and Neil Kerrigan of Bowen Group with two other members sort from the financial sector, government civil service and/or a leading architect.

**RESEARCH INITIATIVES**

**GREENprint** is being developed as a world ranking research programme to contribute towards Ireland's knowledge economy in sustainable development. It will focus on sustainable energy in the built environment for the construction and maintenance of our towns and cities by exploring Ireland's performance as a living laboratory for low carbon zero waste living comparable with similar high profile knowledge-driven initiatives at Masdar (Dubai, UAE) with MIT and Dongtan (Shanghai, China) with UCL. The proposal is described in more detail in Appendix A. See <http://www.masdaruae.com/text/institute.aspx>  
<http://www.epsrc.ac.uk/ResearchFunding/Programmes/PES/SUE/DongtanResearchNetworks.htm>

**Design Dublin** is an exciting initiative that combines creativity and expertise in design from the National College of Art and Design with Trinity College Dublin's School of Engineering co-ordinated by **TRINITY•HAUS**. It integrates the scientific, engineering, business and creative design communities to enhance business and industrial innovation. The first initiative will be to develop education and training courses along with research in Universal Design. This is being done in partnership with the Centre of Excellence in Universal Design for Ireland's National Disability Authority as described in Appendix B.

## **EVENTS**

RAW Debate on "*Has the Green Washed Out of Ireland?*" Trinity College, Science Gallery; w/c 1<sup>st</sup> December 2008.

HotHaus *Seed-Dating* on "*Energy*", Trinity College, Science Gallery w/c 19<sup>th</sup> January 2009

HotHaus *Seed-Dating* on "*Shelters and the Homeless*", Trinity College, Science Gallery 26<sup>th</sup> February 2009

GREENprint Colloquia series hosted by Tony Owens, January to March 2009.

Inaugural lecturer by Prof Mark Dyer on "*Construction Innovation: Contradiction in Terms?*" Trinity College, Science Gallery, 25<sup>th</sup> February 2009.

Innovation Day on "*Construction in Space*" co-ordinated by Dr Andrew Lennon, Trinity College, Science Gallery June 2009

ASTM 4<sup>th</sup> International Symposium on Contaminated Sediments: Sustainable Management, 1-2<sup>nd</sup> July 2009. Trinity College Dublin

## **RECRUITMENT**

Director, Prof Mark Dyer, Michael McNamara Chair in Construction Innovation  
Project Director, Tony Owens (formerly PA Consulting, Altran Technology)  
Project Manager, Marie Callanan (formerly Polymer Research Group)  
Project Architect, Rory Greenan (formerly Pierce and Associates, Dublin)

TrinityHaus Research Fellow, Dr Andrew Lennon, ABL Engineering  
TrinityHaus Research Fellow, Prof Sandy Halliday, Gaia Research  
TrinityHaus Research Fellow, Prof Ruth Morrow, Ulster University  
TrinityHaus Research Fellow, Dr James Hubbard, CEUD Dublin  
TrinityHaus ArtScientist, Dr Michael John Gorman, Director Science Gallery  
TrinityHaus Entrepreneur, Dr Bill Aulet, MIT Sloan School of Management

## **RESEARCH BIDS**

Three proposals submitted to Enterprise Ireland's Proof of Concept Programme in September for 300k euros

- BioCement: Biologically induced calcite precipitation to preserve masonry

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- BioGrout: Biologically induced calcite precipitation to strengthen ground by bonding soil grains together (e.g. sand transformed to sandstone)
- Re-Enveloping Buildings for Improved Energy Efficiency: Combing high technology insulation technologies with high quality architectural design.

EI Bids supported by Dublin City Council, McNamara and Co, Bowen Group, and Faber Maunsell.

EU FP7 Eureka research proposal submitted in October with Czech company on “Application of geophysics to detect weaknesses in flood embankments” for 400k euros

### **INNOVATION REVIEWS**

Innovation reviews have been proposed to Michael McNamara & Co on several topics described in Appendix C. Three of the reviews are described below for information

- *Freeform Construction* is a radically new concept in automated construction based. The process potentially allows the manufacture of full scale building components such as walls and panels with fine control over material deposition. The concept stems from Rapid Manufacturing
- *Novel Materials for Advanced Insulation and Energy Panels* using nano-fibres and phase change materials that potentially offers new solutions for the manufacture of insulation and energy panels that in the case of phase change materials allow the latent heat from solar gain to be stored for later release in the day or night.
- *Use of Systematic Innovation Methodologies to Re-Engineer the Irish Construction Industry for Sustainability*. Systematic Innovation (SI) is a general purpose methodology for problem-solving, based on TRIZ, the theory of inventive problem-solving originated in the USSR. TRIZ seeks to codify the process of invention and was originally applied to technology problems.

### **LEADERSHIP 4 GROWTH**

Discussions underway with Neil Kerrigan of Bowen Group and Professor Roger Flanagan of School of Construction Management and Engineering University of Reading for Professor Dyer to participate in the Leadership 4 Growth programme to deliver presentation on “*Systematic Innovation in the Irish Construction Industry*” Middle East 2008.

# APPENDIX A

## GREENprint Ireland

### **CONCEPT**

Capitalising on the recent donation by Bernard McNamara to Trinity Foundation to promote construction innovation in Ireland, a combined research centre is proposed with the broader remit of Sustainable Energy and with the full support of the School of Engineering.

Provisionally named *GREENprint*, it will be a world ranking research centre to develop sustainable energy technologies and strategies in Ireland. It will focus on sustainable energy management and use in the construction, operation and maintenance of the physical fabric of our towns and cities along with transportation for people and goods. *GREENprint* will explore and report on the overlapping technological, societal and environmental issues influencing sustainable energy usage, identifying root problems requiring solution. In partnership with an international network of academic, commercial and regulatory collaborators, *GREENprint* will conceive pragmatic energy solutions, develop and validate these, and lead change.

Initially based in the School of Engineering, *GREENprint* will be a College wide inter-disciplinary research centre with Principal Investigators from all three Faculties. This will be critical to the success of the research centre and differentiate it from other similar initiatives that are a principally technology driven.

It will deal with the challenge of exploring Ireland's performance as a living laboratory for low carbon zero waste living, comparable with high profile knowledge-driven initiatives at Masdar (Dubai, UAE) with MIT and Dongtan (Shanghai, China) with UCL. See

<http://www.masdaruae.com/text/institute.aspx>

<http://www.epsrc.ac.uk/ResearchFunding/Programmes/PES/SUE/DongtanResearchNetworks.htm>

### **DELIVERABLES**

The *GREENprint* initiative will provide a dedicated world-class energy research centre, hosted by Ireland's foremost university. Outputs will include:

- Inventive, commercially-relevant products, services and business models concerning sustainable energy generation, management and use.
- The independence and authority to unite Ireland's various thought leaders in energy policy and technology
- Support for Ireland's ongoing efforts to reform itself from 93% imported energy dependence to a more secure and responsible position
- High-calibre alumni who combine confident entrepreneurship, ambition and an interdisciplinary outlook.

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- Sustainable energy technologies and strategies covering buildings, infrastructure, and modes of transportation (public and private)

## **RESEARCH ISSUES**

### **BUILDINGS**

- Conservation and optimisation of energy for new and refurbished buildings using passive energy storage (phase change materials), micro-generation (combined heat and power) and renewable energy generation (building-integrated solar and geothermal systems)
- Re-enveloping and retro-fitting existing housing stock for improved energy efficiency, utility and ambience
- Construction of ‘smart’, responsive buildings using digital signal processing and sensor networks to optimise energy usage and promote independent living
- Design and construction of buildings for future de-construction and low embodied energy, minimising waste generation and energy use
- Reduction, re-use and recycling of waste streams within buildings (innovative kitchen designs, re-use of sterilised waste and rain water) and externally (landfill bio-reactors)

### **TRANSPORTATION**

- Design and usage of hybrid and electric vehicles within urban zones as distributed electrical energy storage means, to balance daily energy consumption and generation cycles
- Optimum use of public transportation, cycling and walking within different sectors of a city or town and establishing “Green Routes” for commuting and tourism
- Engineering design of transportation vehicles for sustainable use, including optimal mechanical, manufacturing, and disposal/re-use technologies .....

### **ENERGY STORAGE AND MICRO-GENERATION**

- Storage of energy using novel, low cost technologies distributed assets such as underground caverns, rock stores, geothermal systems coupled with effective strategies for optimum use of the power grid and connected assets (e.g. electric cars) in response to variable load demand management.
- Carbon sequestration in subterranean reservoirs (e.g. beneath the Kish Bank, off Dublin Bay)

### **PLANNING, BIODIVERSITY AND CLIMATE CHANGE**

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- Integration of energy generation, consumption and storage in grid-connected public and private assets.
- Stakeholder responses, attitudes and obstacles to changes in life style in support of sustainable energy consumption
- Protection of biodiversity within the National Development Plan.

### **ESTABLISHMENT PLAN**

- The research centre will be initially accommodated in a fully refurbished and modernized 15/16 Westland Row. This space has already been made available to the proposer.
- The School of Engineering will recruit a number of tenured academics with expertise in Energy Systems as part of its strategic plan.
- As a first step, a bid will be made in the next round of funding for a SFI Lectureship in Energy Systems.
- National partnerships will be established with leading Irish energy and construction companies (e.g. ESBi, Bord Gas, McNamara, Bowen, Kingspan, Arups, Faber Maunsell, Dimplex etc.) along with Sustainable Energy Ireland, Enterprise Ireland Dublin City Council and Marine Institute.
- International partnerships will be established with leading research led universities (UCL, MIT, IOFFE Institute, Fraunhofer Institute, University of Lund, Universities of California).
- The research initiative will be focussed on two major cities; one in Ireland (Dublin) and one abroad akin to the Dantag and Masdar sustainable cities initiatives.
- A research bid is already being submitted to Enterprise Ireland for “Re-Enveloping of Buildings to Comply with Improve Sustainability Standards” in September 2008 with subsequent research bids being prepared for Enterprise Ireland and FP7 Interreg IV for “Novel Materials for Advanced Insulation and Energy Panels including using Nano-Size Particles and Fibres and Polymers”, “Carbon sequestration in subterranean reservoirs in Permo-Triassic deposits” and “Low Carbon Low Waste Affordable Residential Buildings PassivHaus”.
- Resources are requested from College for funds to support a programme of 10 PhD Studentships costing approximately 1 Million Euros which will attract Principal Investigators from across all three faculties. The proposer is willing to engage fully with the Trinity Foundation in seeking the funds for this purpose.

## APPENDIX B

# Design Dublin

**Design Dublin** is a new and exciting initiative that combines creativity and expertise in design from the National College of Art and Design with engineering and business studies from Trinity College Dublin's School of Engineering hosted by TrinityHaus. It integrates the scientific, engineering, business and creative design communities to enhance business and public sector innovation.

**Design Dublin** provides an opportunity to capture the enduring rewards from creativity and innovation by acting as a change agent with its educational and research capacity and the provision of advanced innovation technology services for new and existing industrial partners.

**Design Dublin** will have four main pillars: creating new taught modules and programmes, conduct top-level research, incubate new business ideas and pioneer the next generation of innovation technology. The programme would separate the concepts of design skills from design methods, or to use an often used term in the US, design thinking.

**Design Dublin** first initiative will be to develop education and training courses along with research in Universal Design. This will be undertaken in conjunction with the Centre of Excellence in Universal Design for Ireland's National Disability Authority. The phrase Universal Design refers to the design and composition of an environment that can be assessed, understood and used to the greatest extent possible by all people regardless of their age, size and ability. The research will be evidence based design and performance of products and buildings.

# **APPENDIX C**

## **Proposed Innovation Reviews**

### **September 2008**

Innovation reviews are proposed for the following topic areas that represent potential improvements or advances in the construction industry. The reviews would typically involve a 3-6 month literature study with possibly field visits in order to identify potential benefits and commercial opportunities. Following the reviews it is envisaged that 2 or 3 projects would be developed further into medium to longer term studies (12-36 months) to trial or translate the new development into practice.

#### **Use of Systematic Innovation Methodologies to Re-Engineer the Irish Construction Industry for Sustainability.**

Systematic Innovation (SI) is a general purpose methodology for problem-solving, based on TRIZ, the theory of inventive problem-solving originated in the USSR. TRIZ seeks to codify the process of invention and was originally applied to technology problems. It is hypothesised that SI methods, suitably extended as described, represent the best available basis for generating inventive and engaging solutions to the root problems of the construction industry. The Evolutionary Trends tool in SI convincingly correlates with the historic inventive steps in diverse specialties within the industry, such as soil reinforcement, concrete formulation, plumbing and heating technology, the marketing of resorts, the financial engineering of home purchase. It is equally possible to apply such a tool to predicting how such things will evolve in future.

#### **Freeform Construction**

Freeform Construction is a radically new concept in automated construction based. The process potentially allows the manufacture of full scale building components such as walls and panels with fine control over material deposition. The concept stems from Rapid Manufacturing, which is an additive fabrication technique for manufacturing solid objects by the sequential delivery of energy and/or material to specified points in space to produce that part. The manufacturing process is controlled by computerized mathematical model. It offers the potential for a large advantage in speed and cost compared to alternative manufacturing techniques such as plastic injection molding or die casting. Rapid Manufacturing has a long track record of use in the military and aerospace sectors. The review would examine opportunities to translate developments in freeform construction into the off-site construction of pods and individual building components.

#### **Re-Enveloping or Retro-fitting of Buildings to Comply with Improve Sustainability Standards**

The house of the future is the house of today. There are some 1.8 million relatively new houses built in Ireland that will need to be re-enveloped or retrofitted to bring the housing stock up to new energy and sustainability standards. This includes the older Georgina housing stock. There is a major need and challenge to devise new materials and processes to achieve these

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goals in a creative affordable way. The review would examine the new ideas and solutions being developed around the globe that could be readily applied in Ireland

### **Potential Advances and Savings from e-Commerce**

ICT (Information Communications Technology) offers the opportunity to make significant savings of 80% to 90% of administrative costs by adopting e-commerce practices for the purchasing, invoicing and ticketing of materials and products delivered to construction sites. The review would explore the practical options for transferring existing technology from other industries into the construction industry.

### **Construct for De-Construction (CDC)**

The EU WEEE Directive (Waste from Electrical and Electronic Equipment) aims to reduce the impact of electronic waste on the environment. At least 1 million tonnes of electronic waste from homes and businesses is discarded every year, a figure that is estimated to be growing by 4% annually. Another major source of landfill waste derives from the demolition and refurbishment of buildings sometimes after only 30 to 40 years of occupation. Apart from demolition generating considerable amount of waste, dust and noise pollution, it consumes considerable amounts of energy. In anticipation of similar future restrictions being placed on waste from construction or demolition activities, the review would examine practical ways of building de-construction strategies and techniques into the design and construction of standard buildings.

### **BioGeoCivil Engineering**

The biological enhancement of soils and other construction materials (stone, concrete, ash, sludge) is an emerging and exciting field of technology that has given rise to several new technologies and patents in the last 3 years. It essentially involves harnessing microbial activity to strengthen, repair, seal or coat construction material and so reduce maintenance costs or improve mechanical properties for marginal materials. One such technology is the participation of calcium carbonate in sand to transform the soil to sandstone with greater bearing capacity for foundations and reduced erosion risks from liquefaction.

There are numerous opportunities for Irish Industry to pioneer further developments and so create new markets for these new construction materials and processes such as stabilisation of glacial tills against wash out or strengthening of peat for infrastructure works at home and abroad (e.g. Malaysia and Borneo). The review would examine the state-of-the-art in this embryonic field and identify potential applications and patentable technologies.

### **Novel Materials for Advanced Insulation and Energy Panels including using Nano-Size Particles and Fibres and Polymers**

There a significant advances in polymer chemistry that have created nano-fibres and particles as well as phase change materials that potentially offer new materials for the manufacture of insulation and energy panels that in the

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case of phase change material allow the latent heat from solar gain to be stored for later release in the day or night. The review would explore commercial applications for these new polymer technologies that could be taken to the proof of concept stage.

### **Low Carbon Low Waste Affordable Residential Buildings**

There are several developments underway in the UK, Germany and the Netherlands to apply simple technology to construct low carbon low waste buildings particularly for residential use. The recently published *Sullivan Report* for the Scottish Government sets out a low carbon building standards strategy to increase energy efficiency and reduce carbon emissions. Likewise in Germany a new standard is being trialled in Germany called the *Passivhaus*, which involves the construction of homes that utilise passive solar systems and requires no additional space heating or cooling. Essentially the *PassivHaus* approach pays very close attention to three core issues – improving the air-tightness of the new building, preventing heat escaping through "heat-bridges" and finally maximizing heat gain from the sun in winter and minimizing it in the summer. As a result the energy required for heating the house can be reduced by so much that it does not require any traditional central-heating boiler or air-conditioning unit. This is a passive as opposed to active heating systems hence the term *PassivHaus*. The review would examine opportunities to take this recent development to construct affordability low carbon residential buildings in Ireland.

### **Sustainable Construction Sites Villages**

Apart from the growing interest in sustainable design of buildings, preliminary studies have shown significant potential to reduce energy consumption at construction sites particularly for the heating and lighting of offices and stores. The review would examine opportunities to use ICT for smart-metering and control along with installation of renewable energy technologies.