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**ENGINEERING EDUCATION: NON-TRADITIONAL SPECIALISMS,  
AND THE SMART ECONOMY**

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**1. INTRODUCTION**

Traditional technologically based industries significantly influenced engineering higher education programmes, since industrialisation. The recent appointment of the Irish minister Máire Geoghegan-Quinn to the European Commission for science, innovation and research indicates that non-traditional fields may play a more significant role in the ‘new economy’ of Ireland. In addition, the Irish government appointed the Innovation Taskforce Plans to sustain and enhance the ‘Smart Economy’ model in Ireland. Engineering education is key to areas such as the enhancement of energy supplies and communications infrastructure, as well as environmental technologies. There is a shift of emphasis from the construction traditional engineering industries to communications, energy and the environment.

The demand for graduates and their employment patterns may change significantly. Sustainable employment opportunities may exist in different forms, such as short to medium term contractual opportunities. Potential applicants, with an enthusiasm to study technological based programmes, may consider non-traditional industries, in which to apply their potential expertise, and are of more interest to them. Even at this time, opportunities are growing. One example is the television industry, where Ireland has made commitments to provide a digital, high definition service by 2012. Another example is the growth in technologies to support environmentally sustainable engineering schemes, for instance Building Energy Ratings (BERs).

There is a demand for engineering knowledge in areas that have not traditionally been associated, such as water, airflow, electronics, mechanics and agriculture, chemistry, food and biotechnologies.

These degrees may be made from existing modules from the traditional disciplines, and there is a danger that they may be hybrid degrees without sufficient focus on the overall objectives of the programmes, focussing on progression to employment or further specialist academic studies. The challenge is to develop and sustain academically strong degree programmes in these new sectors.

## 2. DRIVING FACTORS IN THE DEVELOPMENT OF NEW ENGINEERING DEGREES

### *2.1 Background*

The worldwide economic downturn has made the Republic of Ireland, like many other countries; reflect on its strengths and weaknesses in the global marketplace. During the ‘Celtic Tiger’ years, the country began to gain a reputation for high-value expertise in technological areas such as software development and the biotechnology industry. It is believed that the expertise and structures are still in place for re-building the economy to include these sectors. In parallel with the economic downturn, there has been an increasing requirement for systems, products and services that reduce pollution and decrease the expenditure of energy resources. As well as this, the demand for information and communication technology (ICT) in terms of broadband and mobile services continues to increase at a high rate. The technological demands in the current decade will require a re-focusing of existing sectors, and the development of new ones.

### *2.2 Innovation Ireland and the Smart Economy*

Over the past few years, the Irish government has published a number of reports outlining the steps in developing what it refers to as the ‘Smart Economy’ within the context of marketing Ireland as the ‘innovation island’ abroad. With reference to activities in Northern Ireland, the government has developed a strategy for revitalising the economy around the areas of:

- Environment;
- Energy;
- ICT.

It is not expected that these initiatives will, in isolation, reduce unemployment in the medium term to the average levels of the last decade, but will serve as a long term platform for sustainable growth and job creation over the next ten years or so. However, the success of such a plan depends on a number of requirements:

- Technological costs at low levels;
- People being available in Ireland with the correct skill-sets.

The educational and training needs for the smart economy are centred on the following disciplines:

- Engineering;
- Science;
- Business/Entrepreneurship.

### *2.3 Energy and Environment*

A number of initiatives are to be implemented, in order to develop the 'green economy' in Ireland (Department of Communications, Energy and Natural Resources, July 2009; Department of the Taoiseach, March 2010):

- Improved waste management systems, so that all waste can be put to useful purpose in dwellings, agriculture or energy consumption;
- Reduction of greenhouse gases;
- Development of 'green' goods and services;
- Use of ICT and advanced sensor technologies to monitor the environment;
- Water resources controlled more effectively using improved pipe construction and leak monitoring technologies.

The management of energy will also be a major part of the strategy to improve the environment via:

- New or emerging forms of energy source, such as geothermal, bio-waste/anaerobic digestion, solar, wind and ocean;
- Energy efficiency models in occupancies or dwellings to be enhanced to produce low or no carbon' output;
- Control and monitoring of existing resources using monitoring at system level and smart metering in the home;
- Use of innovatively efficient heating technologies, such as wood-chip and combined heat and power (CHP);
- Sustainable market development of 'clean' transport, for instance electric vehicles.

### *2.4 Information and Communication Technologies, and their Applications*

The continued exponential projection in demand for ICT services has not abated during the recession. There is a growing need however for these services, amongst other things, to be used as a tool for economic and environmental sustenance. The market trend is towards the delivery of high speed, high quality audio-visual products and services to the individual, independently of location and to mitigate the need for travel. With this in mind, there are proposals to make Ireland a centre for the development of the necessary advanced technologies. These are summarised below (Department of Communications, Energy and Natural Resources, July 2009; Department of the Taoiseach, March 2010):

- A move away from traditional IP (Internet Protocol) to Packet Burst Networks to satisfy increased demand in on demand video, social networking, seamless mobile and fixed location (broadband) services;
- The development of Web 3.0 which will allow re-programming of web semantics by the user and dynamic procurement of bandwidth;
- High speed Metropolitan Area Networks (MANs);
- Virtual services for businesses and data mining corporations, such as 'cloud computing';

- The ‘Exemplar Smart Network’, which will on a trial basis encompass all facets of new ICT services, including ‘green’ applications such as environmental monitoring, before a full implementation in the next decade.

## *2.5 Government Institutions Involved in Developing the New Vision*

The primary drivers at present are bodies such as:

- Department of the Taoiseach;
- Science Foundation Ireland (SFI);
- Sustainable Energy Ireland (SEI);
- Enterprise Ireland;
- Industrial Development Agency (IDA);
- Those organisations under the umbrella of the Programme for Research in Third Level Institutions (PRTLTI), such as National Digital Research Centre (NDRC), Biometric Diagnostics Institute (BDI);
- Higher Education Institutions (HEIs) such as University of Dublin (Trinity College), NUI Dublin (UCD), UCC (Cork), UCG (Galway), IADT - Dun Laoghaire.

## *2.6 The Emerging Needs of Engineering Education*

The primary drivers of the smart economy recognise the need for change in the way engineering education is approached in Ireland. It is no longer sufficient for graduates to be educated exclusively within a single discipline such as civil, mechanical and electronics engineering. These single disciplines will not be sufficient to meet the demands of the coming decades in themselves. Not only are interdisciplinary forms of engineering education needed, but that there is a rapidly changing scene in which new types of engineering will emerge as disciplines in their own right, for instance in the environmental and biotech areas. It is crucial that students gain the abilities to:

- Recognise the need for interdisciplinary approaches;
- Be better educated in fundamental engineering principles, independently of an engineering sector;
- Enhance life centred and product design skills;
- Improve their abilities to problem solve, think laterally, manage resources, be flexible in their approach and be prepared for the unexpected;
- Improve their business, self working and economic skills;
- Work closely with industry whilst being in education;
- Be prepared for employment in smaller groups with more autonomy but less job security, rather than be a ‘small cog in the big wheel’ of a ‘blue chip’ company;
- Integrate engineering approaches with the arts and humanities;
- Be prepared for lifelong learning.

These demands are significant on the student, however there is a need to re-image the purpose of engineering education and re-visit the principles of the discipline in the context of new requirements.

### 3. EXISTING ENGINEERING DEGREES APPLICABLE TO THE SMART ECONOMY

#### 3.1 Overview

There are a number of engineering degree programme in the Republic of Ireland that can form the basis of engineering education in the smart economy. These programmes encompass the areas such as:

- Environmental/Energy;
- Biomedical;
- Audio-Visual/Multimedia.

#### 3.2 Environmental/Energy

The Environmental Engineering BE Degree at NUI Galway <sup>(1)</sup> (intake of 10 students per year), has three main activity areas: waste and water management, industrial waste management and renewable energy/sustainable development. Within this, students are involved in projects related to particular problems such as industrial and domestic waste management and the design, installation and maintenance of ventilation, heating, lighting, acoustic and air pollution systems at domestic, public and industrial levels. There is a necessity for this programme however to be linked to the traditional discipline of civil/structural engineering rather than carve out a niche discipline in itself.

The M.Eng.Sc in Sustainable Energy at UCC (Cork) <sup>(2)</sup> specifically targets the area of improving the efficiency of energy consumption and developing renewable sources, using a variety of technologies.

#### 3.3 Biomedical

The B.E. in Biomedical Engineering at NUI Galway <sup>(3)</sup> is described as an amalgam of electronic and mechanical engineering rather than a new discipline in its own right, although its links to biological science are implicitly clear. Surgery robotics and radiography applications are suggested as projects and applications, which is relevant in the smart economy to emerging markets such as non-invasive medical procedures and diagnostics.

#### 3.4 Audi-Visual and Multimedia

The B.Eng in Audio-Visual Media Technology (AVMT) at IADT, Dun Laoghaire <sup>(4)</sup> provides engineering education in the area of electronic systems for the music, recording, radio, television and visual industries. Whilst not described as an engineering discipline in its own right, the area of audio-visual technologies is sustained through the recession by, for instance the entertainment sector. The emergence of high-speed multimedia networks and seamless

broadband/mobile platforms supports the need for programmes such as this. The programme, whilst primarily focused on the technical context, also provides a strong creative flavour. AVMT was established in 1999 and has been a degree level programme since 2002, currently with approximately 100 students. It is an example of a programme in a non-standard discipline that has grown throughout the ‘boom years’ and continued to grow during the current economic period.

The School of Creative Technologies at IADT also provides the B.Sc in Multimedia Systems and Web Engineering (approximately 150 students), the M.Sc in Cyberpsychology (approximately 25 students) and the B.Sc (Hons) in Applied Psychology (which has a strong information technology element, with approximately 200 students). Such programmes have continued to grow rapidly since their inception in the late 1990s, and demonstrate an increasing relevance to the new economic models emerging in the state.

It is worth noting that one of the recommendations emerging from the Innovation Task Force (Department of the Taoiseach, March 2010) is the development of synergy between Arts/Humanities/Social Sciences and Science/Engineering/Technology. IADT is well placed to meet this recommendation.

### *3.5 Other Programmes*

It is worth considering that there are other specialist branches of engineering that have been growing in the last decade and will continue to have a place in the smart economy. Examples are:

- Food Engineering: for instance the M.Sc.Eng programme at UCD;
- Fire Safety Engineering: for instance the B.Eng (Hons) programme at Letterkenny IT.

## **4. THE ADAPTATION OF ENGINEERING DEGREES TO THE SMART ECONOMY**

It is clear that the existing engineering degrees have much further to go in adapting to the new economy. A number of recommendations as to how HEIs can achieve this are as follows:

- Critical and timely review of the emerging plans in the smart economy;
- Flexible provision of modules and programmes in order to match the new economic needs;
- Greater liaison with emerging industries, locally, nationally and internationally;
- Development of on-campus companies, with a long term view as well as incubation;
- HEI national committee to strategically advise on programmes, modules, projects and content in engineering education, so that all relevant areas of the smart economy are encompassed, as well as aid the viability of these programmes in lean monetary times;

- A fundamental review of the engineering discipline, as taught at third and fourth levels, so that the skills and competences of graduates will be flexible enough to meet the new demands;
- Active promotion of engineering education in the smart economy.

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