2014

Development of a new MSc in Geospatial Engineering

Audrey Martin
Technological University Dublin, audrey.martin@tudublin.ie

Kevin Mooney
Dublin Institute of Technology, kevin.mooney@tudublin.ie

Eugene McGovern
Dublin Institute of Technology, eugene.mcgovern@tudublin.ie

Recommended Citation

Martin, A., Mooney, K., McGovern, E. (2014).Development of a New MSc in Geospatial Engineering. *International Federation of Surveyors (FIG) XXV International Congress*, Kuala Lumpur,16th – 21st June 2014. doi:10.21427/46qk-v048

Development of a New MSc in Geospatial Engineering

Audrey MARTIN, Kevin MOONEY and Eugene McGOVERN, Ireland

KEYWORDS: Geospatial Education, Spatial information Sciences, Masters, Geomatics

SUMMARY

To meet the changing needs of the Spatial Information Sciences industry and cognisant of the declining numbers of undergraduate students in Geomatics, the Spatial Information Sciences Group at the Dublin Institute of Technology, Ireland, has recently developed a new conversion Masters (MSc) programme in Geospatial Engineering. Conversion Masters programmes facilitate the horizontal movement of graduates with a cognate degree into Geomatics domains and thus cater to a wide audience.

The aim of the MSc in Geospatial Engineering is to prepare innovative graduates to work with high competence, using specialised skills and deep knowledge, as producers, managers and users of geospatial information, at the forefront of developments. The conceptual and technical complexity of the MSc in Geospatial Engineering were primarily aligned with the new developments in measurement science technologies including modules in point cloud data acquisition, manipulation and modelling, whilst also encompassing some fundamental building blocks of Geomatics education.

The MSc in Geospatial Engineering programme was accredited by the Dublin Institute of Technology in May of 2013 and in September 2013, the first intake of students were inducted. It is offered in both full-time and part-time modes to graduates and professionals, in addition, individuals with particular up-skilling requirements can avail of discrete modules. The provision of this new MSc programme in Geospatial Engineering should help to address an identified educational deficiency in the Spatial Information Sciences both in Ireland and internationally.

Development of a New MSc in Geospatial Engineering

Audrey MARTIN, Kevin MOONEY and Eugene McGOVERN, Ireland

INTRODUCTION

The design and provision of third-level education programmes at the Dublin Institute of Technology (DIT) must take account of current Irish Government strategy for third-level education (Government of Ireland, 2011). The vision towards 2030 sees higher education institutions as having a strong engagement with individual students, communities, society and enterprise, giving students a sense of Irish place and identity, and equipping them with the skills to play a strong part on the world stage. Higher education is asked to support this vision through innovative approaches to research-led teaching and learning, programme design, student assessment and a quality assurance system – all of which will reflect a new emphasis on nurturing creative and innovative minds.

Graduates of programmes in the Spatial Information Sciences (SIS) at DIT will work, research and develop careers in a range of domains, namely Architecture Engineering and Construction (AEC), Geographical Information, Land Administration and Management, Earth Observation and Cultural and Natural Heritage. As such, they must possess a range of skills and competences adaptable to the needs of any or all of such domains.

At the same time, significant development continues apace in the broader context in which such programmes operate. Rapid change is evident in the development of spatial data acquisition and processing technology. New terrestrial, airborne and space borne sensors deliver rich data sets which need new processing pipelines to exploit their information content for the delivery of necessary services. Cloud computing offers a solution and spatial information science graduates must be competent in this environment. Limitations in national data sets are being overcome with the maturing of object-based data models compliant with internationally agreed specifications and standards, the generation of dense digital terrain models and the provision of national 3D data sets. This enables the delivery of services that rely on fit-for-purpose authoritative reference data such as 3D cadaster, flood management, urban management and emergency response.

GEOSPATIAL EDUCATION IN IRELAND

In Ireland, the educational needs of the SIS is served by a number of third level institutions and in the programmes which offer a National Framework of Qualification (NFQ) award in Geomatics related disciplines in the tertiary sector (Table 1). Additional short programmes outside of the NFQ structure (NQAI, 2012), and specialist training programmes provided by industry, are not included in Table 1.

Table 1: Spatial Information Sciences Programmes in Ireland with National Framework Qualifications

Institution	Discipline	Award	NFQ Level	Delivery
University College Cork (UCC)	GIS	Higher Diploma	8	30 days Sept.-June
	Archaeology & Geoinformatics†	MA	9	1 yr FT
	GIS & Remote Sensing	MSc	9	1 yr FT
National University of Ireland (NUI) Maynooth	GIS & Remote Sensing	MSc	9	1 yr FT
	Geocomputation	MSc	9	1 yr FT
Dublin Institute of Technology (DIT)	GIS	CPD Cert		24 weeks PT
	Geomatics	BSc	8	4 yrs FT
	Spatial Data Management	MSc	9	1 yr FT/2yrs PT/ options
	Geospatial Engineering	MSc	9	1 yr FT/2yrs PT/ options
	GIS	MSc	9	1 yr FT/2yrs PT/ options
	Land Management†	MSc	9	1 yr FT/2yrs PT/ options

†*Under development; FT = Full-time; PT = Part-time;*
NFQ Level 8 = BSc (Hons) programmes; Level 9 = Masters (MA & MSc) Programmes;

The BSc in Geomatics at DIT is the only undergraduate degree programme offered in the Spatial Information Sciences in the state. This honours bachelor degree programme (BSc Hons), launched in 2000 leads to a NFQ Level 8 qualification with a duration of 8 semesters (4 years) and attracts 240 European Credit Transfer points (ECTS). Notable features of this full-time four year programme include a full semester of industrial placement where semester 6 students spend three to four months with an employer to experience the working environment at first hand. During the final semester students undertake an individual research project and write a dissertation. As a result of both features, formal teaching is only carried out over three years. The number of disciplines encountered by the student, over these three years, has grown significantly in the last decade to include advanced geodetic surveying techniques, photogrammetry, GIS, land management and mathematical methods. Consequently, it is doubtful whether sufficient time exists for effective student learning.

In the last decade, approximately 250 students have graduated from this highly successful Irish BSc programme yet national market demand is not currently being met by the annual supply (Murray, 2012). Difficulties of attracting high calibre candidates onto undergraduate

Geomatics courses is not unique to Ireland and has been the focus of recent papers including Hannah *et al*. (2009) and Esbitt and Werner (2010). The declining numbers of second-level pupils choosing Geomatics as a career option include a lack of awareness of the role and significance of the Geomatics surveyor in society today.

To meet the changing needs of the SIS industry and cognisant of the declining numbers of undergraduate students, the Spatial Information Sciences Group (SISG) at DIT has recently embarked on a series of significant changes to its provision of programmes in the Spatial Information Sciences, including the redesign of its existing BSc in Geomatics programme and the provision of new taught Masters programmes. This paper describes the new MSc in Geospatial Engineering, offered in full-time and part-time modes, which welcomed its first cohort of students in September 2013.

MSc IN GEOSPATIAL ENGINEERING

Programme Aim and Learning Outcomes

The aim of the MSc in Geospatial Engineering is to prepare innovative graduates to work with high competence, using specialised skills and deep knowledge, as producers, managers and users of Geospatial information, at the forefront of developments in domains where Geospatial information plays a significant role in related disciplines. This aim is achieved by providing highly motivated and qualified Geospatial Engineers equipped with domain/industry-specific Geospatial skills. The programme integrates a significant breadth of complex technologies and skills, and applies them, where possible, in a realistic, real-world environment. Thus, where applicable, the learning outcomes include technical requirements for surveying framed around industry problems which allows individuals to develop work-oriented capabilities and vocational skills. Effective learning is achieved through a number of pedagogical approaches, including both instructivist and enquiry-led and problem-solving approaches with industrial and professional relevance. In addition, written and oral presentation skills are developed and through team-led project work, students develop individual thoughtful review and peer and self-appraisal skills.

As measurement science is a leading industry embracing new measurement technologies, graduate surveyors are expected to be familiar with modern instrument operations, data processing workflows and, data manipulation and management techniques. The challenge for academic institutions is to keep pace with the latest technologies and thus provide students with access to a broad range of modern survey equipment. In this respect the MSc in Geospatial Engineering in DIT will reap significant benefits from the recent sponsorship agreement with TOPCON Positioning Systems. This agreement provides DIT students with access to a large range of TOPCONs' newest geodetic survey equipment and processing software, including *inter alia* a TLS laser scanner, robotic imaging stations, reflectorless total stations, a permanent geodetic GNSS antenna and receiver and the MAGENT^{TM} data processing suite. Thus graduates of the MSc in Geospatial Engineering programme in DIT will have relevant experience with the newest precise positioning tools and survey workflows hence, increasing their attractiveness to employers.

Programme Structure

The conceptual and technical complexity of the MSc in Geospatial Engineering was aligned with the new developments in measurement science technologies whilst also including the fundamental building blocks of Geomatics expertise in geodetic surveying, coordinate reference systems and transformations as reflected in the taught modules in Table 2. In total, the programme consists of 10 five-credit mandatory modules and 6 five-credit optional modules permitting specialisms. The Dissertation module accrues 30 credits and embodies a significant research project. To complete the programme students must successfully complete 12 five-credit modules and the Dissertation module thus achieving the 90 credits NFQ requirement. In DIT one ECTS credit equates to 20 learning hours. Individual 5 ECTS modules therefore accrue a total of 100 learning hours, of which 20 - 35 % are direct contact hours either in class or remotely, the remaining learning hours are considered non-contact self- or group-study hours.

Programme Delivery

The programme delivery is designed to be flexible and can be followed in three possible modes: full-time, part-time and modular. In full-time mode three 15-week phases (Table 2) must be completed during one calendar year. Phases 1 and 2 comprise six taught modules, while in Phase 3 students complete an individual research project and write a dissertation. During Phase 2, as part of the module *MSc. Work Placement*, students spend time with a company or organisation for the purpose of gaining firsthand experience of the conduct of the provision, use and quality assurance of geospatial information in the workplace. The inclusion of work placement on the MSc in Geospatial Engineering resulted from the very positive experiences with a similar module on the Geomatics BSc programme.

In part-time mode the programme is normally completed over two years, comprising four semesters of three taught modules each, followed by the completion of an individual research project and dissertation in the final phase. In this mode delivery is arranged so that all relevant modules are delivered on one day per week, thus facilitating students remaining in employment whilst undertaking the programme. A modular approach to gaining an academic qualification is becoming increasingly popular in Ireland as specific modules required for up-skilling in new technological developments or in providing foundation knowledge for non-specialists can be easily identified and delivered. In this mode each five-credit module is undertaken as a stand-alone Continuing Professional Development (CPD) module.

Table 2: Modular Structure of the MSc in Geospatial Engineering

Phase 1	ECTS	Phase 2	ECTS
Project Management	5	MSc. Work Placement	5
Coordinate Transformations	5	Research Skills	5
Geodetic Surveying	5	Geospatial Reference Systems	5

Geospatial Data Provision	5	Point Cloud Science	5
Systems and Practise 1	5	Systems and Practise 2	5
Total Mandatory	**25**		**25**
Digital Elevation Models from Airborne sources	5	Spatial data for 3D Urban Models	5
Visualisation and Delivery of Geospatial Information	5	National Landscape and Land Cover models	5
Geographic Information Science I	5	Geospatial Engineering for Building Information Modelling	5
Total Optional	**5**		**5**
Phase 3		Dissertation	**30**

Programme Assessment

A combination of assessment methods are used in the programme to contribute to the students' learning and to demonstrate that they have fulfilled the objectives of the programme and achieved the standard required for a NQAI level 9 award classification. Assessment requirements are directly related to the programme learning outcomes in four cognitive areas of including: knowledge, skill, know-how and competence as outlined by NQAI (2012). Seventy-five percent of the programme is assessed using interactive learning and formative assessment techniques. Such techniques include project- and problem-based learning including industrial simulation. These interactive approaches place ownership of the learning experience with the student while the academic facilitates and scaffolds the learning process (Martin and McGovern, 2011). The remaining assessment is summative in nature culminating in a number of examinations.

Admission Requirements and Programme Costs

The programme is aimed at deepening the knowledge of graduates who have already obtained a BSc honours degree in disciplines related to Geospatial Engineering. By broadening the undergraduate catchment admissions policy to include cognate degrees, it is expected that the need for specialists in the field of Geospatial Engineering as identified will be facilitated from beyond the traditional Geomatics route. Applications from candidates who have an equivalent qualification for example, a professional qualification, are also considered. The programme is also open to non-European degrees and in the case of non-native English speakers, a minimum score of 6.0 is required on the IELTS (International English Language Testing System) test is required. The full-time programme costs are €5850, whilst in part-time mode they are €2925 per annum for EU nationals. Modular delivery of individual five credit ECTS modules will be offered from January 2014 at a cost of €400 each.

CONCLUSION

This paper has described the development of a new MSc programme in Geospatial Engineering that meets the educational requirements of the SIS industry and satisfies professionals' educational and up-skilling requirements. The MSc in Geospatial Engineering is a unique NQAI level 9 course in Ireland. It underpins the needs of a wide range of disciplines in the Built Environment and Engineering where the accuracy and connectivity of rich spatial data sets is crucial in modern survey workflows. The development of the MSc conversion programme was based on an assessed need for professionals in the geospatial sciences which is not currently being met by the undergraduate degree programme in Geomatics in Ireland. It facilitates the horizontal movement of graduates with a cognate degree into Geomatics domains and thus caters to a wide audience facilitating possible future syngeries with sister disciplines. The programme focuses on new developments in surveying in terms of point cloud data and data modelling whilst encompassing the fundamental knowledge building blocks of Geomatics education and benefits from a new sponsorship agreement with TOPCON Positioning Systems.

The MSc in Geospatial Engineering programme was accredited by DIT in May of 2013 and in September 2013 the first intake of student were inducted. The profile of this initial cohort includes architectural professionals wanting to specialise in modern point cloud manipulation for urban modelling, mining surveyors with requirements for up-skilling in recent point positioning technologies and engineering graduates with a need to develop competencies in geodetic surveying principles. In addition, the one year full-time option of the programme has attracted international survey practioners with requirements to obtain academic qualifications at MSc level for promotion within their national government agencies. The provision of this new MSc programme in Geospatial Engineering should help to address an identified educational deficiency in the Spatial Information Sciences in Ireland and internationally.

REFERENCES

Esbitt, R. and Werner, T. (2010). Rescuing the surveying profession from near extinction: The surveying task force Inc. XXIV FIG Congress, 11th-16th April, Sydney, NSW, Australia. Available at: http://www.fig.net/pub/fig2010/papers/ts01j/ts01j_esbitt_werner_4431.pdf

Government of Ireland. (2011). National Strategy for Higher Education to 2030 - Report of the Strategy Group. Published by the Department of Education and Skills. Government of Ireland. January 2011.

Hannah, J., Kavanagh, J., Mahoney, R. and Plimmer, F. (2009). Surveying: A Profession facing a global crisis? Survey Review, 41:268-278.

Martin, A. and McGovern, E. (2011) Aligning Learning Outcomes with Professional Competencies in Geomatic Education. International Technology Educational and Development Conference (INTED) 6th – 9th March 2011. Valencia, Spain.

Murray H. (2012). Geomatics Education at the Dublin Institute of Technology. Euromatyka 2012. Geodetic Scientific-Technological Conference, Poznan University of Technology Poland, May 2012.

NQAI (2012). The National Framework of Qualifications.
Available at: http://www.nfq.ie/nfq/en/

BIOGRAPHICAL NOTES

Dr. Audrey Martin is the Programme Chair of the MSc degree in Geospatial Engineering and lectures both undergraduate and post-graduate students in the Spatial Information Sciences in the Dublin Institute of Technology. Her area of expertise includes Geodetic Surveying, Global Navigation Satellite Systems (GNSS) and Geomatics pedagogy. Audrey held the DIT Teaching and Learning Fellowship in 2011 and was jointly awarded the 2010 DIT Teaching Excellence Award in the College of Engineering and Built Environment. Audrey is the Irish representative on FIG Commission 2.

Kevin Mooney is Senior Lecturer in the Spatial Information Sciences at the Dublin Institute of Technology, where he lectures principally in Photogrammetry. He is the Irish academic delegate to EuroSDR, the European Spatial Data Research organisation, and immediate past Secretary-General. Kevin is Programme Chair of the BSc degree in Geomatics.

Dr. Eugene McGovern is a lecturer in the Spatial Information Sciences in the Dublin Institute of Technology. His current research interests include Terrestrial Laser Scanning (TLS), Building Information Modelling (BIM) and Geodetic Surveying. Eugene was jointly awarded the 2010 Teaching Excellence Award in the College of Engineering and Built Environment and is Chair of DIT's SiNRG spatial data research group. He is Irish representative on FIG Commission 5.

CONTACTS

Dr. Audrey Martin FSCSI FRICS
Dublin Institution of Technology

Programme Chair – MSc. Geospatial Engineering.
Spatial Information Sciences Group
College of Engineering & the Built Environment
Dublin Institution of Technology

Bolton Street, Dublin 1, IRELAND

Tel. +353 1 402 3736
Fax +353 1 402 3999
Email: Audrey.martin@dit.ie

Kevin Mooney Dip. Geo-Surv., MSc.
Dublin Institution of Technology

Programme Chair – BSc. Geomatics.
Spatial Information Sciences Group
College of Engineering & the Built Environment
Dublin Institution of Technology
Bolton Street, Dublin 1, IRELAND

Tel. +353 1 402 3730
Fax +353 1 402 3999
Email: Kevin.mooney@dit.ie

Dr Eugene McGovern FSCSI FRICS
Dublin Institution of Technology

Spatial Information Sciences Group
College of Engineering & the Built Environment
Dublin Institution of Technology
Bolton Street, Dublin 1, IRELAND

Tel. +353 1 402 3731
Fax +353 1 402 3999
Email: eugene.mcgovern@dit.ie