The Potential of Distance Learning in Meeting the Challenges Facing National Mapping Agencies in the New Millennium

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Key words: Continuing professional development, National mapping agency, Education and lifelong learning, Knowledge sharing, Distance E-learning.

SUMMARY

This paper describes a joint initiative between Ireland's national mapping agency, Ordnance Survey Ireland (OSi) and the Dublin Institute of Technology (DIT). The initiative led to the development of a distance learning course in 'Co-ordinate reference systems for spatial information', which was delivered as a pilot project to a group of fifteen OSi staff members, via the Internet, over a six week period. The pilot course was undertaken during the summer of 2002, and was intended to evaluate the possibilities of 'E-Learning'. The course, which used the WebCT® learning environment, was specifically designed for continuing professional development (CPD) in the workplace. Feedback from participants was positive, and the modular structure of the course, which was regarded as a success by both DIT and OSi, is described.

The paper also discusses the changing needs of users in the geographic information community, and the necessity for the adoption, by national mapping agencies (NMA) of new technologies and methods. In the majority of cases, this results in a requirement for significant skills updating of NMA personnel. Traditional CPD methods of training and education are not always practical in a busy working environment and web-based distance learning is increasingly seen as a possible solution.

DIT is currently developing E-Learning as an educational resource to meet the requirements of society at many different levels, including undergraduate and postgraduate programmes, second chance adult education, and CPD. It has adopted WebCT® as its E-Learning platform.

The paper addresses issues that have arisen during the pilot project and evaluates the potential of distance learning in meeting the challenges facing national mapping agencies in the new millennium.

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1. INTRODUCTION

The Dublin Institute of Technology (DIT) is the largest educational institution in Ireland, with more than 21 000 students engaged in programs ranging from craft training to post-doctoral research. The multi-level structure adopted by DIT incorporates a number of flexible learning models, which enable students to participate in education at different stages of their careers on either a part-time or full-time basis. DIT is also committed to lifelong learning and has a strong tradition of providing continuing professional education and development (CPD) programs to industry and professional bodies.

The Department of Geomatics, in the Faculty of the Built Environment in DIT, provides a four-year full-time degree course in Geomatics. It also services the spatial information industry in Ireland on an annual recurring basis by providing a number of part-time programmes in Global Navigation Satellite Systems (GNSS), Geographical Information Systems (GIS) and digital cartography. Furthermore, diverse CPD modules in spatial information science have been designed for specific user groups such as local authorities and government departments. The delivery of these modules, to date, has been on a block release basis whereby all students attend lectures and practical sessions in the Department of Geomatics in Dublin. However, the rigid timetable of CPD programmes on offer has led to accessibility difficulties for students and office downtime for employers. A new CPD program model, therefore, needs to be adopted.

Recent developments in learning and teaching technology have enabled courses to be delivered via the Internet using E-learning. Shea-Schultz and Fogarty (2003) found that E-learning solutions could cater to the learner by facilitating the delivery of the right information and skills to the right people at the right time. It is now possible to study a variety of subjects, ranging from Business Management to Marine technology (www cvu.strath.ac.uk, 2003), without ever entering a classroom. Thus, the concept of a 'virtual university' as a viable educational model has been internationally accepted. DIT has embraced these virtual academy developments and adopted WebCT® (Web Course Tools) as the institute's E-Learning platform.

Ordnance Survey Ireland (OSi) is the National Mapping Agency (NMA) for the Republic of Ireland with three hundred staff in seven offices located in different parts of the country. It is mandated with maintaining national mapping and related information for Ireland. In order to achieve and maintain the required national mapping standards OSi has adopted new technologies and methods in mapping. One such technology is the Global Positioning System (GPS), and in the past year OSi has established a permanently operating active GPS network in Ireland (www.osi.ie, 2003). The adoption of GPS surveying technologies has led OSi to

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redefine its national co-ordinate reference system to the Irish Transverse Mercator (ITM). Due to these technological advancements and the changing needs of users of geographic information there is a constant need for the updating of skills of NMA staff.

OSi has identified CPD as an area of vital importance and currently spends approximately 4 % of its annual salary budget on training and development (Kirwan and Greenway, 2002). Until recently, CPD within OSi took one of three forms i.e.

- in-house short courses or seminars directed at small groups of key staff,
- distance-learning modules from The Open University and other Colleges and Universities, and/or
- limited study leave for individual courses.

However, it was found that these traditional CPD methods of training were not always - practical in a busy working environment due to:

- disruption to the organization when short courses were held for large numbers of personnel,
- inadequate dissemination of information provided by the in-house seminars,
- difficulties in accessing various courses due to location, as travelling often impinged on work time, and
- difficulties experienced in sourcing relevant CPD courses.

E-learning was therefore identified by OSi as a more flexible training model, particularly in the technical area of mapping and geographic information. To assess the merits of online CPD for NMAs, a joint initiative was proposed between DIT (Department of Geomatics) and OSi. In January 2002, the Department of Geomatics secured substantial internal funding to provide an online pilot course in 'Co-ordinate reference systems for spatial information' with the following specific objectives:

- design a modular course aimed at all users of spatial data, with specific emphasis on NMA requirements,
- evaluate the potential of E-Learning in CPD, and
- disseminate the results of the pilot study.

The role of CPD cannot be underestimated in the surveying and spatial information community (Kennie and Enemark, 1996) and whilst the majority of professional surveying Societies (RICS, 2002; SCS, 2002) engage in some form of CPD, the adoption of online facilities for CPD must be critically assessed before universally applied. Therefore, the aim of this paper is to assess the potential of E-Learning in fulfilling CPD requirements of large geospatial organizations.

2. THE JOINT DIT/OSI INITIATIVE – PILOT COURSE IN CO-ORDINATE REFERENCE SYSTEMS

The design, delivery and evaluation of a pilot E-Learning course entitled 'Co-ordinate reference systems for spatial information' was seen by the authors as the core element in a joint OSi/DIT research project which began in January 2002 and was completed in April 2003. The project can be described under the following headings.

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The subject matter for the pilot E-Learning course was chosen because, in the opinion of the authors, it was of relevance to a wide range of both producers and users of spatial information and, by its nature, would require extensive use of illustrative graphical content in addition to clear textual descriptions. This would enable the course designers to become familiar with the presentation of complex graphics and other content in an E-Learning environment and assess their effectiveness in knowledge transfer.

2.1 Familiarization with Software Tools

Within WebCT®, content is organized as a series of hierarchically numbered html pages, which function as they would directly in an Internet browser. The authors used Macromedia® Dreamweaver® v2.0 to create the html content off-line. Multiple html files were then compressed using standard zip tools and uploaded to WebCT® using its 'File Management' interface, which also included an 'unzip' function to extract the html files, once uploaded.
In total 82 html files were used, the majority of which included an animated graphic, which consisted of a series of sequenced frames (GIF images), which could be navigated via an animation control applet developed in Javascript® by DIT's newly established Learning Technology Team (LTT). The animation control allowed the learner to view the animation at his/her own pace and as often as required. The GIF images (930 in total) were generated using a combination of Adobe® Illustrator® v9.0, and Macromedia® Fireworks®v2.0.

The authors attended a number of short courses in WebCT® facilitated by the LTT and found it to be an intuitive and powerful system. The user interface, however, was cumbersome in the manner in which files were managed, and very much at variance with the 'drag and drop' standard now so widely used in operating systems. As an E-Learning environment, however, it proved an ideal vehicle for the design and delivery of the pilot programme. Academic staff considering their first steps into E-Learning will not find WebCT® to be an impediment to progress.

The software tools Adobe® Illustrator®, and Macromedia®'s Dreamweaver® and Fireworks® were previously familiar to the authors. Adobe® Illustrator® finds extensive application in geomatics, particularly in the cartographic programmes, and Macromedia®'s tools are widely use in web authoring. It must be said, however, that these or similarly appropriate graphic and web authoring tools would require significant time investment by academics if starting from a position of no experience with graphics or html generation. The support of a dedicated learning technology support team is, in the experience of the authors a key component in the development by academic staff of effective E-Learning programmes.

2.2 Liaison between Ordnance Survey Ireland and the Dublin Institute of Technology

The authors collaborated closely in the lead-in period to the pilot programme. In particular, it was felt that course content should be relevant to OSi data, and OSi should take the lead in selecting the participants for the pilot course.

In all, fifteen participants were chosen. It was felt that a greater number than this might cause difficulties in achieving adequate learner/teacher interaction. Participants were chosen by OSi with the following criteria in mind:
- A number should be based in the regional offices
- At least one of the participants should be the sole participant from his/her particular - location
- At least two participants should be chosen from the same regional office
- A group of more than four participants would be chosen from one location.

These criteria were set in order to evaluate the influence of peer support, peer distraction, and group work during a distance-learning programme. OSi agreed to set aside three hours per week for each participant in the pilot to follow the course on-line from his/her work place. The authors are strongly of the opinion that the design of CPD E-Learning resources should incorporate a significant input from the target organization. However, in order to be economical, E-Learning resources should have a long 'shelf life' and therefore be sufficiently general to attract wider interest. The challenge, therefore, to programme designers is to design programmes that are general enough for lasting application and flexible enough for tailoring to the needs of a particular target organization.

2.3 Course Content

The content of the pilot course 'Co-ordinate reference systems for spatial information' was designed in six themes (Table 1). Themes 1 to 5 are general in nature, and were designed in order to fit into a distance learning programme delivered generally, while Theme 6 relates to the co-ordinate reference systems in use in a particular target organization.

Table 1   The six themes of the DIT E-Learning pilot course 'Co-ordinate reference systems for spatial information'

Theme	Title
Theme 1	Describing position with co-ordinates
Theme 2	Defining and realising co-ordinate reference systems
Theme 3	Calculation in a two-dimensional Cartesian co-ordinate reference system
Theme 4	From local to global co-ordinate reference systems
Theme 5	Manipulating co-ordinates
Theme 6	Position in Ireland

Theme content consisted of html pages, each of which followed a standard format. As stated, 82 html files were used, the majority of which included an animated graphic (Figure 1). Page navigation was not included in the html content created by the authors, as navigation is available in all pages through WebCT's® 'Action Menu'.
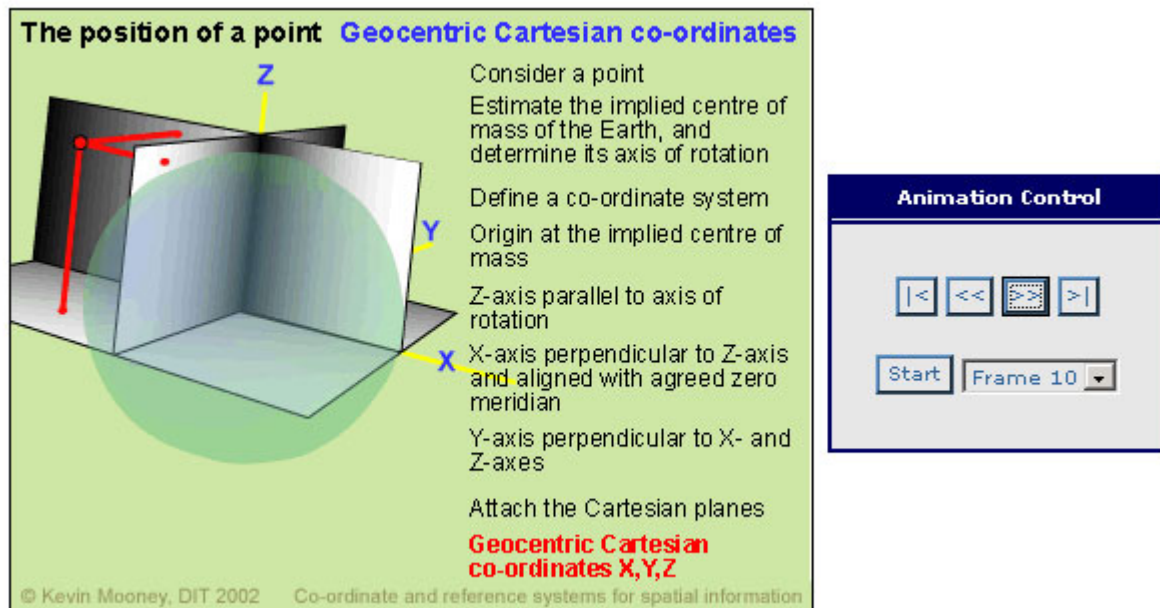
Figure 1. A frame of an animated graphic from Theme 1 of the DIT E-Learning pilot course 'Co-ordinate reference systems for spatial information'. Navigation through the frames is controlled through the 'Animation Control' applet on the right.

2.4 The First Pilot Course

The objective of the pilot course was to evaluate the experiences of a group of OSi personnel to permit:
- a value judgement on the effectiveness of E-Learning
- the identification of shortcomings in the content offered
- an assessment of the quality of the learning experience for the individual participant.

2.4.1 Pre-pilot Workshop

Each participant was issued with a WebCT[®] User ID and password by the LTT one week prior to commencement of the pilot, and was invited to attempt to log on to the DIT WebCT[®] server. Interestingly, it became evident during this period that OSi personnel were blocked by their network security restrictions from accessing the DIT WebCT[®] server, until such time as security clearance was granted by OSi's IT department. It is worth noting that such a network security strategy is typical of any large organization dealing with valuable spatial data, and should be considered during the lead-in period to an E-Learning programme.

All participants attended a one-day pre-pilot workshop in DIT where they were
- provided with course materials, comprising technical papers and course notes
- introduced to the WebCT[®] environment
- given instruction in the requirements of the pilot in relation to assignments, self-tests etc.

It was the intention that participants would use this workshop to get to know each other with the hope of fostering a sense of 'class group' thereby guarding against the possibility of a participant becoming lost in a virtual space and feeling isolated – Höhle et. al. (2000). The pre-pilot workshop, therefore included a social element in the form of an extended lunchtime 'meet and greet' session.

2.4.2   Pilot Course

Each of the six content themes was revealed to the participants on a phased basis, together with assignments. One week was allotted to each theme, and the number of hours spent by participant per theme and per page was logged by the course designers, using the 'Track Student' function of WebCT®. WebCT® offers a number of tools for the assessment of the progress of a course participant. In the pilot course, the authors used two of these tools, namely 'Self-Test' and 'Assignments'.

Self-tests consist of multi-choice questions (MCQs) and represent a very useful aid to the learner in confirming understanding of a topic. An immediate response is automatically generated as to whether the answer is correct or incorrect. MCQs need to be well designed and ideally each potential answer should be equally plausible. Examples of MCQs used, together with the correct and alternative answers, are shown in Table 2.

Table 2.   A selection of multiple-choice questions (MCQs) together with possible answers from Theme 1 of the DIT E-Learning pilot course 'Co-ordinate reference systems for spatial information'.

Question	Possible answer	Possible answer	Possible answer
Geodetic co-ordinates and astronomical co-ordinates are examples of geographical co-ordinate reference systems. Which of the systems requires the choice and location of a reference figure?			
	astronomical co-ordinate reference system	geodetic co-ordinate reference system	
In the case of a geocentric Cartesian co-ordinate reference system based on planet Earth, the origin will be located at			
	the implied centre of mass of planet Earth	a convenient local reference point	the centre of the best-fit reference figure
In the case of a geocentric Cartesian co-ordinate reference system based on planet Earth, the Z-axis will be aligned			
	Vertically	with the direction of North	parallel with an agreed axis of Earth rotation

The assignment associated with Theme 2 was designed as a group assignment, and each course participant was paired with a participant at another location. They were required to consult on the assignment brief; divide the work between them; undertake the task; exchange responses; and compile and submit one joint document. To this end, they made use of WebCT® internal mail and discussion board tools. Each of these tools is intuitive to learn and permits the attaching of files in the normal way. Communication between participants and the course designers used a mixture of the discussion board and E-Mail tools.

The participants, on an individual basis, completed each theme of the course with the submission of a written assignment. The submission of each assignment was facilitated through the WebCT® 'Assignments' tool and proved problem free. The course designers then graded the assignments off-line and posted the grade with comments, individually in each learner's personal user area.

2.4.3   Post-pilot Workshop

On completion of the pilot course, a post-pilot workshop was convened at DIT. Course participants were invited to meet with the course designers and the LTT and provide DIT with their evaluation of the performance of the pilot course. This stage of the project was designed to identify shortcomings in the pilot course, and highlight those areas where improvements could be made.

The feedback workshop proved a considerable success, as it provided constructive criticism of all aspects of the pilot programme, with all participants contributing openly. It is worth noting that such feedback sessions rarely take place in the case of most academic programmes, and course designers must be prepared to take all feedback on board, and incorporate necessary changes into programme revisions if E-Learning courses are to remain relevant and effective.

An analysis of the potential of distance-based E-Learning, based on the performance of the pilot course, is presented in Section 3. As a result of the analysis of the feedback from the course participants, it was decided to run a second pilot course incorporating a number of key changes as follows:
- In the first place, the time taken to generate the content for the first pilot course had been underestimated by the course designers, with the result that none of the many WebCT® tools aimed at enhancing the learning experience were properly exploited.
- Secondly, there was an identified need for more group-based course activity in order to foster the sense of 'class group' among the participants, and help avoid the feeling of isolation among some participants.
- Thirdly, insufficient learner/teacher interaction took place, with the result that the understanding of some concepts suffered in the case of a number of participants.

2.5 Enhancing the Learning Experience

The improvement and evaluation of the learning experience of the participants is seen by the authors as the main goal of changes currently being applied to the DIT E-Learning course in 'Co-ordinate reference systems for spatial information'. The course will then be offered to a second OSi pilot group for participation and evaluation.
The principal elements aimed at enhancing the course will be
- comprehensive content manual and CD-ROM to allow off-line study
- regular scheduled periods for on-line learner/learner and learner/teacher interaction
- extensive pop-up glossary for key definitions
- effective self-test quizzes for each course theme

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- group-based assignments for each theme.

It is intended to carefully monitor the expenditure of time required to realise these enhancements and, together with feedback following a second pilot course, evaluate their effectiveness.

2.6 The Second Pilot Course

A group of twenty-two OSi personnel has been selected by OSi for participation in a second pilot distance E-Learning course in 'Co-ordinate reference systems for spatial information', which will take place from 19th February until 4th April 2003. The course will be jointly evaluated by the OSi participants, the course designers, and members of the LTT. Results of this evaluation will be presented at the FIG Working Week in April 2003 and the Congress of the International Society for Photogrammetry and Remote Sensing in July 2004.

3. EVALUATING THE POTENTIAL OF DISTANCE BASED E-LEARNING FOR CPD IN NATIONAL MAPPING AGENCIES

In general, participants in the post-pilot feedback workshop believed that the E-Learning medium suited the spatial information sciences, and that the principles of Co-ordinate reference Systems were well presented in WebCT®. They were strongly of the opinion that distance-based E-Learning represented a CPD resource that had proved its worth in the pilot course, and one that they would enthusiastically utilise in the future.

Distance based E-Learning, however, represents just one of a number of suitable resources open to personnel of a large organization such as a national mapping agency for their continuing professional development and skills updating.
Some of the resources have been mentioned in Section 1, and are here mentioned again:
- in-house short courses or seminars directed at small groups of key staff,
- distance-learning modules from Open University and other Colleges and Universities, and/or
- limited study leave for individual courses.

The question naturally arises as to how short distance-based E-Learning courses, such as the one piloted in the current initiative, rate as effective CPD resources. Based on the evaluation of the performance of the pilot course in 'Co-ordinate reference systems for spatial information' by DIT and OSi, the potential of distance-based E-Learning for CPD in national mapping agencies may be evaluated in terms of its strengths, weaknesses, and opportunities.

3.1 Strengths of Distance-based E-Learning

Distance-based E-Learning can be effective for CPD and skills updating where
- neither the time nor, indeed, the willingness exists for a staff member to attend formal classes

- the workplace is remote from educational centres or centres where CPD resources are available
- where the subject matter is of a conceptual or theoretical nature, which may be learnt by an individual without the essential requirement for group-based activities such as role playing or workshop sessions, and where hands-on practical exercises are not required.

3.2 Weaknesses of Distance-based E-Learning

It is evident that distance-based E-Learning exhibits weaknesses in relation to other CPD resources, such as
- interaction between students is missed by the participants
- the study environment needs to be free of distraction which is not always possible in the case of a large busy organisation and therefore may suit those working in some areas of an organisation more than others
- a considerable amount of time is required for course preparation, on the part of course designers and builders, and therefore suitable courses for distance-based E-Learning are those with a long 'shelf-life'. Mooney and Martin (2003) found that in the case of the current pilot course, thirty hours preparation time was required for each one-hour of on-line time of the participants.

3.3 Opportunities for Distance-based E-Learning

Modern national mapping agencies are increasingly concerned with the maintenance and management of core spatial databases and the acquisition of new spatial data through geodetic activities is, in many cases, no longer their main focus. Key personnel in such organisations must be skilled in management practice and information and communication technologies (ICT) and in these areas national mapping agency personnel often have a number of CPD resources available. However, developments in reference systems, spatial data acquisition technologies, and database management systems mean that there remains a compelling need for skills update in areas which are not well served by CPD resources. Distance-based E-Learning resources are eminently suited to CPD and skills updating in these subject areas.

4. CONCLUSIONS

The joint DIT/OSi initiative in the form of a pilot E-Learning course, 'Co-ordinate reference systems for spatial information', has confirmed that distance E-Learning is an appropriate and potentially effective medium for the continuing professional development of personnel of a national mapping agency. However, the enhancement of the learning experience of the participants must be seen as a major goal of any E-Learning course in order to function as an effective CPD resource. Course designers should work closely with the target organisation, in so far as practical, to ensure content relevance, but the subject matter should be such as to guarantee a long 'shelf-life' for a resource that requires a considerable amount of preparation time on the part of course builders. The challenge, therefore, to programme designers is to design programmes that are general enough for lasting application and flexible enough for

tailoring to the needs of a particular target organization Distance-based E-Learning is but one from a basket of possible CPD resources available to national mapping agencies but one that presents a very effective means of delivering continuing education in the context of a lifelong learner-centred learning paradigm.

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BIOGRAPHICAL NOTES

Audrey Martin is a lecturer in the Department of Geomatics at the Dublin Institute of Technology (DIT), she specializes in the areas of Geodesy and GPS. Audrey holds a doctoral degree (2001) from University College Dublin (UCD) and has published extensively in the area of applied geomatics from her PhD research work. In the past, Audrey has worked and studied abroad and attained a German Survey Engineering Degree (Dipl.-Ing) from Oldenburg (FH) in 1992. Her primary qualification is a Diploma in Geo-Surveying (1989) from DIT. Audrey is a Chartered Surveyor (MRICS) and an active member of the Society of Chartered Surveyors in Ireland (ASCS) where she is the Geomatics Division CPD officer and a member of the Geomatics Division Committee. Audrey is also a Fellow of the Irish Institution of Surveyors and has in the past (1996-1999) held the position of Honorary Treasurer.

Kevin Mooney is a Senior Lecturer in the Department of Geomatics, at The Dublin Institute of Technology (DIT), where he lectures principally in Photogrammetry. He gained a Diploma in Geo-Surveying (1976) from DIT; a Post-graduate Diploma in Photogrammetry (1977)

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from ITC, The Netherlands; and a M.Sc. in Engineering (1987) from Trinity College Dublin. His research interests are in extracting core spatial information from spatial and image data sets. Kevin is a Fellow of the Irish Institution of Surveyors and a member of the Irish Society of Surveying, Photogrammetry and Remote Sensing, where he has served as Council member, editor of the *Survey Ireland* journal, and currently acts as organiser of the Survey Ireland annual one-day conference of the Society. He is one of Ireland's two delegates to EuroSDR (European Spatial Data Research) where he is a member of the 'EuroSDR Education Service' taskforce.

Iain Greenway joined Ordnance Survey of Great Britain in 1986 after completing an M.A. in Engineering at Cambridge University and an M.Sc. in Land Survey at University College London. During the late 1980s and early 1990s, he worked in geodetic and topographic survey, including short-term consultancies supporting land reform in eastern Europe. After completing an MBA at Cranfield University in 1994/95, which included a term studying at Macquarie University, Sydney, he worked for Ordnance Survey in strategic planning and pricing, sales and marketing, as well as completing a number of management consultancy inputs in Swaziland and Lesotho. He subsequently undertook a secondment to Her Majesty's Treasury, working on the improvement of public sector productivity in the UK. Since the summer of 2000, Iain has been the Deputy Director of Ordnance Survey Ireland, responsible for much of the day-to-day management of a national mapping agency undergoing profound changes in status, structure, processes and culture. Iain is a Chartered Surveyor (MRICS) and a member of the Chartered Institute of Marketing (MCIM). He is the head of the RICS delegation to FIG, and Chair of the FIG Task Force on Standardisation and of Working Group 1.2 (Business Practices). He is also a member of the Management and Editorial Boards of the journal Survey Review.

Jim Davey is currently employed as a digital photogrammetrist in the New Mapping and Technical support Deptartment in the Ordnance Survey in Ireland. His main duties include working on aerial triangulaion and digital archive for the 1:2500 & 1:5000 mapping programs. Jim holds a Diploma in computing from the Open University and a City and Guilds Certificate in Autocad, he took part in the initial e-learning pilot course in 'Co-ordinate reference systems for spatial information'.

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