The Geomatics Curriculum at the University of Cape Town: A Model for Developing Countries

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SUMMARY

The total annual global market in geomatics products and services is substantial. Paradoxically, many university level geomatics degree programmes that have evolved out of surveying degree programmes are battling to survive due to low student numbers. This in turn has often lead to a reduction in academic staff and a lack of resources to implement strategies to promote geomatics as a career encompassing a substantially broader range of commercial activities than a traditional surveying career.

The geomatics programme at the University of Cape Town has an academic staff cohort of five people. The undergraduate degree programme has been under constant development since 1996. Much of the development activity has revolved around building relationships with other departments and faculties in cognate disciplines within the University to allow students to concentrate on core electives in a career stream outside of surveying. Students receive a foundation in surveying and other geomatics core subjects. Since 2002, engineering level degrees have been offered that allow students to complete streams in one of Surveying, Computer Science, Environmental and Geographic Science, or Geology. In the non-surveying streams, students complete a third year major or fourth year honours course in a department in the Science Faculty. Moreover a combined Geomatics and Planning undergraduate and masters degree programme is also offered from 2003. This has been achieved without increasing the number of Geomatics programme academic staff. This paper describes how this multi-streamed programme was established.

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1. INTRODUCTION

Geomatics is one of the fastest growing technology sectors of the last decade. Geomatics professionals provide software, hardware and value-added services that help address problems and opportunities in such areas as, the environment, land management and reform, development planning, infrastructure management, natural resource monitoring, sustainable development, coastal zone management and mapping and business geographics (Geomatics Canada 2002). The global market in geomatics related products and services is substantial. Yet, paradoxically, many geomatics education programmes are struggling to survive or retain an autonomous identity as insufficient high school leavers are attracted to the discipline.

Geomatics has grown out of the surveying discipline, and a substantial part of the theory and practice of geomatics is grounded in areas that have traditionally been the domain of the surveyor. Although there is arguably a greater demand for surveying related services than say twenty years ago, technological developments have greatly increased surveyors' productivity. Thus in many parts of the world, a university level programme in surveying alone is not viable. Fewer surveyors are needed to meet demand and lower levels of skills are required to perform measurements to acquire spatial data. This is no more apparent than in South Africa, where in the last decade, three of the five surveying degree programmes on offer have been discontinued. The remaining two departments at the Universities of Cape Town and Durban have been merged with other departments in their Universities.

The challenge in developing geomatics curricula has been to provide the skills and knowledge required for a graduate to be competent in one or more of a variety of different market segments. At the same time, although a graduate may never practise surveying, a foundation in mathematics, physics, computing, the science of measurement and an intuitive understanding of the structures and processes underlying the accuracy of spatial data should be core to a geomatics degree.

Tension arising out of the relevance of particular courses to a chosen career path is likely to be part of the culture of the student body in a modern geomatics undergraduate programme. One challenge is to provide a degree programme which continues to qualify surveyors for professional registration. At the same time a geomatics programme should be attractive to potential students who are not interested in a surveying career.

Considerable time and other resources have to be devoted to achieving a manageable balance between these conflicts. One way of addressing this is to offer a range of different courses in different streams in a particular programme. Programmes in developing countries are unlikely to have the manpower to do this. Some programmes in southern Africa have continued to focus on a traditional surveying degree, and still offer courses such as field astronomy. The

value of continuing to specify core courses such as field astronomy is questionable. An alternative route was followed at the University of Cape Town (UCT), where a gradual bottom up strategy to link the geomatics programme to relevant existing courses in other departments and faculties was implemented.

2. HISTORY OF GEOMATICS AT CAPE TOWN

Surveying was taught at the University of Cape Town as far back as 1878 and the degree programme was introduced in 1931. Pressure on the Department to attract sufficient numbers of students commenced in the late 1980's, and as a consequence the academic staff numbers were reduced from 7 to 5.

The first strategy to address this issue was the introduction of a postgraduate programme in GIS aimed at middle managers who had not had any formal education in the discipline. This programme was aimed at a niche market, and it proved to be very popular. It ran for 5 years, until it was discontinued in 1998, by which time a substantial portion of the technical content in the postgraduate programme had been included in the BSc(Survey) undergraduate programme.

What this postgraduate programme helped establish was an understanding of the geomatics market, the disciplines involved, and the various niches that could be targeted by the undergraduate programme. In addition, strategic management and management of change in designing and implementing GIS had formed a large component of the course work. These subjects proved to be particularly relevant when the BSc(Geomatics) programme was developed in 1998.

3. DEVELOPMENT OF THE UNDERGRADUATE GEOMATICS PROGRAMME

The Geomatics Department has been located in the Faculty of Engineering since its creation in the 1940's. An early strategy was to attempt to attract students from the Science Faculty to the GIS and remote sensing courses offered as part of the Geomatics programme. Specifically, Computer Science, Environmental and Geographic Science (EGS), Oceanography and, to a lesser extent, Geology students were targeted. The courses included content which was not offered in GIS courses in the Science Faculty. This included spatial data structures, software engineering and spatial data analysis.

To facilitate this, Geomatics programme courses were restructured so that they would have the equivalent number of lectures as a major course in the Science Faculty. Thus a full course comprised 120 hours of lectures and a half course 60 hours. And the Geomatics programme timetable was structured around the first and second year computer science and EGS timetables.

At the same time, geomatics programme students were encouraged to take core elective courses at second year level which would enhance their marketability. In this respect, Geomatics students were encouraged to complete courses in either Computer Science or EGS at the second year level over their four year degree programme. These courses are offered as

half or quarter modules, and it is possible to complete a second year course over two or three years. This was seen as an initial step for students to be able to complete two degrees, a BSc(Geomatics) and a BSc in the Science Faculty in five years. A similar concept had been implemented at the University of Melbourne.

The strategy of attempting to attract science students to particular courses in the Geomatics programme was unsuccessful. Although a few science students have taken GIS courses, there have not been enough for the Geomatics programme to be regarded as self sufficient.

4. THE GEOINFORMATICS STREAM

The intended link with the Science Faculty resulted in an unanticipated development. The strategy of encouraging Geomatics programme students to take science faculty subjects at the 2nd year level spawned a demand from some of these students to be able to complete a 3rd year major in their chosen elective in the Science Faculty. However, they also wanted to be able to register as professionals. This could only be done under the auspices of the South African Council of Professional and Technical Surveyors. In 2000, two students managed to complete majors in computer science and EGS respectively, but this was only after taking on a substantially increased workload.

Rather than tie students into a five-year programme, the feasibility of adjusting the Geomatics programme to cater for students who wish to pursue a career related to their core electives was explored. To address this, a stream in Geoinformatics was designed to run in parallel with a stream in Surveying. In the Geoinformatics stream, the specialised courses in surveying were substituted with credits in science faculty majors. Surveying stream courses that were excised from the Geoinformatics stream related to precise engineering surveying, advanced surveying instrumentation and techniques, hydrography, gyroscopy, physical geodesy and precise GPS surveying. Common core senior courses (3rd and 4th year) include subjects such as GIS, photogrammetry, coordinate systems, satellite navigation, least squares and remote sensing. Teaching methods in other courses such as cadastres and land law had to be changed so that there is an emphasis on spatial analysis and information law as well as content relevant to land law and land tenure administration.

An advantage of having structured the courses along the lines of science faculty majors was that the reorganisation of courses was relatively simple. Some half courses were merely split in two. For example, geoinformatics stream students only take a “quarter course” in surveying in their third year, which deals with the basics of satellite navigation and kinematic GPS surveys, as well as new techniques and integrated instrumentation for data acquisition.

The change process was managed by consultations with the Surveying profession, who fortunately were very supportive in promoting the changes and in adapting the various professional institutions to these changes. The South African Council of Professional and Technical Surveyors opened a registration category in Geoinformatics. Continual formal and informal consultations were held with students so that they could have input into the formulation and implementation of strategies to create the Geoinformatics stream. The first students from this stream will graduate in 2003.

5. PLANNING STREAM

Restructuring of the University in 2000 resulted in a new Faculty of Engineering and the Built Environment (EBE). This included the various engineering departments plus Architecture, Planning and Construction Economics. In 2002, the Department of Geomatics was incorporated into the School of Architecture, Planning and Geomatics in the EBE Faculty. A combined planning and geomatics programme had already reached the final stages of design, motivated largely by the large amount of overlap in the business activities of land surveyors and planners. Also a number of planners are becoming involved in the spatial information industry without having any formal education in the discipline.

The Planning programme offers a two year professional masters programme, after which students are awarded a Master of City and Regional Planning (MCRP) degree. Students of the Planning stream in the Geomatics programme share the same curriculum as students in the Surveying stream for the first three years. By merging aspects of the fourth year BSc(Geomatics) programme with the first year of the Planning masters programme, it was possible to award a student a BSc(Geomatics) after four years of study and a MCRP after their fifth year. This programme is being offered for the first time in 2003.

Table 1 Curriculum Outline

Year	Surveying	Geoinformatics	Planning
I	Computer Science ½, Mathematics I, Physics I, Geomatics I, Electives	Computer Science ½, Mathematics I, Physics I, Geomatics I, Core Elective (e.g. Computer Science, Environmental and Geographic Science or Geology)	Computer Science ½, Mathematics I, Physics I, Geomatics I, Electives
II	Mathematics 280, Professional Communication, Surveying I, Geomatics II, GIS I, GIS Project, Surveying Field Project, electives	Mathematics 280, Professional Communication, Surveying I, Geomatics II, GIS I, GIS Project, Surveying Field Project, Core elective	Mathematics 280, Professional Communication, Surveying I, Geomatics II, GIS I, GIS Project, Surveying Field Project, electives
III	GIS II, Geomatics III, Numerical Methods, Surveying II & III, Land Law & Tenure, Cadastral/ Registration Projects, Control Survey Field Project, electives	GIS II, Geomatics III, Numerical Methods, Surveying II, Land Law & Tenure, Cadastral/ Registration Projects, Spatial Analysis Projects, Core elective	GIS II, Geomatics III, Numerical Methods, Surveying II & III, Land Law & Tenure, Cadastral/ Registration Projects, Control Survey Field Project, electives
IV	Industrial Management, Land Management and Geomatics Practice, Geodesy, Remote Sensing, Precise Engineering Surveying, Land Use Planning and Township Design, Geomatics Project, Electives	Land Management and Geomatics Practice, Remote Sensing, Land Use Planning and Township Design, Geomatics Project, Core elective	Remote Sensing, Geomatics Project, Planning Theory and Practice, Urban Systems, Aspects of City Design, Natural Systems 1, Urban Development Processes, Planning and Governmental Systems, Regulatory and Legal Framework, Planning Project
V			MCRP courses

Table 2 shows the profile of the Department in 2003. What has been encouraging is that first year student numbers have risen significantly from 2002. This occurred in spite of a low-key promotional effort due to the large amount of restructuring that took place.

Table 2 Breakdown of Student Numbers in Geomatics Streams

2003	**Not-Streamed**	**Surveying**	**Geoinformatics**			**Planning**
Years:			**Comp Sci**	**Envir**	**Geology**	
1	19					
2	11					
3		6	1	3	0	0
4		5	1	1	0	0

6. LESSONS FROM THE CAPE TOWN EXPERIENCE

The redesign of a programme in order to embrace new technologies, prepare graduates for new market segments, and to introduce greater flexibility through new streaming options, needs to be accompanied by an aggressive promotional campaign if it is to be successful in attracting students. It has been observed that the direct selling approach is the most successful with face-to-face contact between staff members and potential students yielding the greatest success (Whittal and Barry: 2001). This has resource implications:

- academic staff are heavily involved in promotional activities,
- it is important that academic staff are committed to taking on this additional promotional burden while still having to produce excellent teaching, research and professional service,
- there are significant costs involved in the production and dissemination of promotional material, as well as travel and accommodation for staff on promotion visits.

The geoinformatics and planning streams in the Geomatics programme at Cape Town are in their infancy. However, there are encouraging signs as the student intake for 2003 has grown. One advantage of offering major courses in science disciplines and a combined degree in planning is that the programme enjoys credibility from people within those disciplines. This credibility is important when marketing the image of the programme. Instead of taking two years of a particular subject at university level, graduates have a third year major in an accredited science department. They can then apply this knowledge in a particular niche in the geomatics industry. This credibility can also be used to promote the degree to school leavers who have an interest in quantitative aspects of spatial information and spatial processes, but who are not keen on a career in surveying.

The Geoinformatics stream graduates geographers and environmental scientists with well-developed quantitative knowledge and skills. It graduates computer scientists and software engineers who can conceptualise spatial problems and who have a thorough understanding of spatial data and spatial processes. Likewise, geologists with a degree in Geomatics have expertise in GIS and spatial statistics, which they can apply to geological problems.

The programme has yet to attract sufficient students to be regarded as viable. However the bottom up planning and implementation process based on encouraging surveying students to take advanced level elective courses in cognate disciplines in the science faculty provides a model for similar situations where resources are limited. This is particularly relevant to geomatics programmes in developing countries where academic staff, support staff and physical resources are limited. It does require the cooperation of the different departments involved, especially in operational issues such as timetabling, and continual communication between departments is necessary for such a bottom up strategy to work. However, the experience at Cape Town has been positive to date. The inclusion of students with knowledge and skills in geomatics into classes in related disciplines such as geography is viewed as broadening the understanding other students in those classes.

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BIOGRAPHICAL DATA

Mike Barry recently moved to the Geomatics Engineering Department at the University of Calgary. Prior to that he was an Associate Professor in the Department of Geomatics at the University of Cape Town, where he was involved in the design and implementation of a postgraduate GIS programme and the undergraduate Bsc(Geomatics) curriculum over a period of 11 years. His research interests are in land tenure, analysing and managing change in applying cadastral systems and spatial data analysis.

Jenny Whittal is currently convenor of the Geomatics programme at the University of Cape Town where she teaches introductory and advanced surveying as well as cadastral surveying and registration. Her research interests are in land tenure, land taxation and cadastral systems. She is a former president of the Council of the Institute of Professional Land Surveyors and Geomaticians of the Western Cape and serves as the representative from the University to the Education Advisory Committee (EAC) of the South African Professional Land Surveyors and Technical Surveyors Organisation (PLATO).

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