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GEOMATICS ENGINEERING – A TRADITIONAL DISCIPLINE TRANSFORMED IN AN INFORMATION TECHNOLOGY ERA

by

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Abstract

The last decade or so has seen the transformation of the Department of Geomatics at the University of Melbourne from a 'traditional' surveying department into one actively concerned with designing, building and managing the spatial component of the natural and built environments.

This paper will present an overview of the Geomatics Engineering program at The University of Melbourne, highlighting the fact that although a firm foundation in the basic sciences is maintained the program has become increasingly aligned with information technology and information systems. Geomatics Engineers now play an increased role in the creation of the data infrastructure that underpins much of the development and economic stability of the information marketplace.

Introduction

Over the last decade the Department of Geomatics at the University of Melbourne has been transformed from a traditional surveying engineering program to one concerned with "designing, building and managing the spatial dimension of our natural and built environment". Increasingly Geomatics are playing a central role in designing, building and managing the spatial information systems underpinning a modern society. The discipline builds on a strong measurement science base which is closely linked to its traditional land administration focus. The discipline has built on this strategic advantage to focus increasingly on the science and management of spatial information.

The paper will describe the Geomatics Engineering program within the Faculty of Engineering at the University of Melbourne (it is one of the six engineering departments in the Faculty). While the program still has a firm foundation in the basic sciences, it has become increasingly aligned with information technology and information systems. In simple terms it is concerned with the spatial component of IT and information systems. As all countries develop an information

marketplace, Geomatics are playing an increasing role in developing the spatial data infrastructures which supports that marketplace.

While many graduates move into the growing area of geographic information systems, the Department continues to have an important role in educating Geomatics to enter the traditional construction, land development and surveying areas where their skills in measurement science continue to be in demand. Graduates from the course are eligible to become both Chartered Professional Engineers as well as Licensed Professional Land Surveyors.

The paper describes how the Department of Geomatics at the University of Melbourne has managed this transition. In particular it describes the educational vision the Department has for Geomatics Engineering professionals in the future.

Needs of Society in Ten Years' Time

In re-engineering academic programs it is important to understand what sort of society graduates will be operating within ten years or so in the future. It is then important to focus on the needs of such society regarding the specific discipline area. It is only by going through such a process that engineering degrees can retain their relevancy and can be assured of being appropriate to the needs of the communities which they will serve in the future.

We believe that the trends we are now seeing in society will accelerate in the next ten years. We believe we will be living in a virtual world where the natural and built environment will be modeled by computer and a vast majority of the services we use will be available 'on line' through a range of media. We will be a very mobile society where communication technologies will allow us to communicate with each other from any location in the world at reasonable cost.

These trends in information technology and communications will make the concept of globalisation and the 'Global Village' a reality for all the members of society.

At the same time based on the trend of the 90s there will be an increasing emphasis on environmental and social imperatives which will temper, but certainly not replace, the economic imperative which in general drives development. Sustainable development will be increasingly the 'catch-call' which engineering programs will have to address.

While the 80s and 90s have seen a focus on the environment and now increasingly on social issues, we believe the next decade will see an increasing attention on the sustainability of cities which are now acknowledged as the 'engines' of economic growth.

The roles of government, the private sector and universities will continue to be clarified. However, the increasing role of universities to more directly serve the needs of government and in particular the private sector will be a priority. Governments will get smaller and the private sector will get larger. Privatisation will continue apace with smaller governments and there will be an increasing commitment to the development of risk management issues and quality culture.

What then are the needs of such a society from the perspective of a Geomatics Engineer? Simply:

- We will still need a place to live and work;
- We will still need to manage our cities with this being an increasing requirement;
- We will increasingly need to manage the land and marine environment;
- We will continue to build and increasingly need to maintain our physical infrastructure.

All these activities are central to the role of a Geomatics Engineer. As a result of the above, there will be increasing needs within society for the management of spatial information. Specifically society will require Geomatics Engineers to:

- Design, build and manage **spatial data infrastructures** such as the geodetic framework, the various base mapping systems, the new spatial data collection technologies such as high-resolution satellites and spatial data measuring systems such as the global positioning system.
- Society will increasingly need to design, build and manage the **spatial business systems** concerned with the natural and built environment which build on this spatial data infrastructure. This will include all the systems to manage utilities and services, geographic information systems, land administration systems and all the natural resource information systems including the marine environment.
- Society will continue to require Geomatics Engineers to design, build and manage the urban and rural habitation which has been a traditional function of survey engineers. This includes the development of residential, commercial and industrial land developments.
- Finally within this more complex society, Geomatics Engineers will increasingly be required to design and apply the measurement systems which will control much of the construction and management of the above development and management of the environment.

As can be concluded from the above, society will have an increasing requirement for an engineering profession which is responsible for **designing, building and managing the spatial dimension of our natural and built environment.**

Geomatics Engineering

The Department of Geomatics at the University of Melbourne has determined that the core of the engineering profession as required above is spatial information management. This is supported by three key areas or components, being measurement science, spatial information science, and land administration and land management. The synergy from this mix is what gives the Geomatics profession its strategic advantage as distinct from many other land-related professions such as architecture, town planning, landscape architecture and geography. Geomatics Engineering, as a profession, has a strong "design, build and manage" focus which it shares with the other engineering professions. The schematic structure of the Bachelor of Geomatics at the University of Melbourne is shown in Figure 1.

The core disciplines in the Bachelor of Geomatics at the University of Melbourne are:

- Geomatics Engineering (design, build and manage spatial information systems)
- Surveying, mapping and measurement science
- Spatial information systems
- Data visualisation, cartography and presentation graphics
- Satellite image analysis and interpretation
- Land administration and management

While Geomatics sits logically within the Faculty of Engineering, the discipline does draw on or is closely related to the disciplines of:

- Computer Science
- Information Science
- Civil Engineering
- Geography
- Environmental and Natural Resource Management
- Town and Regional Planning

As in all disciplines of the engineering profession, Geomatics Engineering is influenced by:

- Global trends

- Regional needs and trends (e.g. Asia)
- National needs and trends
- State needs and trends

as well as

- Ethical concerns
- Social responsibilities
- Independence

This year is the 50th anniversary of the teaching of Geomatics Engineering, formerly Surveying, at the University of Melbourne. Throughout that period the discipline has continued to evolve out of the surveying profession while maintaining a strong empathy with the engineering profession.

Undergraduate Objectives and Structure

The core business of Geomatics Engineering at the University of Melbourne at the undergraduate level is to provide support and/or services for:

- the wider community which is increasingly demanding spatial information skills;
- the broad spatial information industry increasingly; and
- a surveying profession which is currently re-engineering itself.

In order to meet the core business at the undergraduate level, the Bachelor of Geomatics includes:

- Fundamental sciences especially mathematics
- Computer science and information systems
- Spatial information science and management
- Measurement science
- Communication technologies
- Land management including environmental and social awareness skills
- Professional skills and engineering management

This figure shows the core subjects which are required for accreditation by the Institution of Engineers Australia, Institution of Surveyors Australia and the Licensed Land Surveyors Board of Victoria.

There is a range of subjects as indicated which may be replaced by approved electives within combined degree structures. The majority of undergraduates undertake a combined degree, however these combined degree programs are specifically designed to serve particular needs of society. The most popular structures are:

- Bachelor of Geomatics/Bachelor of Science (with the major in the Bachelor of Science in either Computer Science or Environmental Science)
- Bachelor of Geomatics/Bachelor of Arts (with the major in the Bachelor of Arts being in Geography or Environmental Studies)
- Bachelor of Geomatics/Bachelor of Information Systems
- Bachelor of Geomatics/Bachelor of Law

Commencing in 2000 it is planned to introduce a new combined degree program between the Bachelor of Geomatics and the Bachelor of Planning and Design (Property & Construction). This combined degree program will be aimed clearly at the land development industry.

In order to support the undergraduate teaching of Geomatics, the Department has access to the latest spatial information technologies including:

- Global Positioning Systems and integrated measuring systems
- Computer and Information Science
- Geographic, Land and Spatial Information Systems
- Remote Sensing and high resolution satellite imagery
- Communication technologies

There are currently over 200 undergraduate students enrolled in the various Bachelor of Geomatics programs at the University of Melbourne.

Postgraduate Education in Geomatics

The Department of Geomatics has an active postgraduate program which is primarily associated with the ongoing research within the Department. The Department offers the following postgraduate programs:

Graduate Diploma in Geographic Information Systems (course work) (normally 12 months)

Master of Geomatics Science (research) (normally 18 months)

Master of Applied Science (GIS) (research and/or course work) (normally 18 months)

Doctor of Philosophy (normally 3 years)

As well as research in the core disciplines described previously, Geomatics supports multi-disciplinary research and graduate studies with the following disciplines:

- Computer and Information Science
- Natural Resource and Environmental Management
- Civil Engineering and Applied Science
- Geography and Archaeology
- Public Administration
- Land Law and Management

The Department currently has about sixty graduate students with about twenty undertaking PhDs. All academic staff are involved in research and graduate supervision. The Department also has a full-time research staff supported by external grants which support in various ways the graduate students as well.

Where Do Geomatics Engineers Work?

Due to the wide demand for skills in spatial information management, Geomatics Engineers find work in a wide and diverse range of areas. The majority of students work in areas designing, building and managing geographic information systems in local government, utilities and other organisations. The next largest group works in the traditional surveying areas of land development, engineering surveying and mapping, while an increasing number are supporting natural resource and environmental management. Each year a number of students join the large accounting firms such as PricewaterhouseCoopers or join marketing firms where spatial information is becoming a critical component. The Department of Geomatics at the University of Melbourne also has a long standing reputation for producing graduates for the hydrographic surveying area with the result that each year a number from the Department enter this challenging and well-paid area.

In general all graduates have either been "head-hunted" or organised jobs prior to graduation or soon after. Graduates work in all states of Australia and many overseas countries with companies from the United States often visiting to interview students. In the last two years twelve graduates have been "head-hunted" to work in the United States.

Strategic Management for Geomatics Education

Managing the Department of Geomatics over the last couple of decades has been an exciting but at times difficult task. It is a discipline which has changed more than most engineering disciplines during this period.

One of the most difficult tasks for the Department has been to manage the change from the traditional focus on land surveying to a new focus and image on spatial information management. This move has been difficult especially for what is in reality a relatively small discipline, which has become increasingly broad as it assumes the responsibility for the spatial dimension of information technology.

The Department has had to undertake a comprehensive and long-term approach to marketing to ensure that school-leavers (and their parents) are fully aware of this rapidly changing and growing discipline. Too often, students and parents see the discipline as part of the "historic past" with a person standing behind a theodolite.

The Department of Geomatics is the smallest department within the Faculty of Engineering at the University of Melbourne even though it is one of the largest Departments of Geomatics in Australia and internationally. However this does create funding pressures where there is often a view that all departments should be of the same size and should be equally funded. The reality is that every department and discipline of Engineering has its own mission and serves a slightly different market, which results in departments of different sizes and complexities. The objective of the Department is to increase its intake of quality students from about 40 each year to about 60, thereby making the Department closer in size to other engineering departments. This should be achievable since the quality of entering students is consistently improving.

Having to manage rapid growth over the last ten years (where the undergraduate population has trebled in size, the postgraduate population has increased ten times, the academic staff have doubled and the research staff have increased five times) has required good management practices.

Due to the nature of Geomatics Engineering, the size of the Department and the type of students attracted to the course, the Department has retained a separate entry into Geomatics from the mainstream Engineering intake. The Department believes it would be unwise to consider changing this policy until such time as the intake into Geomatics Engineering was similar to the other five Engineering disciplines in the Faculty.

The Department is fully committed to a vigorous strategic planning process which includes business plans, marketing and quality assurance. The Department has an emphasis on service delivery and quality outcomes. Another major change in the administration over the last few years has been the development of a professional administration in the Department with the appointment this year of a senior Departmental Manager who will coordinate the administrative and technical service activities in the Department and will assist the Head of Department in his strategic management and coordination of academic staff. The appointment of senior administrators in engineering departments at the University of Melbourne has become increasingly common over the last few years.

UN/FIG International Workshop and International Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development

An example of the role that Geomatics Engineers are playing in designing appropriate structures to support the changing relationship of humankind to land internationally can be seen in the joint United Nations/International Federation of Surveyors (FIG) Global Workshop and Conference on Land Tenure and Cadastral Infrastructures to support sustainable development in the next millennium to be organised later this year by the Department. This initiative, which will involve five commissions from FIG, six United Nations organisations or affiliated institutions, The

Institution of Surveyors Australia, the Surveyor-General's Department of New South Wales, Land Victoria and the University of Melbourne, is a good example of the leadership that the profession is providing in re-engineering land administration systems. Such initiatives will ensure that the profession will be better able to understand its role in the future.

The joint UN/FIG initiative will include a number of activities. First there will be a workshop from 18 to 22 October 1999 held in Bathurst, New South Wales. Second, there will be an international conference where the results of that Workshop will be reported. This will run from 25 to 27 October 1999 in Melbourne. Both initiatives are jointly coordinated by the New South Wales Surveyor-General, Professor Don Grant and the author. At the same time the key land-related and professional commissions in the FIG will coordinate an FIG/UN Roundtable on Sustainable Development on 27 October 1999. The timing of the UN/FIG conference is such that participants can then move on to participate in the 40th Australian Surveyors Congress and the 6th Southeast Asian Survey Congress in Perth from 1 to 5 November 1999.

The objectives of the Bathurst Workshop are to explore humankind-land relationships for the next millennium to determine a broad vision and a set of guidelines for appropriate land tenure and cadastral infrastructures to support sustainable development and to prepare a UN/FIG Declaration on the topic. The Workshop will comprise about forty invited cadastral and land administration experts from twenty-five countries representing all continents. It will have a broad representation from the surveying, engineering, legal, planning, valuation, water policy, economics, environmental management, land administration and land title disciplines. It will represent government, private and academic sectors, as well as the International Federation of Surveyors and a number of United Nations agencies.

The Bathurst Declaration will recognise the trend for current formal land administration systems (for example, the Torrens System) to move their focus from simple ownership and land transfer to the management of a complex land information system comprising overlapping land rights, responsibilities and restrictions, representing both private and government interests (Figure 2).

The International Conference from 25 to 27 October 1999 in Melbourne to be opened by the Premier of Victoria will be the forum for the presentation of the keynote papers produced by the world experts involved in the Bathurst Workshop. The Conference will also present the Bathurst Declaration and will provide an opportunity for discussion as well as a plenary session. The Conference is also providing a day to review the operations and activities of Land Victoria. It is hoped to attract up to 400 national and international participants to the Conference. More information about the Conference can be obtained on the web page: <http://www.sli.unimelb.edu.au/UNConf99>.

This Conference will be an excellent opportunity for engineers and related professionals to get an insight into the increasingly complex land administration arrangements which will occur in the next millennium. Hopefully it will provide a framework which will assist the Geomatics Engineering profession to better plan its future.

Conclusion

Geomatics Engineering at the University of Melbourne celebrates its 50th anniversary this year. These fifty years have seen a dramatic change in the discipline from its traditional focus on Surveying, which was one of the core disciplines when the Faculty of Engineering was commenced in the mid 19th Century, to its current focus on serving society's needs for spatial information management. The change in the discipline has been dramatic and exciting. There is a great deal of demand for the graduates and very good support for sponsored-research in the Geomatics Engineering discipline. However, due to its small size the Department has a continuing need to promote its image and to explain the role of Geomatics Engineers.

What is certain is that there will be an increasing demand for Geomatics Engineers in the next

millennium and from other disciplines for spatial information science and management. So while the future of managing the Department of Geomatics will continue to be demanding, the future of the discipline is assured.

Acknowledgement

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**Figure 1- Schematic Structure of Geomatics, The University of Melbourne
Boundaries of:**



**Figure 2 - Schematic of overlapping rights, restrictions and responsibilities in a
modern multi-purpose cadastre**



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