SUMMARY

Land surveyors have always had a close affinity with the land which has been reflected in their education. There is however a dichotomy in many countries in the education of surveyors, between the emphasis placed on land management and land related issues and the science and technology of surveying. This paper examines how the Department of Surveying and Land Information at The University of Melbourne, Australia has addressed this issue.

1. INTRODUCTION

There is no simple model for educating land surveyors for the next century. Nobody can be certain that any educational model chosen is correct and appropriate. The world is changing and so are the professional disciplines, with surveying changing more than most. The information society is becoming a reality with many professions including surveying being caught up in this tide of change. As a consequence surveying is becoming increasingly dependent on expensive technology. Yet this is occurring in an economic environment where funding for education is being continually squeezed.
Countries like Australia have large foreign debts and balance of payments problems. The Government's attention is turned to export and increasing the wealth of the country while reducing the national debt. At the same time environmental issues are becoming a dominant focus which are reflected very much in policies for natural resource management. Cities are expanding with a corresponding reduction in rural populations, however the planning, management and operation of cities is changing considerably from a decade ago.

What then is the role of the surveyor in society in the future? This is the dilemma educators face for the 1990's without even considering the next century.

The reality is that it can take a decade from the time of a decision to undertake a major review of a course to the time that the change fully impacts on the community. Therefore the programs which educators design today will have to satisfy the needs of the 21st Century.

These uncertainties for and demands of the future, highlight and exacerbate the dichotomy in educating surveyors through achieving a balance between an emphasis on science and land matters, the major strength and tradition of the land surveyor. This dichotomy has been evident for most of this century but has become particularly important over the last couple of decades and will most certainly be a major issue in the future.

2. THE LAND MANAGEMENT AND MEASUREMENT SCIENCE DICHOTOMY

Surveying as a profession has always been closely tied to the land. In most countries the cadastral surveyor has been the dominant professional surveyor, certainly in numbers. Cadastral surveyors have been involved in the full range of activities in the development and administration of land. They have been traditionally involved in natural resource and environmental management, generally at a practical and pragmatic level. In many countries they are closely involved with urban and rural planning and land consolidation. A primary activity of all land surveyors is the support of land registration systems by undertaking and supporting necessary cadastral survey and mapping functions.

At the same time surveyors have been equally involved in the science of measurement in the broadest sense. This expertise has had application in the measurement and mapping of the earth's surface (geodesy, photogrammetry and mapping) and supporting the construction of engineering structures (engineering surveys), to name a few of the surveyors' major activities.

It is this bridging between the sciences, measurement science and a full understanding of spatial data, and land management and an appreciation for the environment, that makes the surveying discipline special and unique; this is the surveyors' competitive edge in the market place. It is this ability which will maintain the strength of the surveyor and the use of the surveyor to the broad community, in the decades ahead.

Educational institutions and professions around the world have taken different approaches in designing education programs for surveyors which address these needs. In general the European model makes surveyors specialize in either the land or measurement science area. North America (USA and Canada) has adopted a range of models ranging from specialist programs in geodesy to generalized programs. It appears the most acceptable and the most common model is to educate surveyors as "survey engineers". In this case however the professional must satisfy professional engineering standards which places some restriction on the flexibility of these surveying programs. Within this model surveying usually has a heavy measurement science bias however there are significant exceptions.

Australia has developed broad surveying programs which are usually administratively located in either engineering or science faculties. These programs have endeavoured to maintain a balance between measurement science and land however some programs have concentrated heavily on measurement science. The concentration on measurement science was influenced to a large degree by the growth of surveying programs in the 1950's and 1960's at a time when geodesy and national mapping programs
were at their peak. The last decade has seen a swing back towards a land focus with particular emphasis on the management of spatial data in the broadest sense and land information management. However the greatest emphasis in all programs is still and will most probably remain, measurement science and the management of spatial data. This is the underlying foundation on which the land related studies build.

The dichotomy between measurement science and land related studies becomes increasingly evident when attempting to design education programs for the next century. With the expansion of knowledge, individual courses in programs are continually under pressure as to their relevance and necessity, particularly from the science and computing areas. Land related studies are easy to reduce, while at the same time the environment, natural resource management and land management (especially in urban areas) are becoming increasingly important.

The difficulty arises in not knowing what are the requirements of the surveying profession or the broad needs of the community for surveying expertise in the year 2000. What is certain however is that the courses we teach now and during the next decade will influence to a large extent the role and skills of the profession in the future. If the educators don't "get it right", they will be responsible for undermining the future role of the surveying profession while at the same time not serving the communities needs.

3. CONSIDERATIONS IN DESIGNING A LAND SURVEYING DEGREE PROGRAM

Considering the changing world and the obvious uncertainties facing the surveying profession, it is important to maintain flexibility as well as a good foundation of basic principles in any surveying program. Surveying programs should provide a range of career opportunities in measurement science (obviously including the range of surveying areas such as engineering surveying, hydrographic surveying, geodetic surveying etc), computing, land and geographic information systems, land management and administration, cadastral surveying and mapping, land development, environmental management and natural resource management. Surveyors should not necessarily be the experts in all these areas but it is highly desirable that they have sufficient background, confidence and skills to move into these areas, in many cases with the addition of further studies.

In designing surveying programs for the future there are a few important considerations:

a. Measurement science as a discipline for surveyors is becoming more cohesive. Programs in the future will not be dominated by the three measurement science streams of geodesy, photogrammetry and plane surveying as separate entities to the same extent as in the past. Measurement science will however continue to be the major focus for surveyors but in a more cohesive form.

b. A balance must be struck between the sciences, measurement science and the management of spatial data, and land management and an understanding of the environment. This is essential in order to maintain the surveyors' competitive edge. (c) Technology has imposed necessary changes on surveying programs. For example the impact of Doppler satellite positioning and the Global Positioning System (GPS) have necessitated fundamental changes to surveying practices, the least not being a reduction and in some cases a disappearance of disciplines such as classical astronomy and some of the more classical surveying techniques. Analytical photogrammetric instruments have had a similar impact on photogrammetry as has electronic distance measurement (EDM) on measurement practices. Arguably the biggest technological impact has been to computing with the development of "field to office" systems becoming the norm. Overall one of the significant impacts of these technologies on surveying education is a reduction in the expertise required for traditional field surveying techniques. It is a concern to many in the profession to see non-surveyors using EDM and GPS.

c. The above changes and the need for flexibility has placed an increasing emphasis on basic principles and in particular the basic sciences. In particular there is an ever increasing requirement
for a greater amount of computer science in surveying programs.

d. While it is essential to design programs for the future, it is just as important that the present demands of the profession, industry and society are served. The requirements of Boards of Surveyors in Australia for example still need to be fully addressed albeit educators should be trying to influence the requirements of such boards to reflect future practices and to discard outdated requirements.

e. The surveyors of the future will have to be skilled in the management of spatial data in the broadest sense. They should be the professionals with the technical expertise to understand the operation and data requirements of land and geographic information systems.

f. Surveyors of the future should loose their "backwoodsman" image. They should become good managers and entrepreneurs in applying and marketing their skills.

4. THE UNIVERSITY OF MELBOURNE, AUSTRALIA - A CASE STUDY

The Department of Surveying and Land Information is located in the Faculty of Engineering at The University of Melbourne. Surveying was first taught in engineering with the appointment of the first surveying lecturer in 1862. The surveying degree was introduced in 1953.

In the early 1980's the Department decided to move its emphasis from the traditional geodesy, photogrammetry and plane surveying focus to a greater emphasis on land information studies and the management of spatial information in the broadest sense. At the graduate studies and research levels the Department wished to consolidate its activities in land information studies and in its existing area of excellence of high precision measurement, particularly in the photogrammetric area. It wanted to also expand its already considerable linkages with industry.

The Department developed a five year plan which it commenced in 1986 to move in this direction. A major component of this plan was the implementation of a new undergraduate program. In order to achieve this objective the Department did a review of professional and community needs, at that time and in the future, attempted to assess future job prospects for surveyors, attempted to determine the type of professional required to serve those needs and fill those jobs, determined the skills required to meet those needs and then attempted to design a surveying degree which would provide the necessary education.

Considering the new direction of the Department towards land information management it became evident that the profession, industry and community required two programs; a modified four year Bachelor of Surveying program and a five year program with a major emphasis on computer science leading to the award of two degrees, namely the Bachelor of Surveying and the Bachelor of Science (Computer Science). These two programs were introduced in 1989 with a combined intake of 45 students. One of the hardest tasks however in designing these two programs was to get the right balance between basic sciences, measurement science and land related studies.

In recognition of the new direction and activities in land information management, the Department included "Land Information" in its name in 1987, and was designated in 1988 as a Centre of Excellence by the international Institute of Land Information based in Washington DC. The primary focus of the Department however still is and will remain "surveying", as reflected in the name of the department and the degree.

5. THE UNDERGRADUATE PROGRAMS

The four year Bachelor of Surveying program was designed around the principles set out above. The program was split into six streams reflecting the six major thrusts of the program. The streams and the percentage of time allocated to each stream is set out below:

MATHEMATICS AND SCIENCE 20%

COMPUTER STUDIES 15%
EDUCATING LAND SURVEYORS FOR THE NEXT CENTURY - THE TECHNOLOGY AND LAND MANAGEMENT DICHOTOMY

SURVEYING SCIENCE 27%

LAND INFORMATION TECHNOLOGY 9%

LAND MANAGEMENT 16%

PROFESSIONAL STUDIES 13%

"Mathematics and science" comprises mathematics, physics, statistics and electronics.

"Computer studies" comprises basic computer science subjects, computer systems for surveyors and computer graphics subjects.

"Surveying Science" comprises plane, engineering and hydrographic surveying, geodesy, photogrammetry and geodetic surveying.

"Land information technology" comprises cartography, spatial analysis, remote sensing, and land and geographic information systems.

"Land management" comprises land law, cadastral surveying, land development, and aspects of land management, land administration, land economy, town planning, ecology, geology and environmental assessment.

"Professional studies" comprises written, verbal and graphic communication, introduction to engineering, economics, project planning and a minor thesis.

The combined surveying/computer science degree over five years has basically the same program as above with some reorganization, however it has a strong computer science stream through the first four years with Year 5 being mainly advanced computer science aimed at information technology and the management of spatial data.

It is recognized that both these programs are new and will need modification over the next few years. However the overall structure is now in place such that improvement is relatively easy. The Department believes the new programs achieve its objectives by providing a sound basis in the sciences, a good balance between surveying science and land management, provide flexibility and options for employment and serve the present needs of the surveying, mapping and land information industry.

6. THE GRADUATE PROGRAM

The undergraduate programs are designed to support the graduate program particularly through the good grounding in the basic sciences and computer science within a broad land management environment. The graduate program at the Masters and Doctorate levels are directed mainly at the two areas of land information systems and high precision measurement.

A new nine month graduate diploma in geographic information systems will be introduced in 1991 which will be jointly managed by a new Centre for Environmental and Geographic Information Systems, a joint initiative between the School of Environmental Planning and the Department of Surveying and Land Information. The graduate diploma will draw on the strengths of the above departments as well as other parts of the University in such areas as computer science, agriculture, forestry, geography and engineering.

An important objective of the graduate diploma is to bridge the gap between science and technology, and land related studies, as well as provide a relatively short coursework graduate program.

7. CONCLUSION
The surveying profession is undergoing major change due to the influence of the information society, technology, the environmental agenda, a difficult economic environment and the general pressure that many professions find themselves facing from government and society to justify their existence. Within this environment educators are finding it difficult to design appropriate programs such that the needs of the profession and society will be well served into the next century.

In designing programs, educators are finding it increasingly difficult to fit all the necessary subjects into a degree program. The traditional problem and dichotomy of maintaining an appropriate balance between measurement science and land studies becomes increasingly difficult. Since measurement science is the underlying foundation of the discipline it is usually the land studies which are under greatest pressure to be reduced. However to a large extent the strength and competitive edge of the surveying discipline comes from its ability to bridge between science and land matters.

Unfortunately there is no ideal model for a surveying degree however the experiences of the Department of Surveying and Land Information at The University of Melbourne, Australia suggest that it is important to maintain or increase emphasis on the basic sciences, increase emphasis on computer studies, move towards the management of spatial data in the broadest sense, maintain a strong program in the land related subjects, but most importantly maintain flexibility and a range of career options for the next generation of surveyors.

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