The Spatial Information Industry in Australia

……profile, education, training and skill demand

This report was commissioned by the Spatial Education Advisory Committee (SEAC) which is the lead organisation in the implementation of the national spatial education and skills formation strategy.

The report is the culmination of the first of seven initiatives to be undertaken by SEAC with financial or in kind support from:

- ANZLIC – the Spatial Information Council
- Australian Spatial Information Business Association
- Intergovernmental Committee on Surveying and Mapping
- Australian Spatial Information Education and Research Association
- Cooperative Research Centre for Spatial Information; and
- Spatial Sciences Institute

The views expressed in this report are those of the independent consultant, Ms Georgie Cane of Performance Growth Pty Ltd and do not necessarily reflect the views of SEAC or the sponsoring organisations. SEAC believes, however, that the Cane report provides a viable methodology for defining the scope and nature of the spatial information industry via the occupations of the people who make up the industry.

Any comments on this report or suggestions for further refinement of the industry definition can be directed to SEAC at the address below.

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Performance Growth

The Spatial Information Industry in Australia

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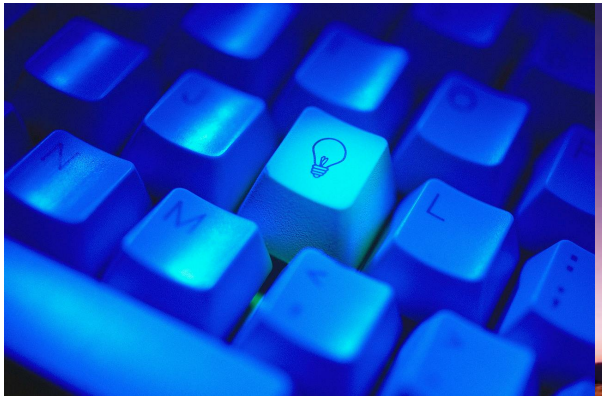
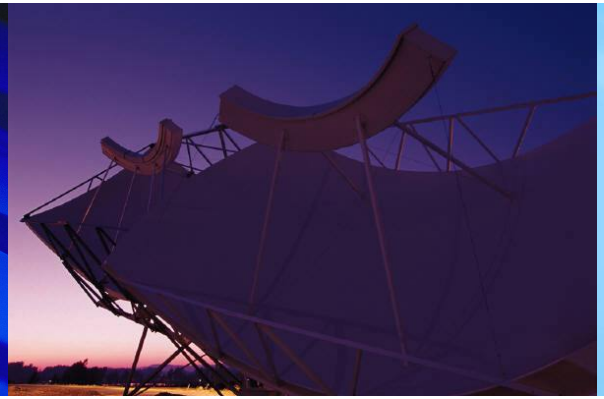
a report to the Spatial Education Advisory Committee

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Introduction

The Spatial Information industry is new, emerging, growing and it is a major player in the development of the nation's economy.

The industry is also emblematic of 21st century enterprise – global in its reach, cross sectoral in its impact and underpinned by the latest technologies.

The Spatial Information industry also shares much in common with a diverse range of other emerging industries such as those encompassing nanotechnologies, biotechnologies, online retailing or knowledge management. It is difficult to define these industries in traditional terms and they are subject to rapid growth and change. In part they are driven by emerging technologies that provide new ways of work and new methods of extending existing products and services. The emerging industries, however, are also driven by the use of new technologies to create entirely new opportunities and innovative products and services.

Defining the industry

The Spatial Information industry has grown from a range of traditional occupations such as surveying and cartography and is radically reforming with the advent of new technologies. The industry's reach, breadth and impact is captured in the following definition:

> **The spatial information industry acquires, integrates, manages, analyses, maps, distributes and uses geographic, temporal and spatial information and knowledge. The industry includes basic and applied research, technology development, education and applications to address the planning, decision-making and operational needs of people and organisations of all types.**

(drawn from the US Department of Labor's Employment and Training Administration project to define the geospatial industry : *Defining and communicating geospatial industry workforce demand Phase 1 Report*[2006].)

The Spatial Information industry brings sophisticated skills and technology to major challenges facing the country such as the management of the nation's water systems, the exploration of new mining operations and the effective management of land resources.

It is the recognition of the strategic importance of the industry that is driving governments around the world to invest in the skilling of the workforce and the development of policy that will ensure the viability and growth of the industry.

A wider focus than any one profession

Spatial Information has its roots in a number of traditional professions including land, engineering or mining surveying, photogrammetry and cartography but, through the introduction of new technologies and the expansion of the work performed, the contemporary spatial information professional may well be working in land management, water management and hydrography, town planning, remote sensing and GIS.

Spatial science practitioners may also have a strong level of identification with existing, and diverse, occupations.

> There is most definitely a geospatial industry and it includes all the practitioners, vendors, consultants, services providers, researchers, standards bodies, and industry organizations that enable and support the use of the technology for the betterment of society…"
>
> GITA past president, Dan Bowditch

The genesis of the industry in a broad set of professions is demonstrated by the scope of operation defined by the Spatial Sciences Institute (SSI) which describes its ambit as being the national body combining the professional disciplines of surveying, mapping, engineering & mining surveying, remote sensing & photogrammetry and spatial information. (http://www.spatialsciences.org.au/)

The Spatial Information industry, however, also extends beyond any individual profession or professions and achieves its status as an industry because it is dependent on the contributions of people in a wide range of occupations who work together to deliver the products, services, information and knowledge that define it. Although the technical roles and skills of the industry are central to its definition the Spatial Information industry also requires the contribution of managers, planners, designers, researchers and teachers.

Spatial information, in common with other emerging industries, can be seen as a 'matrix industry' cutting across and contributing to a series of more traditional industry and occupational groupings.

Indeed, the technologies and practices of spatial science are radically reforming many traditional occupations and, through the process of transformation, are creating new definitions of the work performed and raising significant education and training challenges.

Scope and Trends

The detailed sizing and profiling of the Spatial Information industry has been hampered by the ability to access useful publicly available data – once again a problem shared by other emerging and innovative industries.

Scoping the Industry Size

The traditional source of industry data is the Australian Bureau of Statistics which classifies data about businesses according to a nationally consistent classification -the Australian and NZ Standard Industry Classification (ANZIC). ANZSIC data does not allow a reliable analysis of the size and reach of the Spatial Information industry as the traditional industry coding does not capture the nature of this new industry. It must also be noted that, as yet, there has not been reliable and national primary research undertaken to assist with the definition of this economically and strategically important sector.

An analysis of occupations (defined by the ABS's classification of occupation -ASCO) provides a more useful approach to the sizing of the emerging Spatial Information industry although even this approach will 'under-count' the allied, paraprofessionals and management occupations that truly contribute to the formation of the industry.

An analysis of occupational, or ASCO, codes also informs a useful understanding of the range of education and training needs that may be required to help drive the industry forward as occupations can be defined by a set of tasks commonly undertaken by people. Understanding the tasks that are performed by people enables the identification of their skill development needs and also the identification of skill shortages. In short, education and training requirements can be closely specified for individual occupations. Over time, by building an understanding of the skill development shortages and needs of various occupational groups it will be possible to specify more closely the range of educational support required by, for example, surveyors who are a 'core' occupation within spatial science and also, for example, park rangers who are also engaged with the sector but who will require a differing set of skills to maximise their work performance.

The following occupations have been identified using ASCO classifications. The occupations identified are active creators, analysers, managers and users of spatial information. These occupations can be further extended if the occupations that use spatial information and technologies to improve and support their business processes are also included.

The occupations have been clustered into three tiers to reflect the centrality of spatial information technology and practices to their work.

Tier 1 (yellow) can be seen as core occupations whose primary focus is the creation, analysis, management or dissemination of spatial information. These are the occupations where practitioners most closely identify with the spatial science sector.

Tier 2 (green) represents occupations with high levels of engagement with spatial science information and technologies but lower and diminishing levels of creation and management of the information and lower levels of identification with the sector.

Tier 3 (orange) represents occupations within the IT industry many of whom will have a role to play in the development and support of spatial information systems as well as their use. It is, however, not possible to determine the number of this workforce involved within the industry without further primary research. Similarly, there are many other workers in a range of industries where the management and use of spatial information can and does play a significant role in reshaping work practises and improving productivity. This workforce is also diverse and the exact level of engagement of the workforce with spatial information is also unknown without further research. This 'silent' workforce within the Spatial Information industry should, however, not be forgotten and includes:

- Master Fishers
- Marine Transport Professionals
- Telecommunications Network Planner
- Fleet Managers
- Transport Company Managers
- Outdoor Adventure Instructors
- Trekking Guides
- Emergency Service Workers
- Fire Fighters

- Radio Despatchers
- Train Controllers

It should also be noted that this categorisation and scoping of the sector has been undertaken with significant expert industry input and following desk research. The committee managing this project would, however, welcome the opportunity to refine the analysis through the conduct of primary research.

Occupational scoping of the Spatial Information Industry

	ASCO Code	Occupation
Tier 1 Core Spatial Occupations	212311	Cartographer
	212313	Surveyor
	312115	Surveying and Cartographic Associate
Major component of the spatial information industry	991411	Survey Hand
	252311	Urban and Regional Planner
Creators, managers and users of spatial information	211479	Environmental and Agricultural Science Professionals, nec
High levels of spatial information skills required	211411	Environmental Research Scientist
	211413	Forester
High levels of engagement and identification with the sector	211211	Geologist
	211213	Geophysicist
	211913	Meteorologist
	211417	Soil Scientist

Tier 2 Occupations	211421	Agricultural Adviser
	212913	Agricultural Engineer
	211419	Agricultural Scientist
Medium to High levels of spatial information skills required	311217	Agricultural Technical Officer
	212111	Architect
	211313	Botanist
Medium levels of engagement and identification with the sector	212411	Civil Engineer
	312211	Civil Engineering Associate
	212811	Civil Engineering Technologist
Spatial information reshaping their work	311213	Earth Science Technical Officer
	129917	Environment, Parks and Land Care Manager
	211915	Extractive Metallurgist
	229919	Intelligence Officer
	229513	Land Economist
	212113	Landscape Architect
	211319	Marine Biologist
	212711	Mining Engineer (excluding Petroleum)
	211415	Park Ranger
	229511	Valuer
Tier 3 Occupations	223117	Applications and Analyst Programmer
	223179	Computing Professionals, nec
Containing a proportion of the IT workforce* who are engaged with the creation and support of systems for the spatial information industry and users of the data	329411	Computing Support Technician
	122411	Information Technology Manager
	223115	Software Designer
	223113	Systems Designer
	223119	Systems Programmer

* further primary research required to disaggregate the data and define the proportion of the workforce involved in spatial information.

The Spatial Information industry (at the time of the 2001 Census of Population and Housing) is large and diverse with the central workforce in Tier 1 and Tier 2 occupations numbering more than 92,000 workers. Data from the 2006 census will be available in late 2007.

Given that there are an additional 147,000 workers in Tier 3, many of whom are engaged in the industry, coupled with many more in occupations who regularly use spatial information as part of their work, and who are not identified or counted in this report, it is likely that **the broader spatial information workforce numbers approximately 250,000**.

The employment breakdown for the central Tier 1 and Tier 2 workforce is shown below and clearly indicates the strong representation of surveyors, urban and regional planners, environmental science professionals, geologists and environmental research scientists:

OCCUPATIONS	Males Total	Females Total	Total Male & Female
TIER 1			
Cartographer	1145	395	1540
Surveyor	5913	285	6198
Surveying and Cartographic Associate	1235	316	1551
Survey Hand	1647	149	1796
Urban and Regional Planner	3458	1972	5430
Environmental and Agricultural Science Professionals, nec	3031	1759	4790
Environmental Research Scientist	1413	864	2277
Forester	1667	267	1934
Geologist	3384	688	4072
Geophysicist	856	127	983
Meteorologist	467	122	589
Soil Scientist	168	62	230
	24,384	7,006	31,390

from: Australian Bureau of Statistics, 2001 Census of Population and Housing

Tier 1 Occupations

- with strong representation from surveying, planning and environmental science – the traditional heart of the industry
- heavily male dominated with females comprising only 22.3% of the workforce

OCCUPATIONS	Males Total	Females Total	Total Male & Female
TIER 2			
Agricultural Adviser	1961	624	2585
Agricultural Engineer	176	3	179
Agricultural Scientist	2257	660	2917
Agricultural Technical Officer	1878	1194	3072
Architect	9008	2294	11302
Botanist	487	376	863
Civil Engineer	14356	972	15328
Civil Engineering Associate	3642	404	4046
Civil Engineering Technologist	30	-	30
Earth Science Technical Officer	1767	440	2207
Environment, Parks and Land Care Manager	1819	518	2337
Extractive Metallurgist	152	33	185
Intelligence Officer	742	431	1173
Land Economist	3911	832	4743
Landscape Architect	1029	728	1757
Marine Biologist	499	211	710
Mining Engineer (excluding Petroleum)	1763	129	1892
Park Ranger	1248	338	1586
Valuer	3632	515	4147
	50,357	10,702	61,059

from: Australian Bureau of Statistics, 2001 Census of Population and Housing

Tier 2 Occupations

- The high representation of engineers, agricultural and land management specialists reflects the major changes the new spatial information technologies have had on the work practises of these professions
- women comprise only 17.5% of the workforce

A 'Matrix' and National Industry

The Spatial Information industry supports and draws on people working in a range of occupations and across a diverse range of traditional industries. Just as professional accountants can be found working in almost every industry, occupations which create, manage, analyse and use spatial information can be found across the Australian workforce. As can be seen from an analysis of Tier 1 occupations against the industries in which they work the reach and impact of spatial information is wide:

Industry (ANZIC level 1)	
Property and Business	12,997
Government	7,455
Mines and Mining	3,469
Agriculture	1,940
Construction	947
Utilities	910
Manufacturing	688
Transport	566

from: Australian Bureau of Statistics, 2001 Census of Population and Housing

The relatively large percentage of spatial information practitioners employed in the Property and Business Services industry reflects the fact that, according to ABS coding, most private sector surveyors work in that industry. **Surveyors make up 23% of Tier 1 Spatial Information practitioners.** The industry analysis also shows however that **23% of spatial science practitioners work in government**. This means that the three tiers of government in Australia are major players in the spatial information industry.

Spatial Information workers are also strongly represented in all states and territories of Australia. There is the greatest concentration of Tier 1 workers in New South Wales (9,187), followed by Queensland (6,258), West Australia (5,884) and Victoria (5,427). It is likely that the relatively higher representation of spatial information workers in West Australia is driven by the mining boom.

Within the Tier 2 occupations, New South Wales also has the largest proportion of the workforce (19,874), followed by Victoria (13,801), Queensland (12,710), West Australian (7,239) and South Australia (3,918).

Age Profile

The Spatial Information industry is keenly aware of the pressures industry will face with the aging of its workforce.

There is strong evidence within surveying, for example, that the demand for services is increasing while the number of registered surveyors is decreasing. An examination of this occupation, which is central to the development of the Spatial

Information industry, shows that in New South Wales there has been a decline in the numbers of registered cadastral surveyors from more than 1500 in 1991/92 (albeit not all actively practicing) to approximately 980 in 2005 (Blanchfield and Elfick, 2006). There is little reason to believe that this experience is not mirrored across states and across occupations.

The Spatial Information industry is undoubtedly experiencing an aging of the workforce that is perhaps even more pronounced than other industries. The following table demonstrates that the central Tier 1 and Tier 2 occupational groups within the industry are at particular risk with approximately one quarter of the male workforce being over 50. It should also be noted that this analysis is based on data collected in the 2001 census and the anecdotally low levels of new entrants to the industry will have led to an even greater aging of the workforce and a disproportionate growth in the older cohort.

In contrast, the Tier 3 workforce which is dominated by information technology professionals has approximately 10% of the workforce over the age of 50.

Tier 1	**% males**	**% females**
Under 50	77.62	91.78
Over 50	22.38	8.21
Tier 2	**% males**	**% females**
Under 50	72.02	88.70
Over 50	27.98	11.30
Tier 3	**% males**	**% females**
Under 50	89.55	91.77
Over 50	10.45	8.23

from: Australian Bureau of Statistics, 2001 Census of Population and Housing

Skill Shortages and Skill Demand

The Spatial Information industry is experiencing the dual pressures of an aging workforce and an explosive demand for new skills across a broad base of the Australian workforce. There is, and there will continue to be, demand for skilled professionals working across the field of spatial information. It is commonly understood within the industry that skill shortages are a significant factor that will affect both industry growth and performance.

'Skill shortages', across the economy, are receiving close attention in the media and the community more generally. Often this attention is focussed on the seemingly perennial skill shortages within the traditional trades or in specific occupations such as nurses, hairdressers or chefs. Other shortages are driven by low general levels of unemployment colliding with geographical areas of the country experiencing economic boom times – leading to recruitment difficulties.

Still other forms of 'skill shortages' are a result of 'skill gaps' or deficiencies in the skills of existing workers. Finally, skill shortages may be the result of employers being unable to recruit staff as a result of inherent problems with the industry or enterprises including work conditions, barriers to entry, the level of remuneration, unattractive work hours or the perceived image of the industry.

It is important for an industry to understand the characteristics affecting supply and demand and the true nature of the skill shortage being experienced. These characteristics can be understood by answering the following questions:

- How extensive are the skill shortages – across regions, sectors and employers? Have the shortages persisted?
- Are the shortages for 'occupations' or particular skills within occupations?
- Has growth, or fluctuations, in demand contributed to skill shortages?
- What is the longer-term trend in supply (ie training output)?
- Is retention of skills within industries a cause of skill shortages? Why? Where are the workers taking their skills?
- Is the profile of the workforce showing long term and/or dramatic aging of the workforce?
- What causes skill shortages? What influences impact on particular industries?
- Is the industry or any particular occupation experiencing competition from alternately skilled and qualified workers? Is outsourcing an issue?

- Has technology fundamentally changed the demand for workers in the occupation or industry? Can industry be productive with a smaller number of workers?
- What other issues have emerged from skill shortage research?
- What are the main areas for action to address skill shortages?

(Based on, and extended from: Australian Government's SkillsInfo service - http://www.skillsinfo.gov.au/skills/SkillsIssues/UnderstandingSkillShortages/)

Real skill needs

The Department of Education, Science and Training conducted a study between July 2005 and February 2006 with the aim of gaining a better understanding of the current and future science, engineering and technology skill needs in the Spatial Information industry. The study of 33 organisations explores some of the questions listed above, however, further primary research is still required to flesh out and test the study's findings. The study found that:

- 70% had current vacancies in spatial science related occupations
- almost half of these were for engineering positions, 22% were for science related positions and 29% were for positions not categorised as either science or engineering
- 69% of the survey participants indicated that they had vacancies in spatial science related occupations and that these were 'difficult' to fill
- participants also noted that there is potential for current recruitment and retention problems to be aggravated by the anticipated growth in the spatial information industry unless the supply of qualified staff increases.
- approximately 36% of participant organisations listed conceptual/technical skills as the key attribute sought after in spatial science employees.

(*Industry Study Report – Spatial Information Skills*, draft, undated)

While further research is still required it must be recognised that:

- the very recent development of new technologies underpinning the Spatial Information industry is, by definition, driving the need for the growth of new skills within the existing workforce (eg surveyors, cartographers, town planners)
- the development of new technologies which increase the productivity of existing industries and enterprises has also created the opportunity for the new categories of worker with highly specific skill sets (eg spatial scientists, spatial system modellers, GIS analysts, GIS technicians)
- the workforce engaged across the Spatial Information industry can be found in all geographic regions with strong representation in the mining, planning, water and land management sectors - these include regions of strong economic growth and overall workforce shortages which also create challenges for recruitment
- many core occupations within the industry are facing long term challenges resulting from an aging of the workforce. The surveying profession, for example, has identified a long term trend leading to the reduction in numbers of surveyors in real terms and an aging workforce which is resulting in skill demand being unmet.

> Currently, we are in the midst of a geospatial labor market shortage that shows every sign of growing more acute in the years to come. The explosive growth in the utilization of geospatial tools and data in nearly every sector of the global economy has been driven by dramatic increases in the capabilities of our tools and in the increased availability of better spatial data. This growth has created a substantial demand for additional, highly qualified personnel in all areas of the geospatial industry
>
> Dr. Duane F. Marble, Castlereagh Enterprises, Inc.

There is also a strong recognition within Australia and overseas that while addressing the skill development needs of the spatial industry practitioner there is also a need for all young people to develop skills in the use of, in particular, Global Positioning System (GPS) technologies that are rapidly becoming widely available within the community. The US Geospatial Information & Technology Association (GITA) provides information regarding the spread and importance of GPS and other geospatial information technologies to all forms of enterprise. There is no reason to doubt that the same reach and value of the technology is to be found in Australia. GITA cites:

"Gas and electric utilities use it (geospatial applications) to model distribution networks, issue work orders, dispatch service crews, market to prospective customers and plan service expansions. Telecommunications companies find it invaluable as they seek a competitive edge in the management of outside plant facilities and in the marketing of long distance services. Government agencies rely on this technology to plan new land developments, determine tax valuations, manage public works networks, route emergency vehicles, analyze crime and accident patterns, manage transportation systems and study environmental issues. Private businesses use it to make strategic decisions about locating new outlets and facilities, targeting customers more effectively and determining the impact of new or potential competitors.

Approximately 70 to 80 percent of the information managed by business is somehow connected to a specific location—an address, street, intersection, or "xy" coordinate. Therefore, geospatial technology is finding its way into every corner of the business world. And, because the technology's uses are so widespread and diverse, the geospatial market is growing at an annual rate of almost 35 percent. The commercial subsection of this market is expanding at a phenomenal rate of 100 percent each year."

(http://www.gita.org/about-gita/geospatial.asp)

Education and Training

Currently, the Spatial Information industry is served by three national technical qualifications contained within the PRD01 Property Development and Management Training Package. A project to enhance and extend these qualifications will be completed and a new Training Package will be released during 2007 containing a:

- Certificate II in Spatial Information Services
- Certificate III in Spatial Information Services
- Certificate IV in Spatial Information Services
- Diploma of Spatial Information Services
- Advanced Diploma of Spatial Information Services

There are also Certificate IV and Diploma level qualifications to support surveying.

In addition to nationally developed qualifications within the Vocational Training and Education sector a plethora of higher education courses are also offered at all levels from Graduate Certificates to Masters and PhD programs (see appendix for current provision).

The growth in higher education provision in particular is indicative of growth in the industry with universities competing for candidates through the offering of a broad range of education choices. There is little evidence to date however that the proliferation of choices in higher education has led to an increase in the number of students entering and/or graduating from spatial information courses. Similarly, there is little known about the specific content of the courses, the targeting of the courses to demonstrable industry need and the acceptance of the qualifications by employers. This is not to say the courses are not valuable but that more information is needed to monitor, inform and guide the development of courses that are critical for the burgeoning industry's future success.

Desktop analysis of the higher education courses indicates that the courses have grown in response to emerging need and, while there is undoubted need and support for the courses, there is currently:

- little clarity about the expected audience for many courses, or pathways between qualifications that will support career progression
- significant variation in the level of course (degree, graduate certificate, masters) addressing apparently similar occupations and with content descriptions that often appear to be comparable
- no clear articulation between the offerings of the VTE sector and universities

Mapping Skills to Education & Training

The relatively recent, and ongoing, development of the industry has lead inevitably to a burgeoning of educational offerings to meet the demonstrable need for the upskilling of the existing workforce and initial training of new entrants to the workforce.

The Spatial Information industry is undergoing rapid change that, in turn, demands new knowledge and skills of the competent professional. A profile of young surveyors and the future of the surveying profession (McNamara, nd) identifies, for example, the need to recognise:

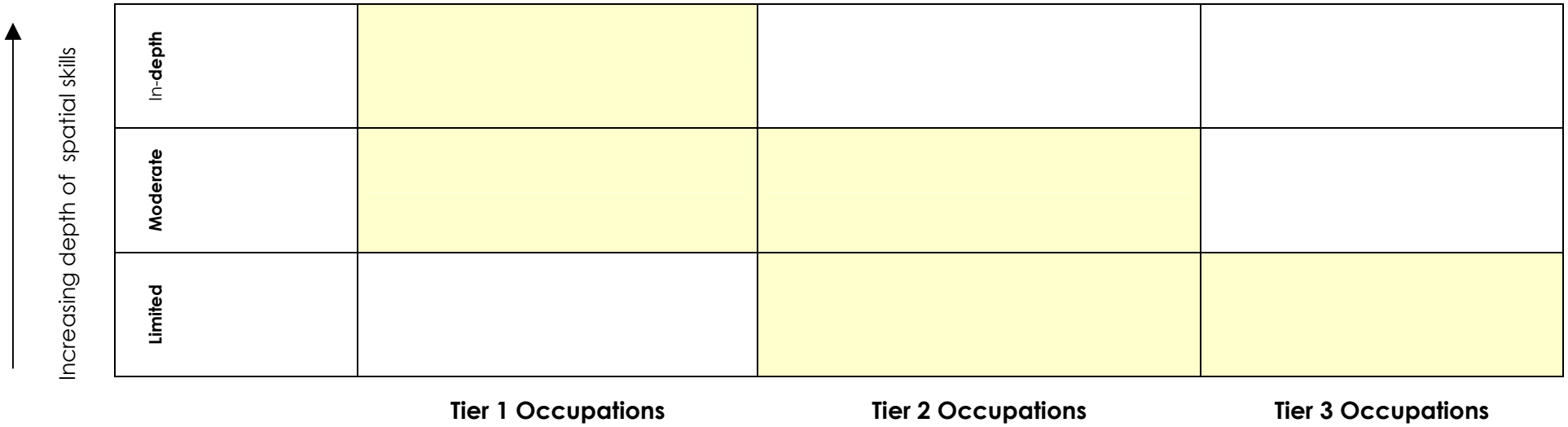
- the close alignment between the Spatial Information industry and the information technology and engineering disciplines
- the increasing awareness by the industry of the economic, legal, environmental and social consequences of their work, skills and services
- the growing partnerships that will continue to develop between the industry and government, the private sector and academia
- the growing role for the industry as managers and vendors of data as well as creators of spatial information.

The development and provision of education and training for the industry is also made more complex by the 'matrix' nature of the industry as well as by the demands for new knowledge and skills. That is, people require different levels, depth and breadth of training depending upon their level of involvement and attachment to the industry.

Tier 1, or core spatial science workers, strongly identify with the industry and require access to a full suite of qualifications across a range of discipline areas that will equip them to enter the industry and, over time, build their careers and gain higher level qualifications to support the growing depth and breadth of their roles and the resultant skill needs.

Tier 2 and 3 workers will have differing levels of education and training needs. Some candidates will require shorter 'top up' spatial science qualifications (such as Vocational Graduate Certificates or Graduate Certificates) to round out a base level qualification in another discipline in order to build spatial skills as the candidate's work changes. While workers in a range of industries may require access to one or two units or modules addressing spatial science skills as part of their 'home' industry qualification.

It is clear that more work needs to be undertaken in this area to clarify the education and training needs of the full spectrum of the workforce and to identify the relationship between the needs of those workers who work at the core of the Spatial Information industry and those who utilise some of the skills associated with the industry as part of their roles in other occupations or industries. The relationship between the tiers of occupations and the depth of skills can be broadly shown as:



- From industry specialists moving to lower level users of spatial skills
- Level of industry involvement and identification decreases

Articulation

In addition to more clearly articulating the education and training qualifications and programs that are required to support the wide range of workers within the Spatial Information industry it is also necessary to ensure that workers who embark on their careers can readily see the range of education and training pathways that are open to them as their careers progress and evolve.

Central to this objective is the need to make clear to the industry the articulation pathways that can occur between the vocational and university sectors. While there is clear understanding of the content, audience and purpose for the qualifications contained within the national Training Package there are opportunities to increase understanding of the content of higher education qualifications and for the industry to have a 'map' of the development opportunities available to the industry and the pathways between the various qualifications for the differing occupations within the industry. The following framework is indicative of how a range of practitioners in the various tiers that comprise the industry workforce may progress through qualifications in the VTE and Higher Education sectors. This is illustrative only and further work is required to map optimum pathways and develop understanding within (and outside) the industry about career development opportunities.

Framework for an industry qualifications and articulation map

	VTE					Higher Education				
	Certificate III	**Certificate IV**	**Diploma**	**Advanced Diploma**	**Vocational Grad. Cert/ Grad. Dip.**	**Graduate Certificate**	**Degree**	**Graduate Diploma**	**Masters**	**PhD/ Professional Doctorate**
Tier 1 Occupations **'Technician Surveyor'** Para professional		Entry level first qualification			'Top up' Vocational Graduate qualification to upskill in new technologies		Second qualification to support career move as a professional surveyor			
Tier 2 Occupations **'Mining Engineer'**					'Top up' Vocational Graduate Diploma to upskill in management	'Top up' Graduate Certificate to upskill in analysis of spatial information	Entry level first engineering qualification		Second high level qualification in initial discipline	
Tier 3 Occupations **'Software Designer'**				Entry level TAFE qualification in programming	Second qualification in 'software design'				Third qualification research-based Masters in enhancement of graphical analysis of spatial data	

Conclusions

The Spatial Information industry provides significant underpinning to the Australian economy. The importance and growth of the industry is also the key factor driving skill shortages as the industry works to retain, attract and upskill workers.

This new and evolving industry requires a workforce with a broad range of skills and knowledge. In order to meet these diverse skill needs education and training opportunities are required across all qualification levels and within both the vocational and higher education sectors.

In conducting this project it has become clear that although much is known about the industry and its skill demands there is still work to be undertaken to develop understanding of a complex, sophisticated and diverse industry.

It is recommended that, consideration be given to:

- conducting national primary research to profile and size the industry and address the gaps in information resulting from the inability of traditional ASCO and ANZSIC classifications to truly reflect the industry and its diverse workforce
- conducting national primary research to explore further the skill shortages and skill gaps being experienced within the industry
- conducting further work to clarify the skill development needs, currently and emerging, of the diverse workforce including the 'core' spatial science workforce and those who require spatial skills but who are attached to other industries
- conducting further work to explore the content of higher education courses and map possible career pathways and the associated articulation pathways for new entrants and experienced workers.

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Appendix – Vocational and higher educational courses

Training Provider	Course	AQF Level	Course Code
SOUTH AUSTRALIA			
TAFE S.A.- O'Hallaran Hill Campus			
Majors Rd	Spatial Data Systems	Diploma	12567SA
O'Hallaran Hill	Spatial Information Services	Certificate II	40476SA
South Australia 5158	Spatial Information Services	Advanced Diploma	PRD60301
	Spatial Information Services	Diploma	PRD50301
	Spatial Information Services	Certificate III	PRD30301
	Spatial Data Systems	Certificate IV	12566SA
Charles Sturt University			
School of Science and Technology	Bachelor of Science (Spatial Science)	Degree	
South Australia	GIS & Remote Sensing - Graduate Certificate	Graduate Certificate	
	Masters of GIS and Remote Sensing	Masters Degree	
	GIS & Remote Sensing Graduate Diploma	Graduate Diploma	
	Spatial Science PhD	Doctorate	
The University Of Adelaide			
GISCA	Graduate Certificate in Spatial Information Science	Graduate Certificate	
Level 8, Napier Building	Graduate Diploma in Spatial Information Science	Graduate Diploma	
S.A. 5005	Masters in Spatial Information Science	Masters	

NEW SOUTH WALES

TAFE NSW - Newcastle Campus

Locked Bag 45 Hunter Region Mail Centre NSW 2310	Spatial Information Services Spatial Information Services (GIS) Spatial Information Services (Surveying) Spatial Information Services (Survey Drafting)	Certificate III Diploma Diploma Diploma	6436 6437 9155 9079

National Environment Centre
TAFE NSW - Riverina Institute

	Spatial Information Services	Certificate III	6436
Ettanogah Rd Thurgoona NSW 2640	Spatial Information Services (GIS)	Diploma	6437

TAFE NSW - Sydney Institute
Ultimo Campus

Mary Ann St Ultimo NSW 2007	Spatial Information Services (GIS) Spatial Information Services (Surveying)	Diploma Diploma	6467 9155

Wollongong College
TAFE NSW - Illawarra Institute

Wollongong, NSW 2500	Spatial Information Services (Surveying)	Diploma	9155

University of Sydney
Division of Geography
School of Geosciences
Madsen Building, (F09)
University of Sydney
New South Wales 2006

Bachelor of GIS	Degree
Postgraduate	
Graduate Diploma of Science	Graduate Diploma
Graduate Diploma of Science (Environmental)	Graduate Diploma
Master of Science	Masters
Master of Science (Environmental Science)	Masters
Doctor of Philosophy	Phd

School of Civil Engineering **University College (New South Wales)** **Australian Defence Force** Northcott Drive CAMPBELL 2601 Australian Capital Territory	**Undergraduate** Bachelor of Engineering (Civil) **Postgraduate** Graduate Diploma in Engineering Master of Engineering Science Master of Engineering Doctor of Philosophy **Units also available for:** Geomatic Engineering, Surveying	 Degree Graduate Diploma Masters Masters Phd	
University of Newcastle **Department of Civil Engineering and Surveying**	Bachelor of Surveying	Degree	10374
University of Newcastle CALLAGHAN 2308 New South Wales	Bachelor of Engineering (Civil) / Surveying **Postgraduate** Master of Engineering Management	Degree Masters	10193 11277
University of Technology Sydney PO Box 123 Broadway NSW 2007	Bachelor of Property Economics	Degree	C10007v7
TAFE NSW - Riverina Campus National Environment Centre Ettamogah Rd Thurgoona NSW 2640	Certificate IV in Outdoor Recreation	Certificate IV	2647

University of NSW

School of Surveying & Spatial Information Systems
UNSW Sydney NSW 2052 Australia
Phone: + 61 2 9385 4182 (Int.)
Fax: + 61 2 9313 7493 (Int.)
Phone: (02) 9385 4182 (Australia)
Fax: (02) 9313 7493 (Australia)
Email:l.daras@unsw.edu.au

Bachelor of Engineering in Surveying and Spatial Information Systems	Degree	3741
Bachelor of Engineering in Surveying & SIS / Bachelor of Science in Computer Science	Double Degree	3746
Bachelor of Engineering in Surveying & SIS / Bachelor of Arts	Double Degree	3747
Bachelor of Engineering in Surveying & SIS / Bachelor of Commerce	Double Degree	3715
Master of Engineering Science (General)	Masters	8651
Master of Engineering Science (Spatial Information)	Masters	8652
Graduate Diploma (General)	Graduate Diploma	5492
Grad Dip (Spatial Information)	Graduate Diploma	5496

AUSTRALIAN CAPITAL TERRITORY

Canberra Institute of Technology

Department of Engineering & Resource Science
Faculty of Science & Technology

Bruce Campus
CANBERRA 2601

Diploma of Envirnomental Science	Diploma
Diploma of building	Diploma
Diploma of Civil Engineering	Diploma
Advanced Diploma of Civil Engineering	Advanced Diploma
Advanced Diploma of Spatial Information Services	Advanced Diploma

WESTERN AUSTRALIA

Central Metropolitan College of TAFE

Western Australian School of Mining, Engineering & Construction

Central Metropolitan College of TAFE
Leederville Campus
LEEDERVILLE 6007

Certificate II of Surveying (Survey Assistant)	Certificate II	5034
Certificate IV of Surveying and Cartography	Certificate IV	5036
Diploma of Spacial Information Services	Diploma	C519
Diploma of Engineering and Mine Surveying	Diploma	5037
Advanced Diploma of Engineering and Mine Surveying	Advanced Diploma	5038

Curtin University

Department of Spatial Sciences

Curtin University

PERTH 6845
Western Australia

Bachelor of Science (Cartography)	Degree	CUEMC
Bachelor of Science (Multimedia Cartography)	Degree	
Bachelor of Science (Cartography)(Honours)	Honours Degree	
Bachelor of Science (GIS)	Degree	
Bachelor of Science (GIS), Bachelor of Science (Applied Geology)	Degree	
Bachelor of Science (GIS), Bachelor of Social Science (Geography)	Degree	
Bachelor of Science (GIS), Bachelor of Commerce (Property)	Degree	
Bachelor of Science - Geophysics	Degree	

Bachelor of Science (GIS Honours)	Honours Degree
Bachelor of Science - Applied Geology	Degree
B of Science - Applied Geology/B or Science - Geophyscics	Degree
Bachelor of Surveying	Degree
Bachelor of Surveying, Bachelor of Commerce (Property)	Degree
Bachelor of Surveying, Bachelor of Commerce (Entrepreneurship)	Degree
Bachelor of Surveying (Honours)	Honours Degree
Bachelor of Science (Mine and Engineering Surveying)	Degree
Bachelor of Engineering - Mining Geology	Degree
Associate Degree in Mine Technology (Surveying)	Degree
Graduate Certificate in GIS	Graduate Cert
Graduate Diploma in GIS	Graduate Diploma
Postgraduate Diploma in GIS	Diploma
Graduate Diploma in Remote Sensing and Land Information	Graduate Diploma
Master of Science (GIS)	Masters
Postgraduate Diploma (Surveying and Mapping)	Postgraduate Diploma
Master of Science (Surveying and Mapping)	Masters
Doctor of Philosophy	Phd
GIS DISTANCE LEARNING - On-Line	
Graduate Diploma in GIS	Graduate Diploma
Graduate Certificate in GIS	Graduate Certificate

University of Western Australia

Perth, W.A	Bachelor of Computer Science/Bachelor of Science	Degree

	Bachelor of Comp Science/Bach of Sci Geophysics	Degree
	Bach of Enviro Design/Bach of Architecture	Degree
	Bachelor of Science	Degree
Murdoch University		
Perth, WA	Bachelor of Enginnering/Bachelor of Science	Degree
	Bachelor of Enrionmental Science	Degree

TASMANIA

University of Tasmania	Bachelor of Environmental Design	Degree	
Centre for Spatial Information Science (CenSIS)	Bachelor of Computing/Bachelor of Science	Degree	
University of Tasmania	Bachelor of Surveying and Spatial Sciences	Degree	058835M
HOBART 7001	Bachelor of Environmental Science	Degree	
		Graduate Diploma	001537C
	Postgraduate	Masters	00471B
	Graduate Diploma in Spatial Information Science with Honours	Graduate Diploma	
	Master Of Applied Science	Phd	
	Graduate Certificate in GIS	Graduate Cert	
	Graduate Diploma of Environmental Planning	Graduate Diploma	
	Graduate Diploma of Science	Graduate Diploma	
TAFE Tasmania	Diploma of Spatial Information Services	Diploma	PRD50301
TAFE Tasmania	Advanced Diploma of Spatial Information Services	Advanced Diploma	PRD60301
HOBART 7001	Diploma of Civil Engineering (Drafting)	Diploma	40399SA
	Diploma Computer Aided Drafting (Operations)	Diploma	69894
	Certificate IV in Conservation and Land Management	Certificate IV	

VICTORIA

RMIT University			
Department of Geomatics	Advanced Dip of Spatial Information Services	Advanced Diploma	
Royal Melbourne Iinstitute of Technology	Bachelor of Applied Science	Degree	
MELBOURNE 3001	Bachelor of Applied Science (Multimedia Cartography)	Degree	BP090
	Bachelor of Applied Science (Geomatics)	Degree	BP087
	Advanced Dip Spatial Information Services (Surveying, Mapping & GIS)	Advanced Diploma	PRD60301
	Bachelor of Applied Science - Surveying	Degree	
	Postgraduate		
	Master of Applied Science	Masters	DR031
	Graduate Certificate in Environment and Planning	Graduate Cert	
	Graduate Diploma of Environment and Planning	Graduate Diploma	
Email: landinfo@rmit.edu.au	Graduate Diploma of Geospatial Information	Graduate Diploma	
University of Melbourne			
Department of Geomatics	Bachelor of Geomatic Engineering	Degree	
Faculty of Engineering	Bachelor of Arts/Bachelor of Geomatics	Degree	
University of Melbourne	Bachelor of Laws/Bachelor of Geomatics	Degree	
PARKVILLE 3052	Bachelor of Geomatics/Bachelor of Science	Degree	
	Bachelor of Geomatics/Bachelor of Information Systems	Degree	
	Diploma of Geographic Information Systems	Diploma	
	Postgraduate		
	Master of Geomatics	Masters	
	Master of Geomatic Engineering	Masters	

	Master of Geographic Information Technology	Masters	
	Master of Geomatics Science	Masters	
	Master of Applied Science (GIS)	Masters	
	Master of Applied Science (GIS) by coursework	Masters	
	Graduate Diploma in Geomatics Engineering	Graduate Diploma	
	Graduate Diploma in Geographic Information Systems	Graduate Diploma	
	Graduate Certificate in Environment	Graduate Cert	
	Graduate Certificate in GIS	Graduate Cert	
	Diploma of Science	Diploma	
	Diploma of Science - Earth Science	Diploma	
Swinburne TAFE			
Healesville Campus	Certificate IV in Outdoor Recreation	Certificate IV	SR040203
Healesville Vic 37777			
Gordon Institute of TAFE			
	Diploma of Outdoor Recreation	Diploma	
Geelong Vic 3220			
University of Ballarat			
Ballarat, Victoria	Bachelor of Applied Science - Enviro Management	Degree	
	Bachelor of Applied Science - Geology	Degree	
Deakin University			
Barwon South, Victoria	Bachelor of Engineering/Information Technology	Degree	
	Graduate Certificate in Planning	Graduate Cert	
	Graduate Diploma of Planning	Graduate Diploma	

Monash University Melbourne, Vic	Bachelor of Environmental Science	Degree	
	Graduate Certificate in GIS	Graduate Certificate	
	Postgraduate Dip of GIS	Diploma	
Goulburn Overns TAFE Wangaratta & Shepparton	Certificate III in Spatial Information Services	Cert III	Traineeship
QUEENSLAND		t	
University of Queensland **Dept of Geographical Sciences and Planning**	Bachelor of Arts (BA)- Geography	Degree	2000
	Bachelor of Science - GIS	Degree	2030
	Bachelor of Arts - Honours	Honours Degree	2052
	Bachelor of Science	Degree	
	Bachelor of Science - Honours	Honours Degree	2031
	Bachelor of Agricultural Science	Degree	
	Bachelor of Environmental Science	Degree	
	Bachelor of Urban Development - Spatial Science	Degree	
	Graduate Certificate in GIS	Grad Cert	
	Graduate Certificate in Science	Grad Cert	
	Graduate Diploma of GIS	Grad Diploma	
	Graduate Diploma of Mineral Resources	Graduate Diploma	
	Master of Engineering	Phd	
Sunshine Coast TAFE			
	Certificate IV in Outdoor Recreation	Certificate IV	SRO40203
Nambour Qld 4560	Certificate III in Computer Aided Drafting	Certificate III	
Griffith University			

Gold Coast, Queensland	Bachelor of Environmental Planning	Degree
	Bachelor of Science	Degree
James Cook University		
Queensland	Bachelor of Environmental Science	Degree
	Bachelor of Planning	Degree
	Bachelor of Science	Degree
	Graduate Certificate in Science	Graduate Cert
	Master of Minerals Geoscience	Phd
University of Southern Queensland		
Darling Downs, Queensland	Bachelor of Spatial Science	Degree
	Bachelor of Spatial Science Technology	Degree
	Associate Degree in Spatial Science	Associate Degree
	Graduate Certificate in Geomatic Studies	Graduate Cert
	Graduate Diploma of Geomatic Studies	Graduate Diploma
	Master of Spatial Science	Masters
	Postgraduate - Diploma of Science	Postgraduate Diploma
	Doctor of Philosophy	PhD
Wide Bay Institute of TAFE		
Wide Bay, Queensland	Certificate III in Computer Aided Drafter	Certificate III
Tropical North Queensland TAFE		
North Queensland	Certificate III in Spatial Information Services	Certificate III
Queensland University of Technology		
Brisbane, Queensland	Graduate Certificate in Geographic Info Systems	Graduate Cert
	Graduate Certificate in Geomatics	Graduate Cert
	Graduate Diploma of GIS	Graduate Diploma