CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

This chapter will review literature to establish the need for a geomatics' education needs-based curriculum in Australia that would also open links between employers, higher education institutions and professional organisations. It is anticipated that such a curriculum model would focus on pre-professional registration undergraduate academic studies that would lead and support geomatics into the next century. A macro model, encompassing post graduate studies and post graduate level continuing professional development, was perceived as a less immediate critical need (refer to 1.3), and a research study of its' own, and did not form part of this study.

This literature review will concentrate on the relevant issues which affect curriculum development in geomatics' education, within Australian and overseas, in the areas of:

(a) The geomatics' industry.

(i) The structure. This section will examine professional organisational trends in Australia and overseas which reflected the change from traditional surveying and mapping mono-disciplinary areas into a single geomatics' structure. A definition of geomatics will be established.

(ii) Professional organisations' needs. An examination will be conducted of the current professional governing status, roles and industry linkages, educational influences, course accreditation, and continuing professional development.

(iii) Professional education and training. Previous studies and reviews into surveying and cartographic educational needs will be considered and outcomes correlated to current models and curriculum developments. Common subject material between geomatics' courses will be reviewed. Competency based education and its impact upon professional curriculum development will also be discussed.

(b) Open access education and curriculum developments.

This section will examine open access education, government and institutional policies and contemporary open access facilities structures and models.

(c) Curriculum development.

Curriculum development will be considered, and specific issues of societal needs and trends that would impact on the curriculum will be reviewed.

A synthesis of the contemporary problems and perceived needs will provide the construct for the remainder of the research activities. A summary of terms and definitions was compiled in Appendix 1. Abbreviations used are listed on pages x to xi.

2.2 Structure of the geomatics' industry.

The blurring of traditional work boundaries between the various surveying and mapping industries is being experienced in Australia and overseas. Technological changes and societal pressures have encouraged a multi-disciplinary approach to tasks and the assimilation of the new technologies and processes guilds into a single discipline. The focuses of this discipline are land management and spatially located geographic information management. This section will investigate these changes before defining this multi-disciplinary 'discipline' and its structure.

2.2.1 Defining geomatics.

Within the surveying and mapping industry there is a myriad of terms representing processes or systems, such as geographic, land and spatial information systems (refer to 2.4.5), which have a variety of definitions and nuances. These terms are often understood differently by individual stakeholders or overlap in their definitions. Individuals may refer to their discipline as cartography, remote sensing, land surveying, hydrographic surveying, engineering surveying, mapping, computer aided mapping, photogrammetry, land information systems (LIS), geographic information systems (GIS), and spatial information systems (SIS). However, many people in the industry work concurrently in several of these areas, albeit at varying levels of intensity over the range of activities, to the same ultimate ends.

A surveyor, who was generally involved in measuring or setting-out land related information and major engineering works, has access to economic data acquisition through non-metric photogrammetry technology, and has also moved from simple boundary or contour plans to desk-top geographic information mapping. Mapping practices have also become involved in similar desk-top graphics activities while expanding their land measurement activities though non-metric and digital photogrammetry, remote sensing technology data, global positioning systems activities and airborne scanners.

All spatial data should ultimately constitute a generic data base from which either hard copy or electronic thematic graphical display is generated, or various forms of raw or statistical data for other users. Generally though, the current structure for spatial information is fragmented into definitive discipline areas, reflecting varied educational backgrounds or opportunities, and small specialised and local operations, such as a cadastral, photogrammetry or mapping practice, reflecting a conservative short-term survival disposition or the need for specialisations. Amalgamating and integrating these data gathering facilities into a single entity should enhance the management of data gathering possibilities and usage efficiencies in both the short and long terms

Because of the client and economic pressures that have required a broadening of the previous discrete work domains, the blurring of artificial or traditional work practice boundaries between measurement and graphical information production, and societal demands for information, the surveying and mapping industries are now being viewed as a single land-related information entity that encompasses all of these professional activities (Anderson, 1992: 116; Bedard *et al.*, 1988: 111; Cameron & Williams, 1989: 828; Gagnon & Coleman, 1990: 377 and 380; Groot, 1991: 367; Hannigan, 1990a: 225; Higgins, 1992: 11 and Trinder, 1990: 1-2). In many aspects this is a reversal of the previous fragmentation of the surveying and mapping discipline into the numerous current discrete disciplines (refer to 1.2; Hannigan, 1990a: 209 and Williamson, 1981: 294). There is a general view that, by the year 2000, only a small market niche will remain for traditional measuring and mapping practices, and that should largely involve paraprofessional level practices (refer to 2.3.2). This will also be encouraged by a de-emphasising of the efforts of sustaining the attitude of a cadastral surveying dominance, through the changes and developments within the geomatics' industry and the rationalisation of the policies and practices concerning the cadastre.

The trend is for a labour-to-knowledge orientation, team work with ancillary disciplines and a proliferation and concentration on value-added products. A curriculum, accommodating these practices and principles for the new graduate at any educational level, should also be useful for the contemporary work-force to sustain and enhance industry efficiencies. Initially, before the modern geomatican is established, the geomatics development leaders should emerge from:

(i) surveyors, because of their specialist scientific and technical expertise in positioning, their land sensitive and land legal knowledge, and their affinity with land development;

(ii) cartographers, as they ... *are profoundly aware of the complexities of integrating spatially, thematically and temporally different data sets into a coherent whole* (Groot, 1991: 367); and

(iii) other professionals within photogrammetry, remote sensing, geographic information and computer systems specialists areas and the geography discipline Many of these specialists could be more suited to influencing the geomatics' industry structure as they would be expected to have a surveying or cartography background and, while possibly lacking relevant computer or respective detailed discipline-specific knowledge of the others, should have attributes defined in (i) and (ii) above.

To envelope these changes and delimit this single spatial information industry, the term **geomatics** has been selected in preference to the GIS or SIS terminologies which encompass less holistic structures and are considered tools in the process of providing specialised information (Refer to 2.4.5). Geomatics was considered as the best terminology to portray a contemporary and evolving unified philosophy of the various disciplines in the Canadian surveying and mapping industry (Bedard *et al.*, 1988: 110). Redefining the term surveyor, within the Australian context, was considered inappropriate for a variety of reasons (refer to 2.2.2, 2.3.3 and 2.4.5). Geomatics was also a common solution to all the various concepts, course variations and names postulated by higher education institutions, the professionals and professional bodies. Recently adopted course titles, such as Geomatics, Geoinfomatics, Geomatic Engineering and Land Information [in Australia and Canada] reinforce the uncertainties of the geomatics' industry. The 'name' geomatics implies modern technical knowledge, administrative, legal, management and human relations abilities:

> *Geomatics is a field of scientific and technical activities which, using a systematic approach, integrates all the means used to acquire and manage spatially referenced data as part of the process of producing and managing spatially based information.*
>
> (Gagnon & Coleman, 1990: 378)

A composite definition of geomatics, based on those previous theorists (Bedard *et al.*, 1988: 111; Gagnon & Coleman, 1990: 378; Gracie, 1989: 259; Groot, 1991: 366; McLaughlin *et al.*, 1991: 1 and Chen, 1995: 569), is that it **(geomatics) is an integrated and systematic approach of those disciplines (surveying, mapping, photogrammetry, remote sensing, and related areas) involved in the application of sensing, mensuration, storage, processing, portrayal, management and dissemination of spatially-referenced information to meet client demands.** With the evolution of this single professional approach, whether practising as a geomatican or in a particular specialisation of geomatics, a compatible, common and dynamic undergraduate curriculum structure, enveloping contemporary societal and political philosophies relating to information and education expectations, is required to ensure an integrated and managed industry. Such a curriculum philosophy would enjoy industrial support and be accessible to new students and those already within the geomatics' industry.

2.2.2 The merging of the geomatics' industry disciplines.

Neither cartography nor surveying is now *seen as a high profile profession* (Brunner *et al.*, 1993: 4; Granger, 1992: 8; Mueller, 1990: 14 and Little; 1993: 5 and Spent & Osborne, 1995:10) and both need to embrace wider skills and flexibility (Lodwick & Wright, 1993: 294). Public perception of the worth and lack of visible outcomes in geomatics is a major part of the limited profile of the profession. With regard to the practices of the field cadastral surveyors, the largest geomatics' group, Toms (1991: 18) considers that their pursuit for 'excellence' (an unnecessary level of accuracy) in boundary redefinition surveys is a waste of public money and time for the end results and the community function. He also believes that the traditional practices of this sector are rapidly passing to technicians (a view not always supported by others, eg. Survey Industry Review Commission, 1991:30-31); the cadastral surveyors' status is diminishing; and they are not coping with pressures from technological, economic and social change. Similar observations were made by Cook and Dawson (1992: 364). The lack of marketing the profession, the visible working ('road side') surveyor and absence of highly visible or dramatic outcomes (bridge or computer enhancement) have not assisted in creating a positive and exciting 'current technologists' professional profile. Comparable observations have been made throughout this study and, while acknowledging there is concern for protecting the public interests in land, it is felt an alternative to the current system could be fabricated. The Torrens Title system is itself not under discussion: the issue is who is capable of cadastral surveys and the relevant emphasis or importance of this activity compared with the wider geomatican Resource Management aspects. Hence, there is a need to reassess practices and adapt to changes to accommodate market-place relevance, enhance the industry status and ensure the new graduate is suitably educated and trained, i.e. *well-rounded and educated graduates are needed to be able to successfully adapt to changing work environments and applications* (ACSM, 1993: 8; Spent & Osborne, 1995:10 and Survey Industry Review Commission, 1991:30 & 32).

The similarities between surveying and cartography, although both disciplines still currently provide slightly different services, have increased with their progression into land and geographic information systems (Cameron & Williams, 1989: 828 and Gagnon & Coleman 1990: 380). Others perceive the more recent disciplines involved in spatial information as subsets of the established disciplines or as 'tools' that should be incorporated into traditional disciplines. In discussing the then current deliberations over a 'modernised' surveying definition to better reflect industry developments and practices, Hannigan (1990a: 210) reaffirmed this when he noted that there is a *trend away from specialist measurement terms towards a broader land information definition*. For example, the remote sensing arena is seen as an integral part of cartography (Dahlberg & Jensen, 1985: 177). Despite minor differences or the endeavours to establish new disciplines, specific calls are being made to combine the surveying and mapping professions (Divett & Mawn, 1992: 435). Higgins (1992: 8) also supports the concept by explaining that the previous cadastral surveying emphasis to support the Australian land titles system has shifted, with a subsequent blurring of discipline work boundaries, to a more general information gathering profession. Leis (1992: 472) also describes how the boundaries between specific surveying and mapping activities are analogous and these disciplines holistically now form a SIS industry.

This merging of discipline boundaries, or the same activities being performed by different disciplines, has been brought about by revolutionary changes in technology. Specific examples are contemporary technological tools with the focus on automation: computer and communications technology (Groot, 1991: 366 and McLaughlin, 1991: 2); its increased affordability (Anderson, 1992: 114); and increased need to analyse, manage, integrate and disseminate resultant information products to meet heightened societal demands for speed, quality and integrity of data (Anderson, 1992: 116 and Gagnon & Coleman, 1990: 377). It is also conceivable that the numeracy, the need to 'learn', and the costs associated with the rapid introduction and changes of these technologies, also inhibit the merging of disciplines, and may in fact encourage specialisation, within the 'cottage-industry' sectors of the geomatics' industry. However, one example where there is substantial technology merging, and hence discipline integration, is between GIS, GPS and remote sensing (Coops & Hill, 1991: 2; Dahlberg & Jensen, 1985: 173 and Higgins, 1992: 11). Specific advancements that have diminished employment of traditional methods and hands-on work (ACSM, 1993: 4; Anderson, 1992: 114; Gagnon & Coleman, 1990: 377; Groot, 1991: 367 and 472 and Taylor, 1992: 46) include:

(i) data collection technology (stereo-photogrammetry, digital cameras, GIS, GPS, video data integration, total survey stations with digital data storage, increased automation, etc.);

(ii) faster computer analysis;
(iii) larger storage and faster retrieval of data; and
(iv) rapid communication and graphical dissemination modes able to satisfy integrated support and management needs and thematic or niche market requirements.

With the rapid technological changes, the growth is in the management of land information and facilities management, away from the measuring sciences where a single operator can carry out work (eg. a subdivision) in a more efficient manner than in the past (Lodwick & Wright, 1993: 296). Rather than function in the traditional labour intensive service industry, surveying tasks will become routine or even perfunctory (Lodwick & Wright, 1993: 295). In the presentation of his paper, Lodwick surmised that traditional surveying practices are expected to only occupy a small market niche by the year 2000, an observation alluded to by (Coleman, 1988: 34 and Swiney & Sneddon, 1991: 1) when describing the expected information systems and mapping dominance at the turn of the century. There will, however, be a need for physical field work: this role can, and will, be performed by the paraprofessional whose development must be coordinated and integrated with that of the geomatics' professional.

Hence, there are calls for the 'discipline merged' professional who has a broader and client orientated approach to work practices underpinned by an integrated or geomatics' approach (Groot, 1991: 369 and McLaughlin & Nichols, 1989: 85). Anderson (1992: 114) describes this developing industry integrated approach as IMAP - Input, Management, Analysis and Presentation - of geographical information, providing quality geo-referenced generic spatial data products to a variety of clients. It is a top-to-bottom involvement spanning problem identification and solving and solution implementation, and flags a further movement from technical specialist to 'professional overseer' (ACSM, 1993: 7). This development can be partially observed in the more progressive and diverse (usually larger) surveying 'practices' in Australia. The smaller practices largely concentrate on their speciality, eg. cadastral surveying or a photogrammetric plotting service, as it provides a 'guaranteed income' and a 'familiar' skill for which they have been trained.

Due to the general movement in industry from the measuring sciences into the spatial information spheres (ACSM, 1993: 4; Bedard *et al.*, 1988: 105; McLaughlin 1991: 8 and Chen, 1995: 570) and the increasing similarities between the disciplines (highlighting the changes within the professions), there is a need to resolve the dichotomy between the measurement and information (or land management) sciences (ACSM, 1993: 19 and Leahy & Williamson: 91: 4). This is particularly so as traditional practices and divisions still exist, in particular, in the Australian and New Zealand cadastral surveying spheres (Bell & Punniard, 1991: 6). The conclusions from a survey of these two industries were that no change had occurred, because both were conservative and introspective and because of the employment of outmoded laws and technologies (Bell & Punniard, 1991: 6). This is only part of the reason, the other major factor is the land titling system laws that the industry must work within. Others have placed some blame for this situation on static curriculum development caused by academics who are perceived as locked into conventional discipline zones (Dahlberg & Jensen, 1988: 179). Similar problems exist with cartographic practitioners as, while they are often open to new technologies, they are closed to new concepts: one example is with acknowledging GIS as a data handling technique, not an independent discipline, and reacting accordingly (Taylor, 1992: 44). Hence, the future of the cartographic profession, or the 'cartographic geomatican', depends to an extent on a willingness to shed their inward-turning habits and come to terms with the social and political grounding of their own knowlecge (Taylor, 1992: 47). While education and training (refer to Appendix 1 definitions) is of vital importance to support a profession, in the first instance *The ... greatest challenge facing cartography does not lie in teaching or learning new techniques, but in creating a radical new concept for our discipline* (Taylor, 1985: 22). Given the changes that have occurred, this statement also applies to all the geomatics' sub-groups and is perceived to include a merging of these groups into a single holistic discipline.

Geomatics is, by its definition, being proffered by some in lieu of traditional disciplines such as surveying, cartography and photogrammetry. For example, ACSM (1993: 14), Anderson (1992: 114) and Blais (1991: 245) consider the divisions as levels of work, i.e. data collection, data manipulation, management and dissemination, within a single structure industry. While acknowledging the industrial changes that have occurred, Anderson (1991b: 159) believes a discipline division does still exist, and will probably remain so, and refers to cartographic geomatics and geodetic geomatics. However, Bedard *et al.* (1988: 111); Gagnon and Coleman (1990: 381) and Ormeling (1994: 4) simply advocate a geomatics' philosophy and the same integrated and systematic approach to curriculum. Gracie (1989: 261) concurs with this philosophy but describes various streaming to maintain some 'discipline specialities' within a geomatics' framework. Other approaches have endeavoured to maintain a multidisciplinary approach at undergraduate level with specialisation occurring during post graduate studies (Leahy & Williamson, 1991: 4). The discipline divisions concept still reflects a short term industry view and does not fully account for changed responsibilities and commitments with an integrated paraprofessional and professional geomatican structure. Specialisation, or endorsements to practice in specialised segments of the geomatics' profession, could be a commitment following a geomatics' education and included in a further training or continuing professional development arrangement.

Applying new technologies' methodologies and techniques are also discussed by Trinder (1990: 6) and the need for the profession to pursue them: the implication is that the curriculum needs to be more flexible and 'precede' the adaptation of the technologies through appropriate educational abilities. The adopting and adaptation to new technologies in the industry environment has not occurred with any vigour, and if the profession is to do so, then there needs to be considerable activity in the area of professional development. Also, to maintain any impetus for future professionals, the new curriculum should reflect the merging of the relevant disciplines and seek to educate in a way that permits graduates to confidently and competently cope with change in the geomatics' industry. Hence, at times of rapid change, academics should acknowledge openly the changes [processes, managerial needs, professional attitudes needs, etc.] that have occurred; place less emphasis on immediate practices; be more innovative; look to the future and develop theory to strengthen the knowledge base of the profession - a graduate is then better equipped to meet the challenge of rapid change (Johnson, 1993: 4).

2.2.3 Linkages within the geomatics' industry.

The establishment and maintenance of communication and resource linkages among employers, higher education institutions and professional organisations can only encourage a cohesive, integrated and co-operative approach to professional education: an approach that will benefit all contemporary and future stakeholders within the industry. The urgency for this to occur is highlighted by the new pressures from the current economic and employment situations, and the affects from a profession consistently only able to attract entrants (of which 50% come straight from school) at the lower entrance standards [compared to other professions] (Hannigan, 1993b: 3 and Trinder, 1993: 228). There are other holistic developments and commitments that foreshadow possible rapid and radical changes: these will require industry wide and sustainable links to realise and maximise on the perceived resultant changes. One such example of this, even though little is known about the policies, procedure, investments of gathering and administrating information and affects of information on decision making processes, has occurred with the Canadian and USA commitments of billions of dollars into the development of spatial information structure (McLaughlin, 1991: 5). In Australia, substantive linkage opportunities will most likely occur after rationalisations or amalgamation within the geomatics' industry organisations, intra state co-operation between the industrial sectors, and inter state (national) adaptations acknowledging a single industry structure and purpose.

Many overseas countries experience a high level of cooperation, which is both open and friendly, amongst the various geomatics' subcultures and associated government, private and academic organisations (Hockings, 1990: 2 and Task Force, 1991: 3). Problems do occur in a homogeneous industry devoid of a substantial linkage structure as;

> *...by having its own individual views and plans, the actions of each partner (individual firms, industry and professional associations, academic institutions, federal and provincial governments) are often uncoordinated and do not always lead to the synergy that we could expect from the association of resources.*
>
> (Task Force, 1991: 55)

Linkages within the geomatics' environment in Australia are not highly developed (Hocking, 1990: 3), but are considered valuable where they do occur or have succeeded. Examples include the establishment of AKCLIS, AISIST (Leis, 1992: 428 and Beletech, 1995: 60), the Graduate Diploma in Surveying Practice (Hannigan, 1992b: 425 and McGhie, 1992) and equipment sharing arrangements between a University and industry (e.g. University of Melbourne and Curtin University of Technology). However, arrangements have often partially lapsed through changes in circumstances, such as loss of interest in equipment when it becomes obsolete, restructuring in a participating organisation; communication difficulties with advisory bodies; or development of other human and physical resource agreements (Bretreger, 1991: 295). Similarly, reasons for the closure of short courses are various, but include a lack of interest (linkage) by professional organisation, industry, and academia; the lack of funds; and the non-replacement of key academic staff (Worth, 1992b: 4).

This means an increased need for academic and professional industrial links (via the various Boards and professional organisations) to align students to industrial needs and objectives and to assume a greater interest and responsibility in education, rather than concentrate on short-term economic gains (Hannigan, 1992b: 425). There have, however, been numerous calls for improved linkages among industry, academia, professional organisations and professionals, and from within the individual sectors, both in Australia and overseas (ACSM, 1993:13; AKCLIS, 1992: 2 and 6; Bottomley, 1991: 76; Dawkins, 1988:10-15; Divett & Mawn, 1992: 441; Hannigan, 1992b: 424; Keates, 1991: 78; Langley, 1985: 293; McEwen, 1990: 75; McLaughlin *et al.*, 1991:15-16 and Kennedy & Woolnough, 1994:166).

The main thrusts of these existing and past links revolve around resource sharing, technology transfer and human resource education and training management. Examples include changes to a course structure from a combined college of Technical and Further Education, profession, industry decision; resource support from the government and vendors; and a data sharing and usage arrangement with industry (Allaburton, 1990: 52). Another resource and staffing cooperative venture between the University of Queensland and Queensland University of Technology (then the Queensland Institute of Technology), with linkage arrangements with government and industry, formed AKCLIS; although subsequent valuable linkages have been virtually nullified or lost due to internal 'politics' rather than being an untenable arrangement (Bretreger, 1991: 295). A further example occurred when a non-profit organisation, involving the GIS industry and academia, was established to develop GIS curriculum and interactive self-learning GIS packages for industrial and academic use (Rogerson, 1990: 60). Other approaches have established commercial links with vendors, consultants, bureaus and agencies through student visits and the former supplying example projects and guest lecturers (Cassettari, 1991: 73). The University of Melbourne employs its professional linkages to raise the bulk of its external funding and achieves cross fertilisation through consultancies, staff exchanges and joint ventures (Hoogsteden & Williamson, 1991: 315). Recent government cost recovery and partial or full self funding policies will require the utilisation of mutually beneficial linkage arrangements to sustain viability, both within academia and the profession.

However, there is no evidence of widespread sustainable or continuous linkages: there is also little commercial research being done at Universities, an activity that supports curriculum development (through resource, technology and methodology transferring and discovery benefits), due to inadequate *cooperation between industries and the universities.* (Trinder, 1993: 283). Other authors note that greater communications amongst all the concerned parties are required to enhance and maintain linkages and to work positively towards improving curricula and developing a more holistic industry (Australian Educational Council Review Committee, 1991: 53-57; Clarsen, 1992: 13 and Groot, 1989: 2). The linkage and co-operation with other academic institutions and other disciplines within the institutions [already well established for 'service' subjects], e.g. engineering, applied science and geography, must also occur to maximise learning opportunities and resource usage through accessing syllabi and physical facilities not available, or offered for economic or expertise reasons, within a particular programme (Groot, 1991: 373 and McLaughlin *et al.*, 1991: 2). This will provide for the diverse geomatics' education requirements and a wide selection of later specialisations. Also, through the increased benefits of only needing to provide those subjects that are educationally 'economic' and not duplicated elsewhere, either in part or full, there is an opportunity for greater 'professional' syllabus diversity within a course or an enhanced ability for currency maintenance within existing syllabi. This would necessitate compatible curricula and an open learning structure (refer to 2.4.9).

A report by the Australian Educational Council Review Committee (1991: 112) hypothesised that quality (relevant and needed) education (including curriculum and research activities) will only occur with established linkage arrangements amongst government, education, industrial and professional groups. In addition to curriculum development and articulation arrangement linkages (refer to 2.4.9(b)), greater resource usage could develop by a linkage arrangement whereby the Technical and Further Education (TAFE) college sector facilities and materials are used for the first year of university discipline courses (Atkinson *et al.*, 1991: 21; Employment and Skills Formation Council, 1992: 47 and TAFE.TEQ, 1992: vii and 53) and paraprofessional training. A further example of this is occurring in the USA, where the first two years of a Land Surveying undergraduate course is able to be completed at other colleges with evening teaching as an option for part-time students (Greenfeld, 1991: 39). While such linkages would be between academic institutions, its acceptance, and hence the graduates acceptance, would require sanctioning by the professional organisations. Similar industry wide linkages, or specific consortium arrangements, have been used to develop curricula, either as a packaged short course commercial venture or for use in the traditional university course (Bedard *et al.*, 1988: 108; Leis, 1992: 479 and Rogerson, 1990: 60).

> *Systematic training programmes will be a much larger activity than at present, and will take over those training activities presently used to fill out education programmes. This will enable Universities to focus on education issues alone.*
>
> (Davies, 1991: 3)

There is a growing realisation and need for educating in the university environment and training in the industrial work environment (Brunner *et al.*, 1993: 6; Dawkins, 1988: 18 and Hannigan, 1992b: 425). This has started to occur to accommodate reducing financial resources, the occurrence of rapid technical changes and increased quantities of theoretical material to be studied. Training on-the-job, in a post graduation scheme or during a part time study programme, is becoming increasingly necessary and will require substantial and substantive industry-wide links (Allaburton, 1993: 52; Carter and Moynihan, 1988: 290; Dawkins, 1988: 95; Greenfeld, 1991: 39; Higher Education Council, 1990: 34; Pollard & Robinson, 1985: 370 and Tight, 1989: 5). Part of the linkage arrangement would occur with the 'practice industry' developing a systematic training structure and collaboratively, with the academic sector, testing for its relevance and educational delivery soundness (Davies, 1991: 6 and Rouch & DeLoach, 1994: 241). Such a scheme will also require university policy adjustments (refer to 2.4 9(c)).

Increased support and understanding between academia and industry, developed by more substantial linkages, is made necessary with the greater awareness that the curriculum should be more market driven (ACSQ, 1991: 1; Australian Educational Council Review Committee, 1991: xi; Mueller, 1990: 16 and Hanna, 1995: 560), or that *...todays courses are very much created in the market place* (Williamson *et al.*, 1993: 312). The latter statement can only be considered holistically as the geomatics' market-place generally consists of individual models of coherence between social and individual needs. Education and training must adapt and adopt but they working towards contemporary generic requirements and future needs. However, although universities have the responsibility for maintaining professional education standards, and not simply changing on a market-place demand and short term whims, market-place forces must be considered and include:

(i) societal demands for quality assurance, standards and professional self regulation and accountability;

(ii) a greater mobility in the workforce;

(iii) a workforce tending to retain employment due to economic and employment opportunity considerations, and hence seeking further training from within a workplace environment;

(iv) needs for usable rather than promotional purposes only credentialism (NBEET, 1992: 18);

(v) the focus on information as a prime commodity to support decision making management (Baker & McLaughlin, 1991: 2);

(vi) the economics that emphasise an individual products approach to provide for niche markets (Baker & McLaughlin, 1991: 7);

(vii) anticipated commercialisation and privatisation role changes between government and the private sector, similar to the leads set in Canada and the USA (Lodwick & Wright, 1993: 295);

(viii) government policies that are *exposing Australia to the rigours of the market place and thereby ensuring that decisions are based on efficiency* (Dupe, 1988:1 as quoted by Gerber, 1992: 2) or, specifically, a policy that *... is one of 'market enhancement', where education and training are seen as part of a micro-economic reform agenda, designed to facilitate and enable, rather than directly influence, the development of market opportunities* (NBEET, 1992: 19);

(ix) the micro-economic needs of keeping abreast of the *... rapidly increasing changes in technology in the surveying profession*" (Trinder, 1993: 286);

(x) the requirements of employers in providing client services; and

(xi) the Australian university model developments away from a full government sponsorship and traditional approach, towards a more combined commercial and societal-responsive and government semi-directed approach.

Although the qualification of a graduate is inexplicably linked with the professional bodies (Bretreger, 1993: 273 and Hannigan, 1990b: 282), accreditation from these bodies is often the main reason for an inflexible curriculum (Higher Education Council, 1990: 34). A collaborative linkage, such as conducting training or other open learning activity in industry, can be used to remove inflexibilities. This is achieved through a greater understanding of the needs and functions between the sectors and subsequent educational modifications, while maintaining workplace and professional body requirements.

Reduced funding to education by government is encouraging linkage development as the educational establishments become more reliant on industry and student contributions (ACSQ, 1991: 2). This situation has continued with the 1996 Australian government change. Other government pressures and incentives encouraging positive linkage, which can benefit all the groups involved, come from the greater commercialisation philosophy of government (Clarsen, 1992: 13), partnership involvement in research activities (Gracie, 1989: 262, Rhind *et al.*, 1991: 3 and Trinder, 1993: 289) and direct incentives such as (Grenfell & Finegan, 1991: 396):

(i) research and development grants (allowing a 120% cost tax deduction allowance);
(ii) the Training Guarantee Scheme (employers with a larger payroll must contribute 1.5% of that payroll to training); and
(iii) the Victorian Education Foundation (VEF) grants (a 0.1% of company payroll tax for specific industry education and training as an alternative to paying the that money into the government consolidated revenue).

Others authors, such as Anderson (1991b: 157) and Usher (1985: 302), extol the advantages to be gained, by academia, in resourcing existing and new courses through close industrial linkages. Some such linkages which have proven beneficial to all parties concerned [also discussed earlier under past linkages], do occur through staff exchanges, guest lecturers, data sharing, short courses, joint research projects, leasing, permanent loaning or donation arrangements, and consultancies (Cassettari, 1991: 73; Hoogsteden & Williamson, 1991: 315 and 317; Groot, 1991: 371 and 373; Williams, 1988: 554 and Fraser & Leahy, 1995: 5). Linkages that can provide flow-on benefits and encourage other linkage arrangements, although often not directly affecting undergraduate courses, are:

(i) the national teaching company scheme (a government, company, graduate and university arrangement with graduate sponsoring by the government and the company and project supervision by the university); and
(ii) the Australian Post graduate Research Awards (tax free financial support to a company supported postgraduate student).

While resource benefits are generally considered the most urgent and critical consideration, it is the transfer of knowledge and understanding between academia, government and the private sector that provide long-term benefits to the industry, to curriculum development and to curriculum acceptance. This is achieved through identifying and rationalising needs, problems, misunderstanding, expectations and limitations. Any increased linkage amongst academia, industry, professional organisations and government will also encourage more applicable research (Task Force, 1991: 71), a more current practice (at the leading edge), applicable and flexible curriculum and greater resource efficiency. This would likely result in a cohesiveness of the industrial components which will attract greater government support (Toms and Perel, 1990: 2). As education needs to be a cooperative economic venture between stakeholders, and not just a subsidised service (Groot 1991: 379), the development of a suitable dynamic curriculum fulfilling the needs of all stakeholders can only be sustained through the continuity of an established linkage philosophy.

2.3 Professional and statutory bodies.

Professional and statutory bodies have a significant importance to the cohesiveness of the industry they represent and to curriculum development. These organisations are the best instruments to provide a focus, support and an 'industry collective' direction: a single representative organisation would be even more effective.

2.3.1 Education and professional organisations.

The last twenty years has seen an accelerated evolutionary change in the surveying and mapping disciplines manifested from the developments in technology, science and societal expectations (Gagnon & Coleman, 1990: 377). To address the problems created by these changes, the Australian surveying and mapping professions are moving more closely to a single professional body (ACSQ, 1992: 1 and Dwyer, 1995: 97) and a need for a complimentary integrated educational model that sets tertiary courses' criteria, audits curricula, and provides for an identifiable career progression (ACSQ, 1992: 3). In providing an educational policy guideline based on the current industry and political situation, the Consulting Surveyors, Queensland, noted the following as having curriculum development implications (ACSQ, 1991: 2-4):

(i) Educational resources and student numbers are declining with funding for education moving from government to students and industry. However, the technician, paraprofessional and bridging courses [ceased in 1996 and replaced by other articulation structures] in Queensland [part of the Queensland education model] are satisfactory.

(ii) Inter campus communications are inadequate.

(iii) The Queensland University of Technology three year degree structure for the cartography or business/surveying option should remain and a fourth year used for post graduate studies (similar to the arrangement of the Queensland University of Technology Graduate Diploma in Surveying Practice). [A redesigned four year course commenced in 1994].

(iv) A distance education degree course must be offered (also refer to 2.4.9(c)). [This commenced at USQ in 1996].

(v) Industry should be providing more physical support for courses.

(vi) There is diminishing demand in undergraduate employment, but greater opportunities for post graduate qualified persons, particularly in the expanding SIS and land management sectors. [there is still a high demand for SIS graduates in 1996 and stabilised undergraduate employment opportunities].

In a similar way, a gathering of a broad cross-section of American employers, spanning all surveying and mapping disciplines, discussed the desirable attributes of potential employees. They noted a deficiency in educational guidelines within their umbrella organisations of American Congress of Surveying and Mapping (ACSM) and American Society Photogrammetry and Remote Sensing (ASPRS) (Carter & Moynihan, 1988: 285). Spatial information systems managers have also identified education and training needs as a major concern (McLaughlin, 1991: 9).

Canadian professional bodies are self regulatory, but each local authority individually licences surveyors to practice land (cadastral) surveying (McEwen, 1990: 68); a situation not dissimilar to Australia in that each State is responsible for cadastral surveyor registration and licensing. While there are some reciprocal arrangements between Canadian Provincial authorities [also between states and NZ in Australia], even experienced surveyors may be required to undertake extra education, practical training or other examination to satisfy a particular local authority (McEwen, 1990: 71). In Canada, the Canadian Council of Land Surveyors developed common standards and reciprocity agreements. The Geomatics Industry Association Of Canada (GIAC) (refer to 2.3.1), representing the commercial interests of the industry, fostered greater cooperation and coordination within a single national strategy that could develop a cost recovery policy and a fair share for participants (Task Force, 1991: 5). This was a genuine attempt to provide a future focus on value-added products and services, SIS networks, and spatial and environmental data base integration (Williamson *et al.*, 1993: 309): something found to be lacking in Australia (Cook & Dawson, 1992: 363). Such an organisation as the GIAC is able to respond to the concerns for a national strategy for human resource development in the whole Industry by having direct access to survey all of its sectors (Task Force, 1991: 13). As ... *many geomatics' practitioners are members of more than one* of the suite of Canadian professional organisations (Task Force, 1991: 19), a situation also prevailing in Australia, a single representative professional institution would appear logical in furthering the common professional and academic good of the industry. Other advantages include a single 'voice' to lobby government statutory authorities and a 'single' professional body with which the community can identify members as having professional status and for solving their problems.

Dahlberg and Jensen (1985: 177) described sections within the surveying and mapping industry as being in conflict and without direction or self definition, a situation that reflects on, or is reflected by, inappropriate curricula. The desirability of professional organisations having a role in curriculum development may also be in question. In responses to a questionnaire survey, only 29% of the University of New South Wales graduates were content with the Institution of Surveyors, Australia (ISA). The remainder were unhappy with the ISA or not members of their professional organisation, suggesting either an ISA neglect of members' needs or that it was not fully representing the needs of the industry (Williamson, 1981: 294). The surveying respondents were questioning the ISA's influence on curriculum development. Davies (1991: 5) believes there are considerable lost energies by the ISA in trying to convince the industry of their broad agenda, and not the perceived view that it is ... *synonymous with 'cadastral surveying and related activities'*, to the detriment of not addressing the real issues in the industry. However, the ISA and Surveyors Reciprocating Board do still influence curriculum (refer to 2.3.2), but mostly through their endorsement of cadastral surveyors (perceived as the industry's only 'real' professionals). Although these bodies are considered the 'peak' or most prestigious and influential of the geomatics' industry organisations, they are only some of a number of groups interested in the education and training of undergraduates. Hence, the wider geomatics' profession does not have a national authority that can address the holistic concerns about the lack of national requirements uniformity; levels and adequacy in education and training; equity to 'practice' and to be recognised (status); or to coordinate developments for the future.

2.3.2 Professional and statutory bodies course accreditation.

Australia has no regular formal course accreditation process for all its surveying and mapping programmes. Universities and other institutions of higher education are encouraged to accredit their own courses (Dawkins, 1988: 10 and Higher Educational Council, 1990: 34), but normally seek professional bodies accreditation as to the relevance level of the curriculum (Higher Educational Council, 1990: 34). Hence, while the Minister of Education is ultimately responsible for the supply of suitably qualified people, *accountability for professional surveying education interests lies squarely with the professional surveying school and, in there, with the quality of teaching"* (Hoogsteden & Williamson, 1991: 324). Despite this, national accreditation guidelines are seen as desirable to facilitate articulation and credit transfer (ACSM, 1993: 13), and any accreditation mechanism should involve industry, professional organisations and academia (Dawkins, 1988: 30). This is particularly important with the increasingly rapid technological changes, increases in professional multi-skilling, open learning developments (refer to 2.4.9(b)), and for the acceptance of the geomatics graduate by all stakeholders and across the nation.

The Surveyors Board of Queensland and Board of Examiners, Mines, administer State Government endorsement of the 'legal' surveying industry in Queensland, setting down assessment procedures with minimum competency requirements and setting examinations (Hannigan, 1990b: 279). These Boards have established a form of articulation and credit transfer through recognising academic training and only requiring specific practical projects, or written examination, to be completed prior to registration and licensing to practice and to be eligible for professional membership with their respective organisations. Hence, there are established close links of academic qualifications with professional and statutory bodies (Hannigan, 1990b: 282) and the need for it to continue to align students to industry and community needs and objectives (Hannigan, 1992b: 424). The corollary is that these bodies, while satisfying government regulations, must align their operations to the needs of the industry, including accepting an increased supportive and proactive role in education and training.

The Surveyors Board (in each State), whose function (referring ostensively to the cadastral surveying portion of the geomatics' industry) is to look after the interests of the public and others in their respective State, determine educational and training requirements and assess projects performed by work-experienced graduates for registration purposes (Hoogsteden & Williamson, 1991: 316). While surveying programmes are submitted through their respective State Board for approval, the various Boards are not proactive in curricula and have passed much of the education and training responsibilities, including its' evaluation and the maintenance of standards, to educational establishments (Hoogsteden & Williamson, 1991: 316). Generally, the professional institutions, who look after the interests of their members, in conjunction with the Surveyors Board of that State, ensure that the collectivity of individual members perform appropriately in the work environment. Once again, the major influence and sphere of interest not only resides with the cadastral surveying sector of the geomatics' industry, but with post graduate practice. There are, however, overseas examples where new undergraduate curricula have been successfully developed by a body comprising academics, professional organisations and licensing boards, such as in New Jersey, USA (Greenfeld, 1991: 34). This process was seen to be advantageous in that it would lead directly to accreditation which in turn was an attraction to prospective students (Greenfeld, 1991: 37). This curriculum development further accentuates the need to ensure that no single group within a discipline works in isolation. There is also a patent need to amend the State Acts governing surveyors in Australia, to give both a national consistency and to include all facets of the geomatics' industry, within either a regulated or de-regulated structure.

The Australian and New Zealand Reciprocation Board endeavours to provide national accreditation guidelines for cadastral surveyors. In 1984, this Board adopted guidelines for assessing courses nominating major and minor areas of study (Table 2.1) and relative course percentages (Bretreger, 1993: 276). The influence of the Board is severely restricted as it only meets every four years and can only make recommendations to each State Surveyors Board, the latter being controlled through individual State, Territory or Provincial legislation and Surveyors Act (Bretreger, 1993: 274). Such legislative restrictions are diminishing with the attempted compilation of new more 'general' acts, e.g. as in Queensland and in emerging deregulation policy changes. In The Australian and New Zealand Reciprocation Board's 1984 objectives, the following were quoted;

> ... *the overall objective of the course is to produce broadly educated graduates who are able to work at professional level in any one of the many branches of surveying and who, at the same time, possesses a fundamental understanding of the principles underlying the surveying applications.*
>
> (Panel of Educationalists, 1984, as quoted by Bretreger, 1993: 275).

> This also includes knowledge of allied professions and *The surveyor of today must be educated to be productive, to question, to be innovative and to apply imagination as well as objective scientific judgment to the problems of the future.*
>
> (Panel of Educationalists, 1984, as quoted by Bretreger, 1993: 275).

In North America, similar restrictions occur but national organisations have been established, such as the Accreditation Board for Engineering and Technology (ABET) in the USA (Colcord, 1988: 45). In 1984, the Canadians formed a National Authority to establish educational and technical standards, have reciprocation recognised, and evaluate and accredit the surveying programme of each educational institution, including their human

Major studies: Guidelines for Assessment of Surveying Degree Courses

Foundation Sciences	Measurement Sciences	Land Studies
Mathematics/Statistics	Plane Surveying (including Topographical and Hydrographical Surveying, etc.)	Cadastral Law and Practice
Physics	Geodesy	Land Development & Management
Computer Studies	Photogrammetry	
	Survey Adjustment	

Minor studies: Guidelines for Assessment of Surveying Degree Courses.

Measurement Sciences	Land Studies	Ancillary Studies
Mapping	Remote Sensing	Economics
Astronomy	Geology	Management
	Ecology and Environmental Studies	Professional Practice
	Engineering Studies	
	Urban & Regional Planning	

(Bretreger, 1993: 276)

Table 2.1 The Australian and New Zealand Reciprocation Board major and minor study areas.

and physical resources. Academic courses now largely satisfy the Board of Examination; the latter comprising an amalgamation of people forming an umbrella organisation concerned with providing common surveying education and training criteria (McEwen, 1990: 71). In a similar initiative in Canada in 1991, at the non-professional levels, a national certification programme was developed for technicians and technologists and for various types of surveys (Groot, 1991: 381). In developing a cohesive, coordinated and dynamic geomatics' industry structure in Australia, where paraprofessionals and professionals benefit from one another through maintaining their respective roles, curriculum development must singularly and actively incorporate both these educational levels and the needs of all stakeholders.

With the responsibility for curriculum effectively controlled by individual institutions within a particular State system, different curriculum emphases emerge in the process of producing the 'best' graduate for the industry. These differences may reflect 'local' industrial needs but do not assist the national geomatics' human resource education and employment strategy that is attuned to national needs and government policies on education and employment flexibility and mobility opportunities (refer to 2.4.8 and 2.4.9(a)). A single professional accreditation authority, representing the total industry, could facilitate coordination and co-operation in curriculum development; enhance credit transferring, articulation and study flexibility arrangements; and support government and professional regulatory changes that would assist in formulation national accreditation standards.

2.3.3 Amalgamation of professional bodies and organisations.

The Canadian Institution of Surveying and Mapping (CISM) considered changing its name to the Association of Canadian Science Geomatics (ACSG), but eventually became the Canadian Institute of Geomatics, to more aptly reflect the industry's amalgamation trends and *modus operandi* (Gagnon & Coleman, 1991). There have been numerous other calls to amalgamate the various institutions and associations, representing the various surveying, mapping and spatial information groups, into a single representative body with a broader membership base (Bell & Puniard, 1991 4; Davies, 1991: 2; Lagerlow, 1988: 539; Ormeling, 1992: 4; Toms & Perel, 1990: 6; Williamson, 1981: 301; Maseyk, 1995: 1 and Zubek, 1981: 253). Toms and Perel (1990: 2) consider the individual sectors within the industry are surveying, cartography, and geographic information, and believe the barriers to combining these are the fears of loss of autonomy, perceived incompatibility and different educational requirements. Other barriers are experienced in satisfying specific land registration and other specific surveying and mapping activities needs. While Hocking (1990: 11) sees amalgamation as necessary to establish national credibility and an increased strength and influence for the common good, it is not perceived as an easy task: *Much of the industry's surveying and mapping energy is dissipated in duplication, one upmanship and power struggles. To pursue a gallant endeavour to promote cohesion, co-operation and prosperity of a united industry at a national level in the international arena is a grand objective* (SLIM, 1989, 3(1) as quoted in Hocking, 1991: 9). This lack of industrial and professional unity is still prevalent (Cook & Dawson, 1992: 363). However, in addition to the other advantages, amalgamation would also enhance the cause of quality assurance and self regulation (Davies, 1991: 3 and Divett and Mawn, 1992: 439). Also, in relation to economic considerations for the industry and self regulation:

> *It can be argued on a priori grounds that, in such a climate, an 'industry' is more likely to attract support from Government at both levels for the enhancing of its efficiency, if it can demonstrate a cohesiveness between its components.*
> (Toms & Perel, 1990: 2)

A Canadian investigation (Task Force, 1991: 5) also concluded that greater cooperation and coordination within a single national strategy can develop a cost recovery policy and a fair share for participants. A single collective industry voice, while maybe not radically influencing government agenda, may be able to divert policy changes for the benefit of the industry. Conversely, the approaches of numerous bodies representing sectors of the industry, all with slightly differing interpretations of the changes need to benefit the industry, can only confuse policy makers and have their will placed upon the profession.

Amalgamation of the various professional bodies into a single organisation, or the collection of the separate sub-sets under an umbrella organisation, can provide an organisation expected to assume a greater leadership role to facilitate industry activities in:

- (i) representing the industry's interests from a position of strength;
- (ii) providing the quantity and quality of information required by society;
- (iii) local and national cooperation and coordinating amongst the various subcultures of the industry;
- (iv) providing a standards framework for professional practice, technical work, data transfer, information products and education;
- (v) quality assurance methodology development;
- (vi) providing information at a reasonable cost to clients;
- (vii) assisting the supporting, development and conducting of an appropriate education and training structure; and
- (viii) maintaining the professional status and economic viability of the whole industry.

Amalgamation desires are not all economic but also emanate from the evidence of the merging of, or commonality between, the surveying and cartography disciplines (Cameron & Williams, 1989: 828 and Hocking, 1990: 2) and the high level or union between disciplines in many (not Australia) countries (Hocking, 1990: 2). While Lagerlow perceives an *integrated Surveying and Mapping Education as the key to a truly united industry and profession* (Lagerlow, 1988: 550), McLaughlin *et al.* (1991: 17) surmised that the need for rationalisation of the industry and an amalgamation of the various association appears necessary in view of economic and technological changes and social expectations; and that this can be largely achieved via an appropriate educational structure and curriculum formulated by the stakeholders. The occurrence of full, or part, amalgamation will impact on curriculum through common goal and regulatory changes, and from developments in self regulation and quality assurance mechanisms for the technical and professional aspects in the work place. An example of the consequences of utilising a whole-of-industry body can be seen from the holistic nature of the findings and recommendations that transpired from the GIAC commissioned study into human resource planning for all of Canada (McLaughlin, 1991: 15).

In Australia, some amalgamation between individual associations has occurred, examples being the Institute of Engineering and Mining Surveyors Australia (IEMSA) and the Remote Sensing Association Australia (RSAA). Other less successful co-operative alliance attempts included the formation of the Council of Surveying and Mapping Associations (CASMA) and the Australian Surveying and Mapping Industry Council (ASMIC) (Hocking, 1990: 5); the latter was to develop communications between public, private and academic sectors (Lagerlow, 1988: 542). Such alliances generally appear to involve too many pecuniary interests; a need to be seen to be part of the structure; or an expectation of benefits far exceeding a contribution: a single national regulating professional body could overcome many of these difficulties. A more recent development, along the path of combining professional organisations, has been with the ISA and IEMSA forming a single Federal Council in order to facilitate amalgamation (Lodwick & Wright, 1993: 297 and Working group statement in Surveying Australia (September 1996, Volume 18, Number 3)). While only a potential amalgamation of the major surveying element of the whole industry, such an alliance will influence curriculum through membership requirements, developments in registration, licensing and workplace articulation requirements and opportunities. The latter possibly requires further education and training which would desirably be accessed from, or conducted in co-operation with, the workplace environment.

One association, the Australian Urban and Regional Information Systems Association (AURISA), with its' diverse discipline (LIS/GIS, surveying, mapping) and large corporate membership provides an Australasian example of a single collective body (Bell & Puniard, 1991: 4). Its charter is to encompass a wide variety of disciplines and the needs of urban and regional information systems. To concentrate on surveying and cartography is not perceived as desirable or realistic, because the ... *relatively insignificant positions of disciplines such as Surveying and Cartography in both the academic and real worlds, such an approach is myopic in the extreme* (Granger, 1992: 8). With the expansion of the SIS industry, this organisation, if it extends its influence and embraces all disciplines with equality, has the capacity to influence curriculum through developments eventuating from internal broad cross-fertilised communication of ideas and problems. Although not a professional body in the traditional sense, it appears to have the capacity to become the representative organisation which may well be the 'normal' professional body structure, with government de-regulation and professional body regulation, of the 21st Century.

Curriculum development must also be influenced by rationalisations such as that within the Queensland Lands Department: the Department witnessed the abolition of such bastion positions as Surveyor General and Valuer General and experienced other significant structural and amalgamation changes continuing into 1996. These structural changes broaden the emphasis from surveying and mapping to include information systems and to ensure ... *coordination, co-operation and integration between agencies* (Wilson, 1992: 8). *In both the Federal and State arenas, there is now recognition of the need for mechanisms to coordinate the effective integration and use of land information* (Wilson, 1992: 8). The

Queensland Land Information Council (QLIC) - formalised in 1991 - is responsible for providing the mechanism for community access to integrated land information, the latter being the primary end to which data are captured and applied (Eden & Barker, 1992: 272). The integrated nature from 'data capture to presentation' for a multitude of end users, provides a foundation format for an educational programme servicing this changed industry practice and to reflect the geomatics' philosophy (refer to 2.2.1).

There is increasing evidence of this shift from surveying and mapping towards an SIS industry (also refer to 2.4.5). For example, in the period 1985 - 1991 there was a decrease of 11% in engineering and land surveying as a portion of the whole Canadian industry (McLaughlin, 1991: 8), with similar changes occurring in the USA (ACSM, 1993: 4). This 'loss' was the result of increased activity in the spatial information systems arena. Hence, a geomatics professional organisation controlling all the industry (Groot, 1991: 370) would appear ideal for the whole of the industry and permit development of the most appropriate and dynamically relevant curriculum to maximise on the industry's human resources. With the call for the future professional to be well versed in 'foundation sciences' subjects (refer to 2.4.10 and Table 2.1) and multidisciplinary (with a SIS influence), through studying in all geomatics' undergraduate contemporarily perceived sub-disciplines, then graduates would conceivably be eligible for membership of several of the current professional organisations. As multiple membership options already exist for many in the geomatics' arena, with some individuals already holding membership of several professional and, sometimes, technical organisations (Murphy, 1992: 37), this increased multiple organisation membership eligibility indicates amalgamation is even more appropriate to accommodate future needs and reflect market-place trends (Swiney & Sneddon, 1991: 9). If amalgamation was pursued with genuine vigour and intent, with: the advantages of recent increased and clearer understanding of the impact of technology and SIS developments; experience with more recent generically educated graduates; the affects of government full of partial de-regulation and education philosophy, then the barriers to amalgamation appear less significant and more easily overcome than at any time in the past.

2.4 Professional education and training.

Societal and market place forces are placing increased demands on spatial information and on the access, delivery speed, quality and integrity of that information. Other societal pressures are experienced from demands for: quality assurance and accountability; socially acceptable solutions; greater mobility and advancement opportunities in the workforce; niche markets; use of the latest technology; a one-stop total service facility; and the provision of information at a reasonable cost to clients. There are also increasing questions on the nexus between paraprofessional and professional services and their respective roles. All these concerns and pressures impact on the industry and consequently must be addressed in the education and training of persons entering that industry.

These pressures translate to two major concerns within the surveying and mapping industry, *viz.*, that of the human needs and physical costs of maintenance of rapidly changing technology associated with the need of providing a broadening range of services;

and the retention of a profession or professional status. The former problem may be solved by finding, concentrating and retaining a lucrative specialised niche market, or by being subsumed into a larger and more diverse organisation.

With the second problem, if a professional is considered as one who offers and uses a unique (to their profession) skill and responsibility to solve a problem (preferably in a socially acceptable manner), one that cannot be provided by another profession, then society will likely continue to confer it a professional status. For example, performing a cadastral task is a unique responsibility providing the platform for the professional surveyor. However, if those skills can be suitably performed, by a technician or paraprofessional trained person from within or outside the surveying and mapping industry, to technically solve the problem, the necessity for a professional is reduced. If the overall responsibility for legal aspects acquiesces to technical indemnity, then professional status is difficult to justify. Technological changes are enabling many of the past technical expertise and practices of the professional to be performed by sub-professional levels from within and outside the field of surveying and mapping. Hence, there is a need for professional education and training to reflect the social and 'worldly' aspects of professionalism and develop new professional roles commensurate with technological developments and societal needs and pressures. To achieve this, a new educational curriculum needs to contemplate structural, as well as, technique and methodology changes to the contemporary system. Any failure to do so will hasten the demise of the surveying and cartographic professionals. At best it would leave them with a minor repertoire of unique skills and their remaining abilities competing on a highly competitive and open market, the latter including paraprofessionals and professionals from a variety of disciplines.

2.4.1 Surveying education

The traditional dominance of field surveying in the geomatics' industry and education is undergoing a change in emphasis (refer to 2.2.1 and 2.4.5). Other observed changes include the steady reduction (since 1982) of the actual numbers seeking New South Wales State Government endorsement to practice in cadastral surveying, and that now only 60% of graduating students seek this endorsement (Fryer, 1992: 180): nationally, those choosing a cadastral surveying path has fallen to about 50% (Coombes, 1995: 151). No indication was proffered concerning the percentage needing the endorsement compared to those seeking the 'position status'. Whatever the true situation, the reduction reveals the changing needs of graduates. Other major influences on the profession and education will occur when contemporary quality assurance and self regulation are fully implemented, or are enhanced and formalised, as is indicated by increasing public and political pressure (Davies, 1991: 3 and Divett & Mawn, 1992: 439).

To address some of the perceived educational problems, it has been shown that resources are needed to establish national accreditation guidelines for curriculum (ACSM, 1993: 10 and refer to 2.4.9(b)). In addition to a set of standards to assist curriculum development, another realisable benefit from the course content requirements of the accreditation process could be preventing the loss, to surveying, of professional areas, or expertise, such as LIS and GIS (Davies, 1991: 2), thereby not replicating the past fragmentation, and hence narrowing, of surveying into various discipline groups (refer to 1.2). Davies (1991: 6) considers the surveying industry must define its role, especially in relation to LIS/GIS, and develop a curriculum accordingly. Brunner *et al.* (1993: 4) acknowledge the lower profile of surveying, compared to new technological areas, as a factor in developing the new curriculum. Hence, the need to develop new areas (such as adopting GIS and GPS) and broaden the surveying curriculum is of great importance for the survival of the profession and professional courses (Brunner *et al.*, 1993: 4; Cameron & Williams, 1989: 828; Divett & Mawn, 1992: 436; Groot, 1991: 378 and McEwen, 1990: 74). This is starting to be acknowledged with deliberations over a 'modernised' surveying definition to reflect better these industrial needs and developments (refer to 2.2.1 and 2.2.2). The broader curriculum will enable the industry to retain its' current expertise; provide the opportunity for expansion and the adoption of technological advances; enhance the support for a professional status; and maintain market place relevance corresponding with changing demands and in developing value-added services.

Part of the re-emphasis in surveying education is to enhance the educational aspects and lessen training [particularly the practical training] aspects (Groot, 1991: 378 and Jones & Ellis, 1994: 53 and 54), the latter moving to industry or post graduate specialisations (Brunner *et al.*, 1993: 5; IEMSA, 1992: 1; Pollard & Robinson, 1985: 364 and Sprent & Osborn, 1995: 90). The hands-on skills, or traditional technical practices, aspects of surveying are diminishing (ACSM, 1993: 4; Groot, 1991: 378; Hannigan, 1990a: 225; Toms, 1991: 17 and Lodwick, 1995: 29). The process of most data collection activities is also increasingly being acknowledged as a paraprofessional technical practice and not a professional activity (Davies, 1991: 3 and Ellis & Edwards, 1993: 318): a view partially supported by others eg. Survey Industry Review Commission, 1991. This is the trend reflected in the surveying industry in moving from a measuring philosophy to a holistic concept of data capture, storage, processing, management and user applications approach (ACSM, 1993: 12 and refer to 2.2.2). This change from surveying to a more holistic approach would be the acquiescing of surveying to accommodate the shift in society's need to that of increased quantities of information (Hannigan, 1990a: 226 and Viitanen, 1994: 134). To develop an existing surveying course along an essentially similar existing philosophy, to satisfy the wishes of a States' Board of Surveyors (ISA & ACSQ, 1992: 50), would appear not to be realising long term goals and societal expectations. With the current concept, after completing a professional undergraduate course, an individual State government authority only 'fully' registers surveyors after extra post graduate practical training and examinations are completed. The need to demonstrate competence to practice in one particular aspect of surveying (McEwen, 1990: 71 and 2.3.2), should be unnecessary (experience is important and will enhance the competence level). It is also not serving the public expectations founded on a belief of uniform professional competence, currency and accountability. An appropriate curriculum should prepare an individual for professional endorsement at graduation. However, some recognised period of training, if not completed before graduation, may be required if academic courses concentrate more on educational and less on training aspects. Continuing professional development (refer to 2.4.4) should address the currency criterion, if only for a portion of the whole industry, and providing it is able to serves its intended purposes. Although access to continuing professional development training and educational opportunities remains a problem for many practising paraprofessional and professional surveyors (refer to 2.4.4), an industry supported open learning environment would provide for these access difficulties.

2.4.2 Cartographic education.

Of concern to the profession and academics are the small numbers choosing cartography as a career (Anderson,1991c: 159 and Worth, 1992a: 290), raising the question of cartography or cartographic curriculum relevance in the 1990s (Gerber, 1990: 48). A membership profile survey in 1992 revealed continuing diminishing student numbers with many potential students opting for GIS studies (refer to 2.4.5), which are offered in a variety of discipline areas. This diminishing demand forced the Queensland University of Technology cartography associate diploma course to cease accepting new students in 1993, leaving only two degree, five associate diploma and two advance certificate courses within Australia (Williams, 1992: 238; Worth, 1991: 98 and Worth, 1992a: 284). Some cartographic studies are offered in parallel with surveying (eg. the USQ Bachelor of Technology (GIS)), sharing many of the foundation subjects (Cameron & Williams, 1989: 828; Lodwick & Wright, 1993: 299 and Mitchell, 1993: 346), but cartography is still largely regarded as a separate discipline. Traditional cartography and hardcopy generic mapping no longer commands a significant portion of the market place. Cartography has a role and direction commensurate with new communication technologies and public needs, requiring a greater professional approach rather than the paraprofessional standard....*with full access to graphic symbolism, transparency, animation and user interaction, cartography will grow to new dimensions of user value and will not merely be regarded as one output option of GIS* (Visvalingam, 1992: xii as quoted by Cartwright, 1992: 205). If cartography is to be able to provide a service not available in a highly competitive technologically oriented market place, then ... *education and related cognitive and perceptual studies need to expand to establish and consolidate this core area of cartographic education* (Visvalingam, 1992: x as quoted by Cartwright, 1992: 205). Other needs for the future cartographer include a high level of mathematics, particularly statistics, and sufficient adaptability and skills to adjust to new directions of handling and displaying spatial data (Williams, 1992: 239).

While remote sensing and photogrammetry are regarded by some as a part of surveying, or aberrations caused by technical innovations (ACSM, 1993: 14), cartography has generally been presumed to logically include remote sensing, photogrammetry and GIS (Anderson, 1991c: 157; Castner, 1991: 8; Coops & Hill, 1991: 2; Dahlberg & Jensen, 1985: 173; Kelly *et al.*, 1991: 26 and de Meyere, 1989: 12). In addition to incorporating these new sub-disciplines into curriculum development are the technological and management requirements, needed to envelope a broader knowledge base, to cope with changing transfer standards, a greater client diversity, communications, data-gathering techniques, data-merging, costing etc. (ACSM, 1993: 8; Ormeling, 1992: 4 and Rouch & DeLoach, 1994: 240).

Curriculum developers are faced with various conceptual models of the modern cartographer. Whether cartography encompasses the SIS domains or is subsumed by SIS, along with surveying etc. (refer to 2.4.5), the demand for an SIS emphasis in courses is increasing (ACSM, 1993: 4; Dahlberg & Jensen, 1985: 170; Groot, 1991: 370; Ormeling, 1988: 536 and Forster & Williamson, 1985: 432). Gerber (1990: 47), Ormeling (1988: 529 and 536) and Taylor (1985: 3) believe that the GIS is a role for cartographers, as this new technology is replacing some, and enhancing other, traditional skills, and that cartographers need to be part of the whole SIS industry. Worth (1992a: 284) perceives the danger that GIS is more concerned with spatial analysis rather than output, the traditional cartographic emphasis. The inference appears to be that GIS use is a paraprofessional role within the control of the professional cartographer. However, with the advent of GIS, the trend has been for curriculum developers to concern themselves with the greater emphasis, within the industry, on current and future needs in the CAD/GIS/desk-top publishing environment (Anderson, 1991c: 157; Cartwright, 1992: 209 and de Meyere, 1989: 12). It is apparent, however, that conceptual changes in curriculum are needed to encompass the influences of economic, societal and technical factors (Ormeling, 1992: 1 and 4), especially in developing the theoretical aspects (Gerber, 1990: 48). This is particularly so in Australia where the concentration is on technical application and practice and not on enhancing the theory (Gerber, 1990: 47).

Curriculum development for solely a traditional cartographic discipline structure does present problems, as cartographers are generally employed in a variety of places, often with no employment standards or recognition (Wood & Forest, 1985: 157). In many countries the cartographer works in geography discipline areas and is absorbed into the geography profession (Gerber, 1990: 50 and Worth, 1992a: 291). In comparison, surveyors form their own professional discipline or are a part of civil engineering, as is seen in the USA (Wood & Forest, 1985: 163). Hence, cartographers are perceived either at a paraprofessional level or a technician level (Ormeling, 1988: 530). They are practical persons for whom, as in Australia, an associate diploma qualification is believed satisfactory, even though it is acknowledged ... *that if the prevailing technical paradigm is allowed to predominate then much will be lost* (Taylor, 1992: 44). There is the option of attaining a more professional level of education by furthering their education at one of the two available Bachelor courses in Australia. Further specialisation studies in cartography are available, but these are limited in favour of SIS style studies (refer to 2.4.5) and, with the exception of the USQ, only in an attendance study mode. A real possibility and alternative, especially if the attitudes in the surveying profession remains largely unchanged, is that cartography will survive, in some form or another, by being absorbed into the geography discipline.

Cartographic curricula still place emphases on traditional practices (Anderson, 1991c: 157 and Dahlberg & Jensen, 1985: 172) and a practical task orientation (Fairbairn & Openshaw, 1991: 80). From the syllabi of the remaining cartography courses and journal articles (Skitch, 1991: 7; Wood & Forest, 1985: 159 and Worth, 1991: 98), it is evident that, with the changes into SIS topics, there has been an increase to a generic geographical information and needs-based thematic output, via a computer-aided emphasis. With the proliferation of this technology, its user friendliness and multi-discipline users, cartographic courses must embrace changes to ensure the continuance of the expertise in integrity of data maintenance, management and output: this requires a professional level of education. It is apparent that the spatial information technological changes and societal needs for information are favouring the development of the cartographic rather than the surveying practitioner. The cartographic profession has the opportunity, and probably its only chance, to embrace these changes; restore a higher profile and professional status of its' members; and merge with the surveying profession on an equal basis to form a geomatics profession and common undergraduate education.

2.4.3 Skills technology training.

With rapid advances in technology, the proliferation of the hardware and software systems, and the employment of 'mapping and surveying' equipment across discipline boundaries and into non-traditional disciplines, there is an emphasis for broader education and less technical training in universities (Brunner *et al.*, 1993: 5; Jones & Ellis, 1994: 53 and 55; Mitchell & Fryer, 1995: 33 and Trinder & Fraser, 1994: 87). A purpose designed course with a vocational emphasis is diminishing in a rapidly changing technological environment, relegating vocational training to a more appropriate chronological and spatial situation (Swiney & Sneddon, 1991: 8). The specific high level of competence in hands-on technical skills or technology training should be left mainly to technologist training in a work place environment (Allaburton, 1990: 51; Davies, 1991: 3 and Hannigan, 1992b: 426). One example of this occurs with the revolutionising technology of the Global Positioning System (GPS), which involves a low cost equipment with a high degree of accuracy and rapid volume data collection capabilities (AKCLIS, 1992: 19; Task Force, 1991: 74 and Toms, 1991: 17):

> *GPS has been nominated as the most pervasive technology to impact on Surveying and Mapping for several decades and capable of revolutionising the whole process of locating oneself, objects or others, in all types of environments independent of weather conditions.*
>
> (AKCLIS, 1992: 19)

As GPS is a new and developing technology which is quick to learn and simple to use, practical field use training should occur in the work environment on the particular system being employed. However, the techniques, methodologies and practical data handling associated with GPS should be included in the undergraduate curriculum: some generic practical field use may be used as part of the teaching strategies. To date, implementation of GPS is outstripping the provision of skilled and trained professionals (AKCLIS, 1992: 19), an issue addressed in curriculum development, behind rather than in front of need, for both undergraduate studies and in providing continuing professional development opportunities.

Some specialised skills training, that are regarded as necessary for professionals as well as paraprofessionals, could be removed from undergraduate curriculum and readily used to form a post graduate course for satisfying specialised professional technical training needs (Allaburton, 1990: 52 and Davies, 1991: 5). This could be conducted as a formal course in an educational institution; as an accredited scheme with a 'master' geomatican; or in a similar method to existing in-house or purchased short courses (Skitch, 1991: 80). The training is then largely removed from undergraduate curriculum and occurs with current technology pertinent to the user situation. Industry is currently not prepared to assume a more responsible role in training or providing adequate on-the-job experience needed for reaching a level for registration or licensing (Brock, 1992: 310). If such a philosophical approach to specialised training is established, curriculum development can concentrate on providing the foundations for this to occur within an atmosphere, and for the benefits, of geomatics' industrial synergy. These supporting foundations would include: technical knowledge and a high level of conceptual skills; a breadth of understanding of the work environment and contextual understanding; the capacity for innovative thinking; a developed ability to make good judgments and critical evaluation; enhanced abilities to adopt and adapt to different technologies and applications; administrative, management and human relations abilities; a developed ability for lifetime learning; a high articulation level; and a highly principled attitude.

2.4.4 Continuing professional education.

CPD (continuing professional development) *is the learning process whereby practising professionals maintain the knowledge base which is the basis of their professional services to the community* (Institution of Surveyors. 1992: 1) and ... *to be recognised as having knowledge and skills to address a widening area of community need* (Institution of Surveyors, 1992: 2). There is increasing expectation and requirement, commensurate with contemporary societal needs. for members of a professional organisation to be active in continuing professional development, preferably in both the professional experiences and continuing education components (Blinn *et al.*, 1992: 59; ACSQ, 1992: 6; Davies, 1991: 6; Hannigan, 1993a: 4; Institution of Engineers, 1990: 3; ISA & ACSQ, 1993: 53; McEwen, 1990: 69; Warner *et al.*, 1991:4-6 and 17; Worth, 1992b: 6 and Lodwick, 1995: 31). While this study is not concerned directly with CPD, CPD does partially depend and impact on prior undergraduate education studies. A greater breadth and depth of knowledge from undergraduate studies provides a wider base, awareness and interrelationships understanding for more diverse CPD opportunities. A recent survey (conducted across Australia) of activities and perceived needs identified the main emphasis was on upgrading in technical and technology areas (new equipment and software packages) with some activity in management training (Munsie 1993: 336). Very little continuing professional development is centred on community involvement with none occurring in the liberal arts and humanities disciplines (Munsie, 1993: 331). This does not reflect a thrust in those topics of studies (e.g. environmental sciences and management) deemed desirable, and experiencing an increase, in undergraduate courses in recent years. It may also signify their unavailability through open learning opportunities; that they are considered unnecessary for the contemporary professional; or are ignored because previous education and training did not adequately provide attributes in past graduates that would facilitate continuing professional development activity in these areas. It is also appears that management is considered as something environmentally specific and hence learnt on-the-job. In addition, because of the skills-specific technical nature still prevalent within the geomatics' industry, there is little perceived need for continuing professional development beyond technical upgrading. While this study is not concerned directly with CPD

This all emphasises the need for continuing professional development and continuing education opportunities to be an integral part of any academic course structure (Lodwick & Wright, 1993: 298 and Worth, 1991: 98), especially when considering the half life of major equipment technology and skills ability is six years (Denning, 1992: 94; Trinder, 1993: 286 and Warner *et al.*, 1991: 12). The ISA Council, also recognising the need for continuing professional development, proposed [and has since initiated] that continuing professional development be mandatory (for registered surveyors only) commencing on the 1st January 1994 (Munsie, 1993: 328). While South Australia has legislation in place on continuing professional development requirements, other state governments and ISA Divisions have no, or limited, statutes regarding continuing professional development (Munsie, 1993: 331). The Mapping Sciences Institute (Australia) commenced Australian wide voluntary CPD in 1996. The establishment of the Australian National Training Authority (ANTA), in December 1992, for co-ordination of national training and to promote lifelong learning within an open learning environment (Persson, 1993: 1), was government recognition of CPD needs.

Continuing professional development activities have been implemented on an *ad hoc* basis (ACSQ, 1991: 4; Rhind *et al.*, 1991: 5; Usher, 1985: 300 and Trinder, 1990: 7). During 1995 and 1996 there has been an increase in the offerings of CPD short courses, demonstrations and seminars. However, continuing professional development is valuable for an industry having to cope with rapid and substantial technological changes and the knowledge enhancements required to reconcile discipline expansion or overlapping into allied disciplines (Dahlberg & Jensen, 1985: 179). It is also necessary to enable the professional to cope and manage changes experienced in the economic and political environments effecting them (Warner *et al.*, 1991: 26). Another identified advantage of continuing professional development (workshops, conferences and short courses) is in providing an education and training substitution for the general lag and inflexibility [to retaining currency or in mounting on-demand short courses] in university education (Granger 1992: 13 and Groot, 1991: 371) a problem that could be overcome with industry wide linkages. Some institutions have adapted continuing education programmes into existing full-time and part-time courses to meet change (Cassettari, 1991: 74). This makes available continuing professional development certificate courses (Wells, 1991: 579) or post graduate courses that concurrently service continuing professional development needs (Trinder, 1993: 289; Williamson *et al.*, 1993: 311 and Worth, 1992a: 288). The latter are increasing with a 49% part-time student attendance ratio, a proportion expected to increase (Worth, 1992b: 6), suggesting the need to develop an open learning structure so that access is available to all individuals. However, the proliferation of in-house training attempts is indicative of the general dissatisfaction with formal course structures and the limited access to them (McLaughlin, 1991: 13). With the limited success of these in-house courses in

Australia, another solution, for education and training in a recent technology (refer to 2.2.3), emerged as a consortium effort The consortium was to concentrate on the production of packaged short courses for continuing professional development use by industry in the workplace or for use at an academic establishment (Leis, 1992: 478). Such a philosophy was suggested by Coleman and McLaughlin (1988: 24) when they proposed that continuing professional development should by organised to utilise industry expertise. On-site short courses and workshops, based on similar arrangements, have worked successfully in Canada (Gracie, 1989: 262).

To incorporate and be able to cope with future continuing professional development needs, it has been proposed that formal course curricula be broad-based (Brunner *et al.*, 1993: 4; Groot, 1989: 3 and Hannigan, 1995: 12) with post graduate courses structured to facilitate specialisation qualifications and discipline upgrading (Hannigan, 1990a: 226). Short courses and seminars in some instances are already being replaced by flexible undergraduate and postgraduate certificates and diplomas to provide both the continuing professional development and a formal credential (Grenfell & Finegan, 1991: 395, McGhie, 1992: 2 and Wells, 1991: 579). Whatever infrastructure is employed, all professionals should be able to access continuing professional development opportunities ... *irrespective of their employment situation or geographical location* (Warner *et al.*, 1991: 24). The level of success of this arrangement would depend on the industry identifying its' needs and direction, and cooperatively planning to develop structures to support actual and perceived needs.

Melbourne University, in developing a new and more diverse course structure, integrated a continuing education programme that includes seminar presentations and collaborative short courses (Williamson & Hunter, 1990: 20). The University of Southern Queensland also encourages continuing professional development by offering all its full time courses subjects as single study units for credit, in addition to post graduate certificates, in full-time, part-time or distance education study modes: a open learning structure supported by the professional bodies (ISA & ACSQ, 1992: 51). A broad-based undergraduate curriculum and post graduate specialist subjects, continually reviewed and developed through established linkage arrangements (refer to 2.2.3), can provide useful continuing professional development opportunities. It also allows easy monitoring of personal continuing professional development programmes by professional organisations and the public. The monitoring aspects are becoming more critical in satisfying the needs of an increasingly aware public and satisfying professional status requirements. Efforts to have mandatory continuing professional development (refer earlier statements) is a reflection of the vulnerability of the professional status for those in the geomatics' industry and the current lack of this 'expected' professional activity. As scrutinised life long learning for professionals is, or will be, a reality, then there must be the opportunity for this to occur from within the work environment. Open access to education and other open learning arrangements are essential (also refer to 2.4.9) to facilitate this educational continuum and ensure its' usefulness.

2.4.5 Spatial information industry

The movement from a land measurement focus, and related surveying discipline activities, into SIS and land information management (ACSQ, 1991: 4; Bedard *et al.*, 1988: 105 and Gracie, 1985: 372) was confirmed by the statistics obtained from an analysis of industrial activities during the 1985-1991 epoch (Task Force, 1991: 32). This trend is expected to continue as the technology impact over the last twenty years has been most significant in the information industry, and not in land measurement (Granger, 1992: 2 and Lodwick & Wright, 1993: 297). Also, during the 1990s, information is expected to constitute 40% of world trade (Gerber, 1992: 2). Consequentially, personnel trained in spatial information continue to be in demand (Dahlberg, 1988: 288), and will likely remain so for some time, as in the foreseeable future ...*there is no possibility of an adequate number of specifically trained graduates* (ACSM, 1993: 4).

The following describes what is interpreted as the role or function of the spatial information industry, and the confusion surrounding common descriptive terminology. Gagnon & Coleman (1990) describe a SIS as a coordinated ... *set of human and material resources .... which allows for better acquisition and communication of spatially based information.* It involves the collection, storage, integration and management of all land and land related (forests, socioeconomic, demographic, political boundaries, etc.) information and data (Leis, 1992). Similarly, a GIS is described as ... *a software package which provides digital cartography, database management and spatial analysis facilities* (Gagnon & Coleman, 1990), and is seen as ... *an over-arching subject that encompasses* ... all those aspects involved in surveying, cartography, photogrammetry, etc. (Visvalingam, 1992: 54). However, when referring to a GIS it generally implies *A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth. This is normally considered to involve a spatially referenced computer data-base and appropriate applications software* (Visvalingam, 1992: 51). Similarly, Trinder (1990: 3) describes LIS as a computerised system ...*for the collection, use, management and exchange of land related information ... about natural resources, the environment, land ownership, land use, transport, communications, mapping, demography, and socioeconomic factors where such information can be related to geographic position* , of which GIS forms a part. In a similar conceptual model, Williamson and Hunter (1990: 22) describe spatial information management as encompassing the areas of LIS (parcel based system), FIS (automated mapping and facilities management system) and GIS (a small scale socioeconomic analysis system). Others perceive it differently. Burrough (1987: 7) and Williamson (undated) consider LIS plus related social-economics attributes forms a GIS, while Granger (1993: 19) describes LIS as the preferred Australasia terminology of that which the rest of the world refers to as GIS. The term SIS appears to be proffered as a solution to the confusion created by the LIS and GIS terms: the latter basically differentiating between predominantly cadastral surveying concerns and mapping surveying and cartography. A generally accepted definition of spatial information is: ... *information which contains as a key characteristic its location on, below or above the earth surface, whereby this location is defined in an earth*