TECHNICAL REPORT

ISO/TR 19122

First edition
2004-11-15

Geographic information/Geomatics — Qualification and certification of personnel

Information géographique — Qualification et accréditation du personnel

Reference number
ISO/TR 19122:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword v
Introduction vi
1 Scope 1
2 Terms and definitions 1
3 Abbreviated terms 3
4 Review of existing qualifications and certification systems 3
4.1 Introduction 3
4.2 Questionnaire results 4
4.3 General comments 5
5 National case studies 5
5.1 Introduction 5
5.2 Australia 5
5.3 Austria 5
5.4 Canada 5
5.5 China 5
5.6 Finland 6
5.7 Germany 6
5.8 Japan 6
5.9 Korea 6
5.10 Portugal 6
5.11 Saudi Arabia 6
5.12 South Africa 6
5.13 United Kingdom 6
5.14 United States 7
5.15 International case studies 7
6 Discussion 7
6.1 Introduction 7
6.2 Definitions 8
6.3 National professional organizations 8
6.4 Current qualifications and certification initiatives 8
6.5 Future directions 9
7 Recommendations 10
Annex A (informative) National case studies — Australia 11
Annex B (informative) National case studies — Austria 20
Annex C (informative) National case studies — Canada 26
Annex D (informative) National case studies — Finland 33
Annex E (informative) National case studies — Germany 34
Annex F (informative) National case studies — Japan 44
Annex G (informative) National case studies — Korea 47
Annex H (informative) National case studies — Portugal 48
Annex I (informative) National case studies — Saudi Arabia 51
Annex J (informative) National case studies — South Africa 60
Annex K (informative) National case studies — United Kingdom 66

Annex L (informative) **National case studies — USA** 78
Annex M (informative) **International Case Study** 86
Bibliography 98

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 19122 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics* in collaboration with the following ISO/TC 211 Class A liaison organizations:

— International Federation of Surveyors (FIG)

— International Cartographic Association (ICA)

— International Hydrographic Organization (IHO)

— International Society for Photogrammetry and Remote Sensing (ISPRS)

— Open GIS Consortium, Incorporated (OGC)

— World Meteorological Organization (WMO)

Introduction

In 1998, the Canadian delegation made a proposal that the domain of interest for ISO/TC 211 should extend beyond data standards and encompass issues of certification and qualification of personnel. This proved to be a radical shift. From the beginning, the work encountered some difficulty. The voting on the original work item reflected ambiguity on the perceived value of the work. The initial reaction centred on whether there was a need for a single system of certification and whether it should be implemented through a central body.

After several years of discussion, a questionnaire was developed to obtain some of the background on different initiatives across the ISO/TC 211 membership. In August 2001, a small working group met to review the first eight case studies, analyse their content and develop recommendations to ISO/TC 211 through this Technical Report. Subsequently, five more case studies were added to this Technical Report.

To make further progress on the original Project Team 19122 agenda, there existed a continued need to expand the membership to represent better the different domains and approaches to certification and qualification of personnel. Nationally, this means the involvement of experts beyond the data standards arena; internationally, it means representation of the full range of professions and disciplines embraced by the broad geographic information/geomatics domain.

Certification in a technical subject domain raises issues for individual practitioners, education and training institutions, government agencies, professional organizations and the private sector. There remains the need for a mechanism that permits fair comparisons across jurisdictional boundaries; however the measures of skill and competency must be flexible and be cognizant of the social and cultural context.

The universal nature of geographic information/geomatics and the recent and ongoing publication of ISO/TC 211 data standards dictate a common international requirement for a deeper understanding of different education and training systems, and the available processes for the recognition of professional qualifications across a broad subject domain. In addition, this domain is changing rapidly as the result of the changes in the Information and Communication Technologies (ICT) industry and the integration of GI Technologies into an ever-expanding range of applications. This rapid rate of change has significant implications for educational institutions, professional associations as well as standard setting organizations. All of these must take care to build change management into any standards established. The Project Team hopes this report will initiate a broad dialog towards greater understanding of national and disciplinary differences.

Geographic information/Geomatics — Qualification and certification of personnel

1 Scope

This Technical Report describes and defines the following objectives of the field of Geographic Information/Geomatics.

— To develop a Type 3 report, which describes a system for the qualification and certification, by a central independent body, of personnel in the field of Geographic Information/Geomatics.

— To define the boundaries between Geographic Information/ Geomatics and other related disciplines and professions.

— To specify technologies and tasks pertaining to Geographic Information/Geomatics.

— To establish skill sets and competency levels for technologists, professional staff and management in the field.

— To research the relationship between this initiative and other similar certification processes performed by existing professional associations.

— To develop a plan for the accreditation of candidate institutions and programs, for the certification of individuals in the workforce, and for collaboration with other professional bodies.

While the background research leading to this Technical Report has remained true to the framework provided by these objectives, the focus has shifted to a more comprehensive, descriptive study of the current situation in some member countries and the ongoing activities of some of those international professional associations which cover the subject domain. This is in contrast to a prescriptive study, where the solution would be dictated by ISO/TC 211.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
qualification
knowledge, skills, training and experience required to perform properly GIS/Geomatics tasks, normally achieved through formal education

2.2
certification
procedure leading to a written testimony of the qualification of an individual's professional competence provided by a range of public, private and professional institutions

2.3
subject domain
disciplines included in the following subdivisions:

- Geographic information (ref: ISO/TC211/WG1 N119)
  - knowledge obtained as the result of the synthesis, analysis or integration of geographic data;
  - information concerning phenomena implicitly or explicitly associated with a location relative to the Earth.
- Geographic Information Services (ref: ISO/TC211/WG1 40.6)
  - services that transform, manage or present geographic information to users.
- Geomatics (ref: ISO/TC211/WG1 N119)
  - discipline concerned with the collection, distribution, storage, analysis, processing, presentation of geographic data or geographic information
- Geographic Information Science (ref: Mark. 2000)
  - Geographic Information Science (GIScience) is the basic research field that seeks to redefine geographic concepts and their use in the context of geographic information systems. GIScience also examines the impacts of GIS on individuals and society, and the influences of society on GIS. GIScience re-examines some of the most fundamental themes in traditional spatially oriented fields such as geography, cartography, and geodesy, while incorporating more recent developments in cognitive and information science.

NOTE 1 When defining the subject domains, it is important to recognize the suite of tools which most professionals accept as directly applicable to geographic information/geomatics. These tools include GIS, Remote Sensing, Global Navigation Satellite Systems and others, all of which are information and communication technologies (ICT).

NOTE 2 Each country has its own terms and their definitions for the subject domains encompassed under ISO/TC 211. The wide variance in definition and their acceptance, especially within the academic community, is indicative of the challenge for standardization in the human resources (personnel) arena. Later in this report the range of definitions used is outlined. However for clarity, we provide here the definitions that have been previously specified by ISO/TC 211. The fourth term is added since that domain has not been previously defined within the ISO/TC 211 context.

2.4
Education systems
academic and technical instruction and training at the post-secondary level

NOTE 1 The education system within a country is influenced by historical and cultural factors that impact the relationship between government and society. In Europe, education systems can traditionally be described, for example, in terms of the “British system”, the “German system” and the “French system”. Current European Union initiatives to harmonize education systems across Europe required by Article 149 and 150 of the Treaty of Amsterdam of the European Union are leading to rapid changes in national systems that may or may not resolve these differences. Globally, many countries have education systems based on these European foundations as the result of colonial expansion, while other systems, such as the North American one, have less relationship to colonial roots. Systems in Korea, Japan, China and the Arabic speaking world likewise show important variations.

NOTE 2 Within the context of this report, these systems affect the level of autonomy between the needs of the national government for skilled manpower and the curriculum at the higher education institutions. This in turn affects the relationship between academic and technical education and training (i.e. university and community college in North America, or Universität, Fachhochschule and Technikerschule in Germany).

3 Abbreviated terms

AGI	Association of Geographic Information
ASPRS	American Society for Photogrammetry & Remote Sensing
CIG	Canadian Institute of Geomatics
CRSS	Canadian Remote Sensing Society
EU	European Union
FIG	International Federation of Surveyors
GI	Geographic Information
GIS	Geographic Information System
GISSA	Geo-Information Society of South Africa
IAG	International Association of Geodesy
ICA	International Cartographic Association
IHO	International Hydrographic Office
ISO	International Organization for Standardization (iso – Greek for “same”)
ISPRS	International Society for Photogrammetry & Remote Sensing
NCGIA	National Center for Geographic Information & Analysis
OGC	Open Geospatial Consortium
TC	Technical Committee
UCGIS	University Consortium for Geographic Information Science
UNIGIS	University Consortium for Certificate & Graduate Programs in GIS
URISA	Urban & Regional Information System Association
WMO	World Meteorological Organization

4 Review of existing qualifications and certification systems

4.1 Introduction

To develop an understanding of the need for a system for the qualification and certification of personnel, the Project Team 19122 completed two activities: a questionnaire and review of submitted case studies. The questionnaire represented a preliminary effort to gain an overall appreciation of the national variability on the topic. The case study approach permitted nations to elaborate on their within country variation. It also provided international professional associations with the opportunity to make a contribution.

4.2 Questionnaire results

The questionnaire can be found in ISO/TC 211 N 902. Replies were received from eighteen P member countries and two Class A liaison members. The questionnaire included nine questions.

1) Does your country have a set of guidelines for the qualification and certification of personnel in the field of geographic information/geomatics?

   9 Yes   6 No   2 Yes/No   1 Unknown

   Many of the Yes respondents qualified their answer with respect to specific subject areas e.g. surveying, photogrammetry. Given the national emphasis, international Class A members could not provide a valid answer.

2) If No to Question #1, are you planning to initiate this activity in the near future?

   9 Yes   6 No   2 Yes/No   1 Unknown

   Curiously, the response follows closely the first question. Countries that replied Yes to Question #1 also replied Yes to Question #2.

3) Do you have national legislation for certification of personnel?

   10 Yes   6 No   2 Yes/No

   Legislation applied only to the Surveying profession.

4) Do you have legislation for certification at the regional level?

   4 Yes   13 No   1 Unknown

   Regional legislation exists for surveyors in Australia, Canada, Germany and the United States.

5) Do you have industry standards?

   5 Yes   12 No   1 Unknown

   Standards exist for surveyors in Australia, Japan, Saudi Arabia, Thailand and the United States.

6) Is there a group that has defined a model curriculum?

   6 Yes   9 No   3 Unknown

   Curricula have been developed in Germany, Iran, South Africa, Thailand, United Kingdom and United States.

7) Do you have a mechanism for program accreditation?

   6 Yes   9 No   2 Yes/No   1 Unknown

8) How many higher education institutions teach geographic information/geomatics?

   The response varied from two to a maximum of over seven hundred in the United States.

9) What geographic information/geomatics professional associations exist in your country?

   The response ranged from two to a maximum of twenty-two (Japan).

4.3 General comments

Most of the respondents provided the perspective from the surveying profession. There was limited input from the broader geographic information professional. The variation of content and the range in the amount of detail of the questionnaire responses pointed out the need for more in-depth analysis of individual country situations.

5 National case studies

5.1 Introduction

The preparation of comprehensive national case studies needed input from different sectors and disciplines. As well, in those countries with a large geographic extent, there may be different approaches within the individual states or provinces (e.g. United States, Canada). The project leader distributed the Canadian case study as a template of topics i.e. terminology, professional associations, current qualifications and certification initiatives and future directions. This allowed each case study to use the terms in common usage in their country and to identify those agencies which had taken a leadership role in the subject of education and training of Geomatics personnel.

Case studies (Annex A) have been received from Australia, Austria, Canada, Finland, Germany, Japan, Korea, Portugal, Saudi Arabia, South Africa, United Kingdom and the United States. The reader should refer to the individual submissions for the details. In this section, the emphasis is upon the key features of each case study.

5.2 Australia

Australia is divided into a number of states and thus implementation of qualifications and certification in Geomatics will vary across the country. At the national level, there has been an emphasis on national vocational (technical) standards. In terms of subject domain, there are different viewpoints from those disciplines which **apply** Geomatics technologies for resource management and those disciplines which emphasize the base data sets for surveying and mapping (see Annex A for details).

5.3 Austria

The Austrian contribution offers insight into recent changes in their higher education system which reflect broader European Union (EU) initiatives encouraging cooperation between member states with respect to education. Variations in the structures for higher education in geographic information/geomatics in Austria are outlined (see Annex B for details).

5.4 Canada

Canada exhibits the same jurisdictional variations in the education system at the provincial level as found in Australia and the United States. Nationally, the federal government is a strong proponent of Geomatics and commissioned a consulting study of the personnel requirements for this industry. The response to that study indicated considerable ambivalence towards certification. Currently, there are several voluntary certification programs in place, supported by their respective professional associations (e.g. CIG, CRSS) (see Annex C for details).

5.5 China

The Chinese contribution is an expansion of the original questionnaire. It does not provide sufficient detail to be incorporated here as a national case study.

5.6 Finland

The Finnish report summarizes their contribution to the 1995 Allan report which provides an analysis of the different education and professional profiles for Geodetic Surveyors in Western Europe. Although this information does not contribute to the current study, reference to the Allan report provides useful historical insight into the pre-cooperation situation in Europe for a subset of the broader geographic information/geomatics domain (see Annex D for details).

5.7 Germany

One of the defining characteristics of the German case study is the formal system of education in the country. Equal emphasis is placed on academic education and technical training (see Annex E for details).

5.8 Japan

The Japan case study focused on surveying and mapping. In this case, a national examining body is responsible for determining achievement of certification (see Annex F for details).

5.9 Korea

Based on the working group discussion, the Korean model is very similar to the approach in Japan and China. There exist a series of levels and the movement to the next level depends upon a combination of formal education and work experience. To reach the next level, the candidate must pass an exam set by the national body (see Annex G for details).

5.10 Portugal

Training for cartographic production and management of the cadastre of real property is accredited through the National Mapping Agency. The structure of university level education described here will be affected by the new European Union policies (see Annex H for details).

5.11 Saudi Arabia

Saudi Arabia has a traditional university system. To meet the need for technical Geomatics personnel, they have been investigating the concept of technical institutes or colleges. At the same time, they continue to actively study the different models in North America, Europe and Australia (see Annex I for details).

5.12 South Africa

South Africa is unique in that there is a general recognition of the need to redress past unfair discrimination in education, training and employment opportunities and the need to recognize prior learning. A concerted national effort is underway to define the qualifications needed by GIS professionals at various levels of qualification. A formal system of learning objectives and qualifications is expected to be in place very soon (see Annex J for details).

5.13 United Kingdom

The response to this work item was prepared by the Association for Geographic Information (AGI) who has developed a program for continuous professional development. They believe that there is no need for a system of qualifications and certification of personnel since the marketplace is too dynamic; there is too much overlap between the different disciplinary interests; and that a certification system would not serve the interests of the public, the industry or the practitioners (see Annex K for details).

5.14 United States

In the United States, education and training is organized at the state level. There is considerable national variation in the certification of surveyors and other Geomatics professionals. From the industry perspective, there is a concern for technically qualified personnel and the relationship between technology and science. The United States has been a strong proponent of Geographic Information Science. The concept of certification remains an active discussion item, especially within the professional organizations (e.g. URISA). There remains the requirement to balance a concern for the public good against the maintenance of an open, free market Geographic Information economy (see Annex L for details).

5.15 International case studies

5.15.1 International Federation of Surveyors (FIG)

National professional associations see value in forming international bodies. Within the geographic information/geomatics field, FIG has been very effective in presenting the international interests of the surveying profession. Within the context of certification, they have adopted a mutual recognition of qualification strategy leading to greater labour mobility of survey professionals. This requires institutional recognition of equivalence between member countries and measures of individual competence. The concept has obvious utility within the context of the European Union.

While this approach may be quite feasible within the narrow definition of Geomatics employed by FIG, the broad definition of geographic information/geomatics used by ISO/TC 211 suggests it may be difficult to implement more widely within the profession (see Annex M for details).

5.15.2 International Hydrographic Organization (IHO)

In the hydrographic community, there prevails the concept of shared ownership of the oceans and the need for standardization of electronic navigation charts. In comparison with land-based mapping, the number of agencies or partners is much reduced. The existence of an international curriculum provides an excellent model for the creation of a certification system albeit for a narrowly defined domain.

5.15.3 International Society for Photogrammetry and Remote Sensing (ISPRS)

The International Society for Photogrammetry and Remote Sensing is an international scientific society that, according to its mission statement, is “devoted to the development of international cooperation for the advancement of knowledge, research, development, education and training in the photogrammetry, remote sensing and spatial information sciences, their integration and applications, to contribute to the well-being of humanity and the sustainability of the environment”. Membership of ISPRS is within the categories of Ordinary Member, Associate Member, Regional Member or Sustaining Member. No minimum qualifications are placed on member organizations to join ISPRS.

Member organizations may have minimum qualification criteria within their own organizations, but they are not assessed by ISPRS as criteria for membership. Professionals working in the fields of photogrammetry, remote sensing and spatial information sciences within their own country will be required to gain suitable qualifications to practise. These are usually tertiary level qualifications, but ISPRS does not monitor the level of these qualifications, nor does it attempt to standardize levels of qualifications of practicing professionals in each country. Hence, the international reputation of ISPRS is dependent on the output of individuals within its members, as displayed in its conferences and publications.

6 Discussion

6.1 Introduction

Each case study was to be divided into four sections: definitions, national professional associations, current qualifications and certification initiatives and future directions. Given the variation in terminology, it made more sense to allow each country to define its own terms. These definitions refer to both the subject domain and the education system. Within each country, certain professional associations are more active than others. These associations may or may not be linked to the international forum.

The core component of the case study is the description of current initiatives. These initiatives include existing certification systems and mechanisms for the achievement of competency in the relevant technical or conceptual domain. Future directions elucidate areas of concern, where current initiatives are inadequate or where new technologies and concepts are changing the face of the industry.

6.2 Definitions

Even with a limited set of case studies, there is no consistency in the use of terms to describe the profession. Geomatics has strong acceptance in Canada. In the United States, academically, there is a movement to establish the term ”Geographic Information Science”. The Europeans prefer the term “GeoInformatics”, whereas in Australia there is primary reference to Spatial Information Systems. In South Africa, both terms Geomatics and Geoinformatics are in common use. The preferred terminology appears to be a function of historic events and the prevailing education system.

Within the context of ISO/TC 211, terms must be open and inclusive. Rather than invent new “inclusive” terminology, the preference is to equate a variety of different national terms under a broad consensus.

6.3 National professional organizations

In theory, the international professional organizations exist at the country level. In practice, different professional groups may or may not be active in a country. The other challenge is that in large geographically extensive countries, there is considerable variation in different states and provinces. This variation may be greater than between countries.

Japan and Korea have established national government bodies, which have responsibility for the certification of personnel. Germany has a strong educational structure, which has certain similarities to these Far East countries. In the UK, a number of professional organizations are linked to AGI, which is a consortium of private and public interests. Canada and the United States have academic consortium (e.g. UCGIS) and also active professional bodies (e.g. ASPRS, URISA, CRSS). In South Africa a strong national association (GISSA) has formed to bring together regional GIS organizations.

6.4 Current qualifications and certification initiatives

6.4.1 Introduction

While limited in coverage, the set of submitted case studies allowed the identification of a number of critical dimensions across which the different national systems of qualification and certification varied. These dimensions are described in the following sections.

6.4.2 Authorities who confer qualification and certification

In those countries where a system exists, the organization that confers or acknowledges a level of qualification or certification may include one or more of the following:

— Accredited universities

— A government agency

— Professional organizations

— Industry or Trade organizations

6.4.3 Methods for determining required competency

Recently, there has been a significant effort by various agencies and countries worldwide to define skill sets and competencies. Technical skills are often amenable to measurement under national vocational qualifications system (e.g. Australia, UK, South Africa). FIG has been working on the definition of competencies. Within the academic community, there is a history of attempts to define core curriculum, in particular in the United States with GIS e.g. NCGIA, UCGIS. Through an organization like UNIGIS with its presence in several countries, there is the potential for a *de facto* international curriculum.

Required competency can be stated and assessed in a number of different ways. These include

— competency/knowledge/skills guidelines such as those provided by national governmental vocational qualifications and professional association guidelines,

— international regulations such as those set out by IHO,

— standardized curricula.

6.4.4 Levels of qualification/certification conferred

In those countries where systems exist, professionals can be qualified at one or more levels. How those levels are defined varies considerably.

6.4.5 Factors used in determining the level of qualification/certification

In general, there are two factors used to determine if an individual can be considered for a certain level of qualification or certification. The weight accorded to each of these varies. These factors are

— level of academic education,

— amount of practical experience.

6.4.6 Mechanisms for granting qualification/certification

There is a very broad range of mechanisms used to assess and grant qualifications and certification. This includes

— mutual recognition of qualifications (see Annex B FIG),

— examinations as part of an education program,

— examinations independent of education,

— portfolio assessment,

— continuing professional development programs.

The mutual recognition strategy is particularly applicable to the exchange of personnel between countries with a similar institutional structure. However it may not be appropriate where matching institutions do not exist. To be effective, it requires careful assessment of both formal academic programs and work experience, since the recognized educational value of these components varies and the content, duration and assessment of formal courses has wide cultural and institutional discrepancies.

6.5 Future directions

If we accept the continued globalization of society, then there will be an increased demand for transferability of skills and qualifications across national boundaries. This serves to illustrate the need for continued effort to develop some equivalencies between different curricula and the work experience components.

If it were possible within the broad definition of Geographic Information / Geomatics to create an agreed international curriculum as in the IHO case, this could lead to *de facto* standardization. However, with the increasing delivery of courses over the Internet, the challenge will be to measure the practical applications of the science and technology and professional experience.

Within the field of technical education, in some countries such as Canada, there is a trend towards “portfolio” education, where the portfolio contains a learning contract and examples of the students’ work. In these cases, it will be important to find consistent methods to assess the contents of the portfolio and to ensure that the work has been completed by that individual.

We can establish frameworks and policies for dialogue between professional organizations and national education bodies. Ultimately, skills and competencies are tied to the individual. To establish a credible and workable certification system will require further research on existing national situations, i.e. additional country case studies addressing qualification across the full range of relevant domains and better understanding of current trends in technical education research.

Present barriers to progress on this complex subject are lack of consensus on the subject domains, lack of interest by a number of the contributing professions, lack of understanding of different learning strategies in different countries. On the horizon, we can see new attempts to define skills and competencies, new curriculum models and new delivery mechanisms.

7 Recommendations

Given the range of approaches, definitions and solutions identified by this limited set of case studies, this project team concludes that it is not possible, within the context of the ad hoc set of technical experts, to achieve the original goals of the project (see Annex M for details). These findings cannot provide an exhaustive review of all existing systems of qualification and certification. However, the research has identified a number of workable mechanisms and thus the project team presents the following recommendations.

1) An effective and feasible system for the transferability of qualifications and certification of personnel in geographic information/geomatics should be advanced by a broadly based international professional organization which promotes the wide range of qualification and certification systems currently in place within individual countries. Such a system would support the national and international mobility of properly trained and educated personnel in the field of geographic information/geomatics.

2) The domain embraced by this organization must be inclusive and extend to all disciplines encompassed broadly by the ISO/TC 211 definition of the field. This organization shall invite representation from all relevant international associations, including members of the ISO/TC 211 community as well as other related international and national organizations.

3) At all times, this organization must acknowledge the dynamic and evolving nature of the domain and related technologies and thus should take care not to institute any procedures or requirements which would make it difficult for professionals to advance the knowledge and skill sets required.

4) A preliminary charge of this organization should be to extend and further investigate the findings of this project team, building upon the framework outlined here in order that similarities and differences between national and regional systems can be identified and equated. Examples of national or regional qualification and certification systems, which may act as examples for implementation in or comparison among other countries and regions, should be documented.

   Our historical model is the 1995 report by Professor Allan on “The Education and Practice of the Geodetics Surveyor in Western Europe”. Today, we need a new report which addresses the “The Education and Practice of the Geographic Information / Geomatics professional in the global marketplace”. This is a much broader subject domain with a larger geographic area of concern. The current document offers a first step in that direction.

Annex A
(informative)

National case studies — Australia

A.1 Definitions

A.1.1 Spatial Information Services

Spatial Information Services are characterized by the collection, storage, manipulation, analysis and display of data and information which can be related to a location on the Earth; and the use of that information for the purpose of planning and implementing the efficient administration and development of the land, the sea and structures thereon.

NOTE Property Services Training Advisory Body Ltd, 1998.

A.1.2 Geomatics

The science of Geomatics is concerned with the measurement, representation, analysis, management, retrieval and display of spatial information describing both the Earth's physical features and the built environment.

Geomatics includes disciplines such as

— Surveying;

— Geodesy;

— Remote Sensing & Photogrammetry;

— Cartography;

— Geographic Information Systems;

— Global Positioning Systems.

NOTE Centre for Spatial Information Science, University of Tasmania.

A.1.3 Commentary

— While the terms “geomatics” and “geoinformatics” have gained some currency in Australia, their use has generally been confined to academia and the naming of qualifications. No professional organization has included either term in its name.

— The term “spatial information” has gained wide acceptance as an umbrella term covering the full spectrum of the industry.

— The traditional terms of “surveying”, “cartography”, “photogrammetry” and “remote sensing” persist as a mechanism for distinguishing between sectors of the industry.

A.2 Education and Training

A large proportion of the material for this section was sourced directly from “National Competency Standards for Spatial Information Services”, Property Services Training Australia, 1998.

A.2.1 Overview

- Spatial information services qualifications are structured to conform to the Australian Qualifications Framework (AQF) Level Descriptors. An outline of the AQF is included as Attachment A to this case study.
- The key characteristics which distinguish levels of the AQF are
  - Autonomy;
  - Responsibility and accountability;
  - Complexity of skill and knowledge;
  - Choice and range of contingencies;
  - Discretion and judgment.
- Spatial information services qualifications are available at the Certificate, Diploma, Advanced Diploma, Bachelor Degree and all post-graduate levels.
- Courses are provided by
  - Universities – bodies authorized by legislation to award degrees;
  - Colleges of Technical and Further Education (TAFE) – publicly funded post-secondary institutions – that, generally speaking, do not grant university-level degrees.
  - Private Training Institutions – for industry short courses.

A.2.2 Competency Standards

- In 1998, Property Services Training Australia (PSTA) undertook a project to develop national competency standards for spatial information services. The project’s focus was on developing standards that could lead to qualifications in the vocational education/training sector up to Advanced Diploma. The standards were a response to the need for
  - consistent industry benchmarks for assessment and training in the vocational education/training sector, and
  - the need for national coherency in qualifications and training in the industry.
- The competency standards were developed on the basis that training must be undertaken in the context of meeting the needs of industry. They describe the performance required in the workplace and the knowledge and skills necessary to undertake work to a particular standard. Their scope covers the work of those whose primary role is related to
  - the acquisition of spatial data,
  - the management and manipulation of spatial data, and
  - the delivery of spatial information products, services or design.

- The standards were developed following extensive industry consultations and validation. Sources of information included
  - existing competency standards, curriculum, job descriptions, skills audits,
  - research documents on Spatial Information Services,
  - advice from workplaces,
  - advice from national focus groups,
  - advice and workshops by members of the National Sub-Committee.
- A functional approach to the industry was applied during standards development, functions providing a focus on work outcomes. The functional approach had the advantage of highlighting common areas of work across jobs that appeared quite distinct when viewed as a series of occupations. Five broad functional areas were identified as having application across a wide range of organizations, being:
  - Project Management;
  - Data Acquisition;
  - Data Management and Manipulation;
  - Design and Delivery;
  - Business Operations.
- Having national competency standards means that assessment will take place against competencies and that future training and national qualifications will be developed with direct reference to what industry needs.

A.2.3 Qualifications and Courses

- The structure of post-secondary education for the Spatial Information Services industry closely follows that of Canada.
- The Spatial Information Services Industry standards have been packaged and indicatively aligned to the Australian Qualifications Framework (AQF) at Certificate II, Certificate III, Certificate IV, Diploma and Advanced Diploma. The full-time duration of these courses varies from one semester (Certificate II) to two years (Diploma and Advanced Diploma). Areas covered include
  - Surveying;
  - Cartography;
  - Land Information System;
  - Geographic Information Systems.
- Degree-level qualifications are typically offered in the land surveying or spatial information systems streams. Institutions that offer qualifications in both streams (for example, Bachelor of Geographic Information Systems and Bachelor of Geoinformatics and Surveying) usually include a level of commonality in the early years, incorporating units such as Surveying, Geodesy, Cartography, Photogrammetry and Remote Sensing, together with core science units such as Information Technology, Mathematics and Geography. The Land Surveying stream subsequently includes coursework in areas such as Land Development Planning, Municipal Engineering, Land Law and Cadastral Studies. The Spatial Information Systems stream includes coursework in areas such as Spatial Data Structures and

Data Bases, Spatial Analysis and Digital Mapping. Degree-level courses in one or both streams are offered by tertiary institutions in all states and territories of Australia (with the exception of the Northern Territory).

— Degree programs that link geographic information and information technology studies are becoming more available (for example Bachelor of Information Technology (Geographic Information Systems and Computing)). In addition, double-degree options (five years duration) are available at several tertiary institutions. Examples include

  — Bachelor of Engineering (Geomatic Engineering) and Bachelor of Science;

  — Bachelor of Engineering (Geomatic Engineering) and Bachelor of Arts;

  — Bachelor of Engineering and Bachelor of Science (Computer Science);

  — Bachelor of Surveying and Civil Engineering;

  — Bachelor of Surveying and Information Technology.

— Most universities with a school of geomatics offer post-graduate programs at one or more of the Graduate Certificate, Graduate Diploma, Masters and Doctorate levels.

— Within the same education institution (and increasingly, between institution), there is usually a systematic progression through the various qualification levels. For example, a Certificate IV in Spatial Data Systems may be the full first year of a Diploma in Spatial Data Systems (2-year course). Similarly a Diploma of Geographic Information Systems may comprise the first two years of a Bachelor of Geographic Information Systems (3-year course) or Bachelor of Geoinformatics and Surveying degree (4-year course), again facilitating qualification upgrades.

A.2.4 National Professional Associations

— Within Australia, the following professional institutions have an interest in Geographic Information and Geomatics:

  — Mapping Sciences Institute (MSI) (http://www.mappingsciences.org.au)

  — Institution of Surveyors Australia (ISA) (http://www.isaust.org.au)

  — Institution of Engineering and Mining Surveyors Australia (IEMSA) (http://www.home.aone.net.au/iemsaust)

  — Remote Sensing and Photogrammetry Association of Australia (http://www.rpsaa.com.au)

— The Australian Urban and Regional Information Systems Association (AURISA) (http://www.aurisa.asn.au) provides a forum for all practitioners and organizations with an interest in spatial information services. This organization is supported by both GIS professionals and by those who use GIS in other occupational areas.

A.2.5 Certification

A.2.5.1 Professional recognition

— In general, professional recognition is gained through membership of the appropriate professional body. Membership is usually dependent on an academic qualification or a period of long experience.

— There is currently no statutory professional recognition for industry practitioners other than the gaining of registration as a surveyor. This precludes a large group of people, including GIS and IT professionals, who specialize in spatial information systems and applications.

— The Institution of Surveyors Australia is currently investigating the implementation of a voluntary accreditation system for professional surveyors who work in areas outside of the jurisdictions of the Surveyors' Boards. This scheme is being established jointly with other associations under the banner of Spatial Sciences Accreditation Australia.

A.2.5.2 Registration of Surveyors

— The practice of surveying in each Australian state and territory is governed by a “Surveyors' Board” or similar body. The authority of the Boards is derived from government legislation. A Board will have the power to register surveyors. In some jurisdictions, surveyors whose registration is endorsed to enable them to perform cadastral surveys are referred to as Licensed Surveyors.

— Typically, registration as a surveyor requires

  — an appropriate degree,

  — completion of a period of practical experience under the supervision of a registered surveyor,

  — completion of a professional assessment project.

— If an applicant wishes their registration to be endorsed to enable the practice of cadastral surveying, the period of practical experience must be under the supervision of a licensed surveyor and the professional assessment project must be in cadastral surveying.

— Registration as a Mine Surveyor is possible in some Australian states.

— Surveyors' Boards in some jurisdictions have made provision for the registration of practitioners with certificate or diploma level qualifications. A period of practical experience is required prior to registration. Emphasis is on technical competence.

— Reciprocal arrangements between Surveyors' Boards in Australia and New Zealand allow surveyors to practice outside their jurisdiction of registration subject to a Letter of Accreditation being provided.

A.2.5.3 Hydrographic Surveying

— The Australian Hydrographic Surveyors' Accreditation Panel was set up under the auspices of the Institution of Surveyors Australia (ISA) in 1995. It maintains a register of Accredited Hydrographic Surveyors.

— The Panel enables hydrographic surveyors to apply for voluntary accreditation against guidelines that have been adopted by the Institution, and are aligned to the Standards of Competence as developed by the IHO/FIG Board.

— Hydrographic Surveyors can be accredited by the Panel as to the level of their skills to Level 1, or Level 2, in the specialisms of Industrial Offshore Surveying, Nautical Charting and Surveys for Coastal Zone Management.

— Accreditation will confer eligibility for membership of the Institution of Surveyors, Australia, with notation as a hydrographic surveyor, and inclusion on the Register of Accredited Hydrographic Surveyors.

— Accreditation as a Hydrographic Surveyor is the official recognition by the Institution of Surveyors, Australia Inc (ISA) that a person has demonstrated to the satisfaction of the ISA Australian Hydrographic Surveyor Accreditation Panel (AHSAP) that he or she has the necessary knowledge to perform hydrographic surveys and the ability to apply that knowledge. An applicant must do this by meeting academic and experience qualifications, and submitting documentation to support this. Accreditation will confer eligibility for membership of ISA, with notation as a Hydrographic Surveyor, and inclusion on ISA Hydrographic Commission's list of Accredited Hydrographic Surveyors.

A.2.6 Summary of the Australian Case Study

— As is the case in Canada, the Australian profession of Land Surveying has a well established licensing and registration structure. Reciprocal arrangement between Surveyors' Boards enable surveyors to practice outside their registering jurisdiction subject to a Letter of Accreditation being provided.

— There are no certification measures in the broader Geomatics profession. IT professionals who are making contributions to the electronic delivery and access to geographic information are not part of the current Geomatics certification framework, yet they are active participants in the data standards community (mostly through OGC special interest groups).

— Implementation of a voluntary accreditation system for professional surveyors who work in areas outside of the jurisdictions of the Surveyors' Boards is being investigated. This scheme is being established jointly with other associations under the banner of Spatial Sciences Accreditation Australia.

A.2.7 Bibliography

Material for this case study was obtained from the following sources:

"National Competency Standards for Spatial Information Services", *Property Services Training Australia*, 1998

Web site of the Surveyors' Board of Queensland (http://www.qld-som.com.au/C1/Part-c1.html)

Web site of the Center for Spatial Information Science, Department of Geography and Environmental Studies, University of Tasmania (http://info.utas.edu.au/docs/geomatics)

Web site of the Institution of Surveyors, Australia (http://www.isaust.org.au)

Web site of the Institution of Engineering and Mining Surveyors Australia (http://www.home.aone.net.au/iemsaust)

Web site of the Mapping Sciences Institute of Australia (http://www.mappingsciences.org.au)

Web site of the Australian Urban and Regional Information Systems Association (http://www.aurisa.asn.au)

Course material, School of Geoinformatics, Planning and Building, University of South Australia

Course Material, Land Information Management Faculty, Onkaparinga Institute

A.3 Attachment A to Australian Case Study

(Sourced from "National Competency Standards for Spatial Information Services", *Property Services Training Australia,* 1998.)

A.3.1 Draft National Competency Standards for Spatial Information Services

A.3.1.1 Australian Qualifications Framework Level Descriptors

A.3.1.1.1 Senior Secondary Certificate of Education

Studies range from traditional academic disciplines taken to prepare students for university entry to more vocational and semi-vocational courses taken to prepare students to enter the workforce directly or to enter formal training programs.

A mix of directed classroom studies, extensive written assessments, formal examinations and/or common assessment tasks. Other studies may require application of skills, understandings, performance and project work, and group work and fieldwork activities.

The balance between breadth as against depth of knowledge and skills, and between academic disciplines and applied and work-related courses may vary depending on the needs of the student.

A.3.1.1.2 Certificate I

Breadth, depth and complexity of knowledge and skills would prepare a person to perform a defined range of activities most of which may be routine and predictable.

Applications may include a variety of employment-related skills including preparatory access and participation skills, broad based induction skills and/or specific workplace skills. They may also include participation in a team or work group.

A.3.1.1.3 Certificate II

Breadth, depth and complexity of knowledge and skills would prepare a person to perform in a range of varied activities or knowledge application where there is a clearly defined range of contexts in which the choice of actions required is usually clear and there is limited complexity in the range of options to be applied.

Performance of a prescribed range of functions involving known routines and procedures and some accountability for the quality of outcomes.

Applications may include some complex or non-routine activities involving individual responsibility or autonomy and/or collaboration with others through members of a group or team.

A.3.1.1.4 Certificate III

Breadth, depth and complexity of knowledge and competencies would cover selecting, adapting and transferring skills and knowledge to new environments and providing technical advice and some leadership in resolution of specific problems. This would be applied across a range of roles in a variety of contexts with some complexity in the extent and choice of options available.

Performance of a defined range of skilled operations, usually within a range of broader related activities involving known routines, methods and procedures, where some discretion and judgement is required in the selection of equipment, services or contingency measures and within known time constraints.

Applications may involve some responsibility for others. Participation in teams including group or team coordination may be involved.

A.3.1.1.5 Certificate IV

Breadth, depth and complexity of knowledge and competencies would cover a broad range of varied activities or application in a wider variety of contexts most of which are complex and non-routine. Leadership and guidance are involved when organizing activities of self and others as well as contributing to technical solutions of a non-routine or contingency nature.

Performance of a broad range of skilled applications including requirements to evaluate and analyse current practices, develop new criteria and procedures for performing current practices and provision of some leadership and guidance to others in the application and planning of the skills.

Applications involve responsibility for, and limited organisations of, others.

A.3.1.1.6 Diploma

Breadth, depth and complexity cover planning and initiation of alternative approaches to skills or knowledge applications across a broad range of technical and/or management requirements, evaluation and coordination.

The self-directed application of knowledge and skills, with substantial depth in some areas where judgement is required in planning and selecting appropriate equipment, services and techniques for self and others.

Applications involve participation in development of strategic initiatives, as well as personal responsibility and autonomy in performing complex technical operations or organizing others. It may include participation in teams including teams concerned with planning and evaluation functions. Group or team coordination may be involved.

The degree of emphasis on breadth as against depth of knowledge and skills may vary between qualifications granted at this level.

A.3.1.1.7 Advanced Diploma

Breadth, depth and complexity involve analysis, diagnosis, design, planning, execution and evaluation across a broad range of technical and/or management functions including development of new criteria or applications or knowledge or procedures.

The application of a significant range of fundamental principles and complex techniques across a wide and often unpredictable variety of contexts in relation to either varied or highly specific functions. Contribution to the development of a broad plan, budget or strategy is involved as well as accountability and responsibility for self and others in achieving the outcomes.

Applications involve significant judgement in planning, design, technical or leadership guidance functions related to products, services, operations or procedures.

The degree of emphasis on breadth as against depth of knowledge and skills may vary between qualifications granted at this level.

A.3.1.1.8 Bachelor Degree

The acquisition of a systematic and coherent body of knowledge, the underlying principles and concepts, and the associated problem-solving techniques.

Development of the academic skills and attitudes necessary to comprehend and evaluate new information, concepts and evidence from a range of sources.

Development of the ability to review, consolidate, extend and apply the knowledge and techniques learnt.

A course leading to this qualification also usually involves major studies in which significant literature available. Course content is taken to a significant depth and progressively developed to a high level which provides a basis for post-graduate study.

A.3.1.1.9 Graduate Certificate

The qualification may involve broadening skills of individuals already gained in an undergraduate program, or developing vocational knowledge and skills in a new professional area.

A.3.1.1.10 Graduate Diploma

Broadening skills of individuals either already gained in an undergraduate program, or developing vocational knowledge and skills in a new professional area and/or further specialization within a systematic and coherent body of knowledge.

A.3.1.1.11 Masters Degree

The enhancement of specific professional or vocational skills which may be undertaken by directed coursework and/or research, and the acquisition of in-depth understanding in a specific area of knowledge which is usually undertaken through research.

A.3.1.1.12 Doctoral Degree

A searching review of the literature, experimentation or other systematic approach to the relevant body of knowledge.

The undertaking of an original research project resulting in a significant contribution to knowledge and understanding and/or the application of knowledge within a discipline or field of study.

The preparation of a substantial and well-ordered thesis, demonstrating the relationship of the research to the broader framework of the discipline or field of study. Application of knowledge within a field of study.

Annex B
(informative)

National case studies — Austria

B.1 Academic Qualification for Geo-Information Science and Technology in Austria

B.1.1 Introduction

This is an overview of post-secondary and tertiary education in Austria for study fields comprising Geo-Information Science and Technology. In Austria – as well as in many other countries – there are two major aspects that currently dominate the discussion and the status of higher education in these study fields:

— substantial structural changes of university studies and institutions in general,

— rapid development of new fields of study like Geo-Information, breaking into traditional domains and changing those in varying degree.

Remark: The English term “Geographic Information” is in the German-speaking world translated both into “Geographische Information” and “Geo-Information”, since Geography as well as Geodesy have made substantial contributions to this field. By using the abbreviation GI in the sequel, both paths can be combined.

The following section 2 provides an overview of the general system of higher education in Austria. In section 3, an overview of GI-related study courses and their embedding in traditional domains is being given. In section 4, the case study of a new bachelor/master program GEO-IT at the University of Technology in Graz is being presented.

B.2 Higher Education in Austria

Detailed information on this topic can be found on the web pages of the Austrian Federal Ministry for Education, Science and Culture at www.bmbwk.gv.at.

B.2.1 Post-secondary Courses

Access to post-secondary courses [Kollegs] is conditional upon a “Certificate of Maturity” [Reifeprüfung, Matura], a TVE-Diploma or the respective Higher Education Entrance Exam. Post-secondary courses run for four semesters (or six semesters for people under employment). They provide students with the practical and theoretical education of a secondary technical and vocational college and end with a diploma exam. Such courses are offered in engineering, business and the social and services sector. It is also possible to attend training courses in the fields of nursery school teaching and social education. Post-secondary courses are designed to provide mainly graduates of secondary academic schools who do not want to take up studies at a university (see 2.3.2) or at a “Fachhochschule” (FH; see 2.3.1) with the opportunity to acquire initial vocational qualifications within a relatively short time.

B.2.2 Post-secondary Colleges [Akademien]

There are post-secondary colleges for social work [Akademien für Sozialarbeit], teacher training [Pädagogische Akademien] and training of para-medical staff [medizinisch-technische Akademien]. Admission usually presupposes the “Reifeprüfung”-Certificate, the respective Higher Education Entrance Exam or a TVE-Diploma. Classes and exam procedures are similar to those at universities.

B.2.3 Institutes of Higher Education

B.2.3.1 Fachhochschule (FH)

There is no commonly accepted English translation for the term “Fachhochschule”. Therefore in the sequel the abbreviation FH will be used. The FH concept is fairly new in the Austrian academic arena (see www.fhr.ac.at). The respective FH Study Act went into effect in October 1993. Since then, a growing number of study courses (about 100 up to the year 2001) have been initiated all over Austria. Approximately 15’000 students are enrolled in FH courses (compared to approx. 300’000 university students).

FH courses provide for high-quality professional and academic training for specific occupations. Minimum length of studies is six semesters, but usually studies at FH courses last eight semesters, work placement periods included. The structure of the curricula is to guarantee that students may complete their studies within minimum time.

Standard admission requirements are the “Reifeprüfung”-Certificate, the respective Higher Education Entrance Exam, the TVE-Diploma or relevant professional qualifications.

Applicants who have received training in the dual system or in secondary technical and vocational schools need to hold additional qualifications which may be acquired in preparation courses. FH graduates are awarded the academic degree of a “Mag.(FH)” or a “Dipl.-Ing.(FH)”, giving access to doctoral programs which, however, will last two semesters longer than for university graduates.

With respect to structure and organization, FH courses differ considerably from universities. FH courses may be provided by the state or by other corporate bodies of public and private law such as interest groups, local authorities or associations. The most important body for this new type of courses is the “FH-Rat” (an independent council). This council has to approve the FH courses proposed by the various providers. They may be accredited for five years. After this 5-year period the courses are subject to re-approval.

The accreditation of FH courses has to be approved by the Federal Minister of Education, Science and Culture. For accreditation of a course, a number of requirements have to be fulfilled. Needs analysis and feasibility studies have to be submitted, just as regulations on admission and examination procedures. Furthermore, enough staff, appropriate premises and other equipment have to be available for the period of time for which approval is required. Classes have to be held by teaching staff holding adequate academic, professional work-related and pedagogical qualifications.

B.2.3.2 Universities and Art Colleges

There are twelve universities and six colleges for art and music in Austria, all of them are state-run. Austria's universities and art colleges offer 184 different study programs; most of them offer the possibility for further specialization which increases their number to 287.

Since many programs are installed at various universities, the total number of study programs offered at Austrian universities and art colleges amounts to some 640. These regular study programs are complemented by post-graduate ones like doctoral programs [Doktoratsstudien], non-degree study programs [Kurzstudien], career-related courses [Lehrgänge] and some other short study programs.

The College for Music and Performing Arts [Hochschule für Musik und darstellende Kunst] in Vienna is the world's largest college for music. The College for Applied Arts [Hochschule für angewandte Kunst] in Vienna is one of the most important art colleges all over Europe.

Academic standards and the structure of higher education in Austria are characterized by tradition, at the same time, however, Austria's scientific scene has been transformed into a centre of studies and research by recent developments of the modern information society (see also section 2.3.3).

Access to regular study programs is granted to all persons holding a “Reifeprüfung”-Certificate, a TVE-Diploma or the respective Higher Education Entrance Exam who have adequate command of German and who have met the admission requirements for the respective course in their country of origin. As far as students from outside the European Union are concerned, there is a “numerous clausus” for certain programs. In addition to that, admission to art colleges requires the passing of an aptitude test.

The most important type of studies at universities and art colleges are the regular degree programs [Diplomstudien] which are designed to provide students with the academic and artistic basics for their prospective profession. Regular degree programs last for 8 to 12 semesters (universities) or 8 to 16 semesters (art colleges) and are mostly divided into two sections. Few students, however, manage to complete their studies within minimum time. Graduates of regular degree programs are conferred the academic degree “Magister/Magistra” or “Diplom-Ingenieur”/“Diplom-Ingenieurin”, degree programs of medicine leading directly to a doctor's degree.

B.2.3.3 Recent developments: Bachelor/Master Programs

Substantial changes of the Austrian academic arena in recent years (and yet many more to expect in future years) are to be attributed to decisions taken on the European level. In the wake of the Sorbonne Declaration signed in May 1998, the Bologna Declaration of June 1999 on the creation of a European space for higher education is a pledge taken by 29 countries (including Austria) to reform the structures of their own higher education system in such a way that overall convergence emerges from the process at the European level.

The Bologna Declaration has had major impacts on Austria. Existing efforts towards internationalization have been given a new impetus, and reforms which were already in the pipeline for some time have been tackled. Austrian domestic sub-goals derived from the Bologna Declaration have been defined and related action plans have been developed. The areas of action comprise – among others – the introduction of bachelor/master degrees, the wider use of ECTS (European Credit Point Transfer System), additional measures for the promotion of mobility and quality assurance.

The basis for the bachelor/master degree was created by the amendment of the University Study Act in September 1999. One of the first bachelor/master programs introduced in Austria is Geomatics Engineering / Geomatics Science (“GEO-IT”) at the Graz University of Technology (see section 4).

Information about the follow-up structures and activities of the Bologna Declaration at the European level, as well as the follow-up activities in progress at the national and institutional level can be found at www.unige.ch/cre/activities/Bologna%20Forum/Bologna_welcome.htm and www.unige.ch/eua. Further information regarding this convergence process is available at the web site of the National Unions of Students in Europe (ESIB) at www.esib.org/prague.

B.2.3.4 Post-graduate Education

Post-graduate education in Austria has only recently started to expand, thus it is still lacking some kind of organizational structure. Regulations as to providers, admission requirements, fields of study and degrees differ widely. An important step towards the development of and meeting the demands for post-graduate education has been taken with the establishment of the “Danube University Krems” (www.donau-uni.ac.at) in 1994.

The Austrian law governing university studies defines post-graduate studies as courses which may be taken up only by people holding an academic degree (“Magister”, Doctor of Medicine or any equivalent foreign degree). Post-graduate studies comprise:

— Doctoral Programs: Apart from studies of medicine, which lead directly to a doctor's degree, doctoral programs may only be taken up after completion of degree programs. Depending on the course of studies, doctoral programs take two or four semesters and are completed by a dissertation and an oral exam in various subjects. From Fachhochschule (FH) graduates, the doctoral program usually will require two more semesters.

— Special Courses: They comprise “Universitätslehrgänge” and “Hochschullehrgänge” which are provided on an independent basis by art colleges and universities. These courses which are career-related and financed by means of fees usually last 2-4 semesters. Taking into account the whole range of courses, the length of the courses varies between some weeks and 10 semesters.

— MAS and MBS: "Universitätslehrgänge" which are organized on a post-graduate basis and which provide for at least 70 hours per semester may confer a Master's degree (Master of Advanced Studies, Master of Business Administration). An example is being provided by the Master of Space Sciences Program recently initiated by the University of Graz and the TU Graz (see www.spacesciences.oeaw.ac.at). Other "Universitätslehrgänge" which provide for at least 40 hours per semester may confer the title "Academic…" (followed by a term referring to the relevant course).

B.2.3.5 University-like Courses

Upon authorization by the Federal Ministry of Education and Cultural Affairs, non-university institutions of education which also provide for study programs may for a stipulated period of time refer to these programs as "university-like courses". The criteria upon which the university-like character of these courses is to be evaluated are laid down in the Federal Law for University Studies [Universitäts-Studiengesetz]. Prior to this authorization, universities offering courses in the same field and university committees have to be consulted. The right to confer the academic title "Magister" or the title "Academic…" is conditional upon the same prerequisites as required of "Universitätslehrgänge" and "Hochschullehrgänge".

B.3 GI-related academic fields of study in Austria

This overview mainly follows the information contained in the web pages of AGEO, the Austrian Umbrella Organization for Geographic Information (see www.ageo.at). The following places and academic curricula comprise study courses in GI.

Vienna University (Uni Wien): Embedded in the 10-semester regular degree program [Diplomstudium] "Geography" there is an optional specialization in digital cartography and GI being provided. (see also www.gis.univie.ac.at).

Vienna University of Technology (TU Wien): There is a regular 10-semester degree program "Surveying and Geoinformation" [Diplomstudium Vermessung und Geoinformation] as well as a specialization branch [Studienzweig] "Geoinformationswesen" building upon it (see also http://vg.geoinfo.tuwien.ac.at/haupt.htm).

Vienna University of Technology, individual course program "Geoinformation": In addition to the regular program stated above, an individual study branch [Individuelles Diplomstudium] on GI is being offered with a course program that can be slightly modified by students to meet specific GI interests. (see www.geoinfo.tuwien.ac.at/diplom/default.htm).

Vienna University of Agricultural Sciences (Boku Wien): The "Center for GI Technology" stands for support in teaching as well as research and development in the field of GI. (see also www.boku.ac.at/bzg).

Vienna University of Economics and Business Administration (WU Wien): GI is not a standalone field or branch of studies, but it enters some of the courses and study programs e.g. via geomarketing. (see also wu-wien.ac.at).

Graz University (KF-Uni Graz): Embedded in the 10-semester regular degree program [Diplomstudium] "Geography" there are courses dealing with GI, cartography, remote sensing etc. (see www.kfunigraz.ac.at/zvwww/studplan/spgeograph00.html).

Graz University of Technology (TU Graz): As a consequence of the Bologna Declaration (see 2.3.3), a number of study programs is now being transformed into a bachelor/master form. One of the first among these has been the new 6-semester Bachelor Program in Geomatics Engineering as well as the new 4-semester Master Program in Geomatics Science "GEO-IT", replacing the studies in surveying. See also section 4 and www.geo-it.tugraz.at.

Salzburg University: The study program "Geographie-Diplom" focusses on Geographic Information Processing. (see also www.geo.sbg.ac.at/studium/schwerpunkt_giv.htm).

Salzburg University - UNIGIS: The Competence Center for Geographic Information ZGIS (www.zgis.at) at Salzburg University takes part in the worldwide initiative UNIGIS on Postgraduate Courses in Geographical

Information Systems. UNIGIS is a worldwide network of educational institutions which offer distance learning courses in GIS. Institutions within the UNIGIS network offer internationally recognized qualifications for GIS professionals and those seeking to enter the field. (see also www.unigis.ac.at).

Innsbruck University: As in other Austrian universities, GI is embedded in the 10-semester regular degree program [Diplomstudium] "Geography"; there are courses dealing with GI, cartography, remote sensing etc. (see http://geowww.uibk.ac.at/studium).

Klagenfurt University: Embedded in the 10-semester regular degree program [Diplomstudium] "Geography" there are courses dealing with the application of GI etc. (see also www.uni-klu.ac.at/groups/geo).

Fachhochschule Technikum Kärnten (Carinthia Technology Institute CTI): In October 2000, the first program of studies dealing with GI in the new Austrian "Fachhochschule" (FH) domain (see 2.3.1) has been opened in Villach, Carinthia. It is an 8-semester course and the students will obtain an academic degree Dipl.-Ing. (FH) in Geoinformation (see also www.cti.ac.at).

Linz University in cooperation with Graz University of Technology: At the Forschungs-zentrum Rottenmann (Styria), an individual branch of studies [Individuelles Diplomstudium] "Geoinformation Technology (G-TEC)" is being offered. This 8-semester course is blending economics- and technology-oriented domains of GI (see www.rottenmann.at/diplomstudium).

B.4 Example GEO-IT at TU Graz: Bachelor in Geomatics Engineering, Master in Geomatics Science

In October 2001, the 10-semester study program of Surveying & Geodesy [Diplomstudium Vermessungswesen] at the Graz University of Technology (TU Graz) has been replaced by a 6-semester bachelor program "Bakkalaureat Geomatics Engineering" and a subsequent master program "Magisterstudium Geomatics Science". Both programs are being marketed under the label GEO-IT (see www.geo-it.tugraz.at). The graduates from the bachelor program will carry the academic title "Bakk.techn.", while the graduates from the master program will carry the title "Dipl.-Ing". A follow-up doctorate study program would be the last step in a three-tier structure. In this way, conformance to the European initiatives (Bologna Declaration, see 2.3.3) is being achieved.

Since already the first part of the three-tier structure yields an academic graduation, courses had to be re-structured substantially. In the conventional diploma studies, the first few semesters usually contain the basics and the theoretical background of applications which then are being discussed and processed in the last few semesters. Therefore, many of those application aspects had to be brought to the front (i.e. to the bachelor program) while some theoretical backgrounds had to be moved to the back (i.e. to the master program).

Many long discussions and investigations led to the decision to transform the studies in Graz in this way and there is no argument that does not also spawn counter-arguments that do have their merits too. However, in total, the choice of the bachelor/master concept held more promises than drawbacks. A number of aspects and goals are being met by the new structure:

— better European conformance, fostering increased mobility of students and teachers;

— increased compatibility to other bachelor/master programs in Austria; several other study fields – especially IT-related ones – are also changing to the bachelor/master schedule and therefore an interleaving with them will be easier;

— GI can in this way be embedded in the IT mainstream as much as possible;

— a two-tier structure (respectively three-tier if the doctorate is also included in the discussion) will shorten the average length of study per student since two shorter study programs in sequel are easier to manage than one longer study program.

The bachelor program Geomatics Engineeering gives in 6 semesters and in a total of 135 semester hours a thorough preparation for a wide range of occupations dealing with GI and related fields in the IT sector. By opening up to many students interested in general IT matters but looking also for specific examples of IT applications (the GEO-IT applications), the number of applicants is significantly widened in comparison to the previous study program that was dominated by surveying and geodesy and would lead straight into these domains of profession.

A sound background knowledge for an efficient and appropriate handling of data having strong geo-components, of positional and navigational technologies is in the prime interest of the bachelor program. Graduates will carry an academic degree of “Bakk.techn.” and are then eligible either to work in GEO-IT-related occupations or to continue studies in the master program Geomatics Science or in comparable master programs. By a relatively strict curriculum, the bachelor program ensures that the timetable for the length of studies is not endangered.

The master program Geomatics Science is built upon the bachelor program Geomatics Engineering (or comparable other bachelors). In 4 semesters and in a total of 45 semester hours and an additional diploma thesis, it offers a range of choices. In contrast to the Bachelor Program, students of the Master Program can choose among several branches, like

— Geo-Information, and

— Satellite geodesy, positioning, navigation.

The traditional surveying and geodesy disciplines are also being mirrored in the new master program. This means that those students picking the appropriate choices in their master program curriculum are comparable in their knowledge and skills to the Dipl.-Ing. of the former program; also their academic degree will be the same as it used to be. However there are now also other choices for specialization fields available. In the master program, there is much room for integrating courses from research fields and occupations like informatics, civil engineering, traffic and transport, geography, architecture, space sciences etc. In this way, the changing paradigms in those fields that are containing or overlapping with GI are being met in a flexible and efficient way.

Dr. Norbert Bartelme, Univ.Prof., Department of Geodesy

TU Graz, Steyrergasse 30/3/A305, A-8010 Graz, Austria

Norbert.Bartelme@TUGraz.at, www.GEO-IT.TUGraz.at

Jan. 11, 2002

Annex C
(informative)

National case studies — Canada

C.1 Definitions

C.1.1 List of terms

"Geomatics is a field of activities which, using a systemic approach, integrates all the means used to acquire and manage spatial data as part of scientific, administrative, legal and technical operations involved in the process of the production and management of spatial information. These activities include, but are not limited to, cartography, control surveying, engineering surveying, geodesy, hydrography, land information management, land surveying, mining surveying, photogrammetry and remote sensing."

Canadian Institute of Geomatics (CIG) (http://www.cig-acsg.ca)

"Geomatics is the science and technology of gathering, analysing, interpreting, distributing and using geographic information. Geomatics encompasses a broad range of disciplines that can be brought together to create a detailed but understandable picture of the physical world and our place in it. These disciplines include: surveying and mapping, remote sensing, geographic information systems, global positioning systems."

Geomatics Canada (http://www.geocan.NRCan.gc.ca/geomatics/)

"Geomatics is a technology and service sector focusing on the acquisition, storage, analysis, dissemination and management of geographically referenced information for improved decision making."

Geomatics Industry Association of Canada (GIAC) (http://www.giac.ca)

Geographic Information Technologies (ref: Goodchild 1977)

— Technologies for collecting and dealing with geographic information;

— they include at least three broad categories: GIS, Remote Sensing (including Photogrammetry) and GPS.

Geographic Information Science (ref: Goodchild 1997)

— The science behind the technology

— Multidisciplinary field

— Geographic: two dimensional surface representation; three dimensional atmosphere, oceans, and sub-surface

Geographic Information Scientist

— Expert in the conceptual framework of Geographic Information and possessing an in-depth knowledge of an application domain and its geo-temporal context

Geomatics Engineer

— Expert in the conceptual framework of Geographic Information and possessing an in-depth knowledge of spatial systems engineering tools

Geomatics Technologist

— Knowledgeable in the application of GIS and related technologies for the purposes of land, water, air or environmental (including people) management.

C.1.2 Commentary

In Canada, the term "Geomatics" has been embraced by government, industry and the professional associations. The Canadian Institute of Geomatics (CIG) was formerly the Canadian Institute of Surveying and Mapping. Evidence of the close collaboration can be observed in the federal GeoConnections (http://www.cgdi.gc.ca) initiative on the Canadian Geospatial Data Infrastructure (CGDI) and the Geomatics sector human resources study by HAL Corp, commissioned by CIG, GIAC and the Canadian Council of Land Surveyors (CCLS).

C.2 Education and Training

C.2.1 General structure of educational system

Post-secondary Education – Education provided by degree-granting institutions, commonly called universities, and by non-degree granting institutions, which are typically referred to as colleges, community colleges, CEGEP's or institutes of technology.

University – used to designate a degree-granting institution. In Canada universities are generally publicly supported, however they are highly autonomous as they set their own admission standards and degree requirements.

College – applies to a wide range of publicly funded post-secondary institutions that, generally speaking, do not grant university-level degrees.

Community College – a non-degree-granting institution which offers technical or vocational post-secondary courses leading to a diploma or certificate, or courses that can be transferred to a university.

Certificate – a qualification awarded upon successful completion of a university program which is usually one year in length.

Diploma – a qualification awarded on the basis of one or two years of successful study. Usually, it is at less than degree level, but some diplomas are at the graduate level.

Post-graduate diploma – post-graduate diplomas require first degree as a prerequisite.

C.2.2 Commentary

At the post-secondary level, education and training is provided by universities and colleges. The exceptions are industry short courses or private training institutes.

In the field of Geomatics, i.e. GIS and Remote Sensing, technical colleges offer post-graduate diplomas. In the fields of Geomatics and Geographic Information Science, Canadian universities offer a variety of graduate degrees. Technical colleges also accept direct intake from high school into certificate and diploma programs in Geomatics Engineering and Cartography. These graduates may continue to university and complete an undergraduate degree in Geomatics Engineering.

Career paths may commence with an undergraduate degree in an application discipline, followed by a post-graduate diploma at a technical college which, in turn, may lead to employment in the Geomatics sector or further graduate studies at university. (see Figure C.1)

C.3 National Professional Associations

Within Canada, the following professional associations share an interest in Geographic Information and Geomatics.

Canadian Association of Geographers (CAG) http://www.uwindsor.ca/cag/cagindex.html

Canadian Cartographic Association (CCA) http://www.geog.ubc.ca/~cca

Canadian Council of Land Surveyors (CCLS) http://www.ccls-ccag.ca

Canadian Institute of Geomatics (CIG) http://www.cig-acsg.ca

Canadian Remote Sensing Society (CRSS) http://www.casi.ca/remote.htm

This list does not include those professional associations which **apply** Geomatics technologies e.g. forestry, landscape architecture, planning, civil engineering, and hydrology.

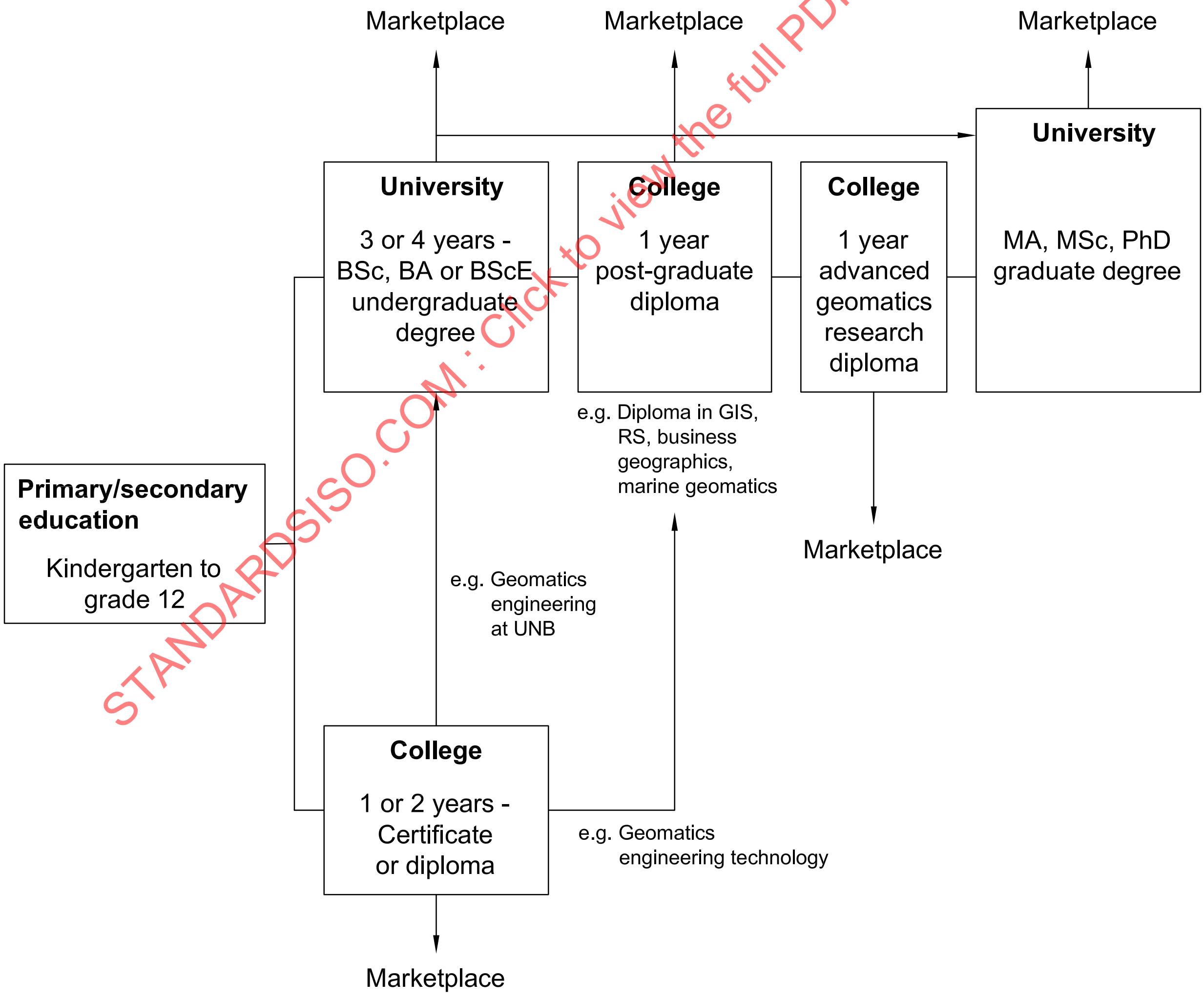

Figure C.1 — Education pathways for Geomatics-related careers (eg. Centre of Geographic Sciences)

C.4 Current Qualifications and Certification Initiatives

There are two types of Geomatics certification in Canada. Voluntary certification exists through a professional association. This is currently available through the Canadian Remote Sensing Society (http://www.crss.ca) and the Canadian Institute of Geomatics (http://www.cig-acsg.ca). (see Figure C.2.)

Canadian Remote Sensing Society (CRSS)

Certified Mapping Scientist in Photogrammetry
Certified Mapping Scientist in GIS
Certified Remote Sensing Scientist

On voluntary certification:

"It is not a substitute for registration as, for example a Land Survey or Professional Engineer. Registration is a legal act to protect the public health, safety and welfare. It is a procedure by various governments that requires "licensing" of certain professions, practices, trades etc. under formal statutes and ordinances to protect the well being of its citizens. Registration may be required by your jurisdiction of work, whether or not you secure certification."

Canadian Institute of Geomatics (CIG): proposed November 2000

Geomatics specialist (photogrammetry)
Geomatics specialist (remote sensing)
Geomatics specialist (GIS/LIS)
Geomatics specialist (GPS-geodesy)

Figure C.2 — Voluntary Geomatics Certification in Canada

The profession of Land Surveyor has a more formal process. To practice land surveying in a particular jurisdiction, the individual must be licensed in that province. This involves both examinations and a practicum. A land surveyor can pass these examinations set by a provincial examination board (e.g. NSLS) or for practicing on federal lands (CLS).

Under the Agreement on Internal Trade, the Canadian Council of Land Surveyors is seeking to standardize this process from province to province, recognizing the specific differences in legislation. The Board of Examiners Coordinating Committee of CCLS also provides a service to universities for the accreditation of their Geomatics programs, which includes Land Surveying courses. (see Figure C.3)

All provinces in Canada have Associations under provincial statutes. The Association of Canada Lands Surveyors (ACLS) is self-governing by federal statute.

" Land Surveyors who practice boundary line determination, which is exclusively restricted and controlled by statute or regulation, must hold a valid license issued by or on behalf of the jurisdiction in which the practice is undertaken."

Draft MRD under NAFTA.

" License is "the right to practice in the exclusive field of cadastral land surveying in the respective jurisdiction."

Draft Labour Mobility Consortium report.

Technical level

There are five Board of Examiners. The candidate is required to satisfy the requirements of the regional board (by credit, exam or equivalent)

Western Canadian Board of Examiners for Land Surveyors (WCBELS)
Atlantic Provinces Board of Examiners for Land Surveyors (APBELS)
Academic and Experience Requirements Committee of the Association of Ontario Land Surveyors (AERC/AOLS)
Board of Examiners of Quebec (OAGQ)
Board of Examiners, Association of Canada Land Surveyors (BE/ACLS)

Professional level

Upon receipt of Board certification, applicant proceeds to the next level – the particular jurisdiction – each having its own Board of Examiners. Normally, the applicant would proceed as follows:

WCBELS: British Columbia, Alberta, Saskatchewan, Manitoba
AERC/AOLS: Ontario
OAGQ: Quebec
APBELS: New Brunswick, Nova Scotia, PEI, Newfoundland
BE/ACLS: Canada Lands Surveyors

Each jurisdiction has the responsibility to ensure that applicants have the necessary knowledge and practical experience under the various statutes governing title interest in that jurisdiction. That is, each provincial association and ACLS has its own Board of Examiners which is responsible for reviewing articles, providing assessing exams for its jurisdiction (including statutes, regulations and case law).

The Canadian Council of Land Surveyors (CCLS) is a body made up of member associations. All self-governing associations of land surveyors in Canada are currently members of CCLS, with the exception of Quebec. CCLS is recognized as the national voice for Land Surveyors in the NAFTA discussions but it is not a "licensing body".

Difficulties arise when looking at the surveyors' role in the broad field of Geomatics. In Ontario, a person may be registered as an Ontario Land Information Professional (OLIP) without being licensed to do boundary determination, for this one must be an OLS. (www.aols.org)

Under the OLIP there are five sub-categories:

Cadastral Surveying
Geodetic Surveying
Hydrographic Surveying
Photogrammetric Surveying
Geographic Information Manager

(Material provided by Philip Milo, Past President CCLS)

Figure C.3 — Licensing Land Surveyors in Canada

Hickling, Arthurs and Low (HAL Corp 2001) have been commissioned by CCLS, CIG and GIAC to update a previous (1994) HRDC sponsored report entitled:

"People and Skills in the Canadian Geomatics sector: positioning for the future."

Their study, based on interviews and surveys, described the current status of Human Resources in the Geomatics sector, the implications for the future, and identified the outstanding issues. Interestingly, one of their conclusions was that there was no significant demand for certification of Geomatics professionals.

Part of the study includes an inventory of Geomatics education and training programs in Canada. The current inventory references thirty-nine universities and twenty-three colleges and technical institutes.

The study defined five main Geomatics areas: Surveying, Earth Observation (Remote Sensing), Geographic Information Systems, Cartography and Navigation and Positioning.

Each of these areas was subdivided into specific field skills and generic skills. (see Figure C.4)

Surveying	**Cartography**
Survey Law Legal surveys procedures Traditional survey equipment Computerized land information systems Global Positioning Systems (GPS) Geographic Information Systems (GIS) Computer Aided Drafting systems (CAD) Computer hardware and software Construction surveying Pre-engineering surveying Property rights systems Land planning and management Understanding/interpretation of data (applied analysis)	Specialized equipment Computer graphic systems Image processing software Image interpretation Geographic Information Systems (GIS) Computer Aided Design systems (CAD) Desktop publishing Computer hardware and software File management: meta data and file transfer
Earth Observation (Remote Sensing)	**Geographic Information Systems (GIS)**
Hyperspectral/ultraspectral/radar/lidar techniques Algorithm development Spectral data exploitation Specialized equipment Large volume data mining Data visualization Data format conversion and GIS/RS integration Field campaign design and implementation *In situ* remote sensing validation techniques LIDAR GIS/RS integration Analytical principles and procedures Electromagnetic spectrum Image acquisition, processing and interpretation	Principles of Geodesy Control survey networks Spatial referencing systems and positioning Computer Aided Drafting systems (CAD) Engineering surveying Coordinate geometry Photogrammetry Computer hardware and software – external databases Surveying, earth observation and cartography Database/information structures, algorithms, design and systems Geospatial data analysis, modelling and display Spatial statistics
Navigation and Positioning	
Electronic navigation systems Custom software User interfaces for navigation and guidance systems Position-related information organized in databases Use of integrated inertial measurement units and GPS Understanding of ellipsoids, datums, map projections Application into other Geomatics sectors Geometrical geodesy	

Figure C.4 — Geomatics Skill Sets in Canada

C.5 Future Directions

The HAL Corp study takes a demand and supply approach to Human Resources in the Geomatics sector. The demand is driven by the marketplace and the rapid changes in IT and sensor technology. While the educational institutions, traditionally, find it difficult to respond rapidly, there is evidence that there is movement towards greater flexibility, placeless education and “just-in-time” training. Three initiatives are described below. It is noticeable however that this volatility has not lead towards professional certification but rather credit exchanges and the certification of expertise in particular industry products.

a) The distinction between universities and colleges is becoming blurred. Colleges are seeking to partner with universities such that the post-graduate diploma becomes an integral component of a graduate degree (see Figure C.1). Universities are recognizing the need for new graduate degrees in Geographic Information Science and also more joint degrees between Geomatics and other sciences (physical, social and health). Colleges are developing specialized post-graduate diploma programs in the **application** of Geomatics technologies e.g. Marine Geomatics, Business Geographics at the Centre of Geographic Sciences (COGS).

b) The recommendations from the HAL study will promote best practices in Geomatics education and training. This will include joint cross-institution programs, greater credit transfer, distance learning components and new relationships between the private sector and academic institutions.

c) The federal government, likewise, is promoting several new initiatives. They encompass standards and the Canadian geospatial data infrastructure, a new data pricing model, more funding for Applied Geomatics research and economic encouragement to the Geomatics sector. These initiatives impact education and training needs.

C.6 Summary of the Canadian Case Study

The Canadian profession of Land Surveying has a well established licensing and registration structure. Under the CCLS, they are addressing issues of labour mobility within Canada (Agreement on Internal Trade, AIT) and in North America (North American Free Trade Agreement, NAFTA). The broader Geomatics profession has instituted new voluntary certification measures which include several of the specialist groups. The success of these new measures depends on the response from their respective membership.

A third component of the broad Geomatics profession are those professionals in the IT sector who are making contributions to the electronic delivery and access to geographic information. This group, operating with spatial data warehouse and Internet mapping tools, are not part of the current Geomatics certification framework and yet, they are active participants in the data standards (ISO/TC211) community.

Canada offers an excellent example of the diversity of interests involved with qualifications and certification of personnel. The traditional professions are struggling to realign themselves with the new technological and global perspective. Technology brings new techniques and methods which replace the old approaches to traditional problems. Some technologies revolutionize the conceptualization of the problem and hence define new disciplines and domains.

Within the context of Project 19122, the following observations are considered appropriate.

a) The traditional Canadian professionalism associated with Land Surveying is unlikely to disappear in the near future. Furthermore, the international activities of FIG for mutual recognition are consistent with these efforts. The challenge for the profession is its ability to assimilate the new technologies.

b) The concept of a broader Geomatics seems problematic since the definition of its boundaries remains open to debate. The voluntary certification of specialist areas within the broader field is a relatively recent strategy. It remains to be seen whether this new strategy will bring the desired recognition and structure to the broader field.

Within the context of data standards of geographic information, there is a group of IT professionals who are developing new tools for the delivery and access to this type of information. Currently, this specialist group is not represented within the Canadian case study.

Annex D
(informative)

National case studies — Finland

NOTE Please refer to:

http://www.ge.ucl.ac.uk/clge/allan_report/D14.html

Annex E
(informative)

National case studies — Germany

E.1 Introduction

E.1.1 General Information

In order to give the reader an impression about the various universities where GIS-related educational programmes exist or courses in GIS are taught, the following table is presented. The data is taken from the “Higher Education Compass", a database published by the German Association of Universities and other Higher Education Institutions (Hochschulrektorenkonferenz HEI). The last update took place June 29th, 2001.

The majority of GIS-education on the level of the HEI is achieved in the disciplines of geography and geodesy. In the last years the new discipline of geoinformatics has been established at various HEI. In most cases Geoinformatics was formed from the original disciplines of geography, geodesy and informatics.

Elements of GIS-education may be found in many other neighbouring disciplines. The most important ones have been chosen to illustrate the role of GIS-education and GIS-research in Germany: Agricultural sciences, environmental sciences, forestry, geology, landscape architecture and spatial planning. With no doubt GIS-topics play a role in other disciplines like computer sciences and economic sciences too. They may be taken into consideration in a broader sense as well.

Table E.1 — Higher Education Institutions (HEI) in Germany with GIS-related education and research

	geog	geod	geoi		agr s	env s	for	geol	la ar	sp pl
Aachen	U							U		
Anhalt (Dessau)		F			F	F			F	
Augsburg	U									
Bamberg	U									
Bayreuth	U					U				
Berlin	2U	U+F			U+I	U		U	2U+F	U
Bielefeld	U					U				
Bingen					F	F				
Bochum	U	F	F			U		U		
Bonn	U	U			U			U		
Braunschweig						U				
Bremen	U					U+F+I				
Chemnitz	U									
Clausthal						U		U		
Cottbus						U				U

Table E.1 (*continued*)

	geog	geod	geoi		agr s	env s	for	geol	la ar	sp pl
Darmstadt		U								
Dortmund										U
Dresden	U	U+F			F	U	U+I	U	U+F	
Duisburg	U									
Düsseldorf	U									
Eberswalde							F		F	
Eichstätt	U									
Erfurt									F	
Erlangen-Nürnberg	U							U		
Essen	U					U			F	
Esslingen						F				
Frankfurt/M.	U	F						U		
Freiberg		U				U+I		U+I		
Freiburg	U						U	U		
Furtwangen						F				
Gießen	U				I		I			
Göttingen	U				U		U+F			
Greifswald	U							U	U	
Halle-Wittenberg	U				U	U		U		
Hamburg	U		F			U+F+2I		U		U
Hannover	U	U							U	
Heidelberg	U							U		
Hildesheim							F			
Hohenheim					U+I					
Jena	U					U		U		
Kaiserslautern										U
Karlsruhe	U	U+F+I	F			U		U		
Kassel	U				U				U	U
Kiel	U				U+F+I			U		
Koblenz	U					U+F				F
Köln	U							U		
Leipzig	U							U		
Lübeck						F				
Lüneburg						U				
Mainz	U		F					U		
Magdeburg						I				
Mannheim	U+I					F				
Marburg	U							U		

Table E.1 (*continued*)

	geog	geod	geoi		agr s	env s	for	geol	la ar	sp pl
Mittweida						F				
München	2U	2U+F	F		U		U+I	2U	U	
Münster	U		U						U	
Neubrandenburg		F	F		F+I				F	
Nürtingen					F	I			F	F
Paderborn	U				F	F			F	
Passau	U									
Potsdam	U					U		U		
Oldenburg		F	F			U			U	
Osnabrück	U				F				F	
Regensburg	U									
Rostock					U				U	
Rottenburg							F			
Saarbrücken		U								
Stuttgart	U	U+F+I				U+I		U		2I
Trier	U					U+F				F
Tübingen	U					U				
Vechta	U					U				
Weihenstephan					F	F	F		F	
Weimar										I
Wiesbaden					F				F	
Würzburg	U	F						U		
Zittau						U+F				

Comments:

geog	=	geography	including	physical, cultural and economic geography
geod	=	geodesy	including	surveying, cartography, photogrammetry
geoi	=	geoinformatics	including	geomatics
agr s	=	agricultural sciences	including	agroecology, agrobiology, agricultural marketing, agricultural management, agroeconomics

Table E.1 (*continued*)

env s	=	environmental sciences	including	environmental protection, environmental monitoring, environmental engineering, ecology, nature conservation, quality, safety and environment, geoecology
for	=	forestry		
geol	=	geology		
la ar	=	landscape architecture	including	landscape cultivation, landscape planning, landscape ecology
sp pl	=	spatial planning	including	environmental planning, infrastructure and environment, infrastructural planning, urban planning
U	=	Diploma-degree at the Universität (university) or diploma-degree at the Technische Universität (technical university) or schoolmaster at the Universität (university)		
F	=	Diploma-degree at the Fachhochschule (Diplom (FH))		
I	=	International degree: Bachelor-degree at the University or Master-degree at the University or Bachelor-degree at the Fachhochschule (University of Applied Sciences) or Master-degree at the Fachhochschule		
2U, 2F, 2I	=	The discipline is offered at two HEI at this city		
The education at other HEI like the pedagogical schools has not been regarded in the Table E.1.				

E.1.2 Research — Topics

The following research-topics are related to the given groups. Many of the topics are taken from a study of Bill [2001]:

— geography: GIS and remote sensing, environmental modelling, location-allocation problems and spatial interaction, climatology, regional research, geology, geomorphology and terrain relief, ecology and ecosystems research;

— geodesy: ATKIS - ALKIS - AFIS (German land information systems), digital terrain models, remote sensing and GIS, digital cartography, raster vector conversion and hybrid GIS, 3-D city models, 3-D GIS, data quality, GIS and the Internet;

— agricultural sciences: remote sensing, terrain relief, modelling of material flows in soils, water protection, precision farming, environmental damage and environmental protection;

— environmental sciences: environmental monitoring, environmental information systems, GIS in the planning process, databases for environmental samples;

— forestry: landscape information systems, hybrid GIS for forestry planning;

— landscape planning: GIS in municipalities, GIS in landscape planning, environmental information systems; and

— spatial planning: urban information systems, environmental quality targets, GIS for citizens, GIS as the base of the planning and decision-making process.

E.2 The General Situation of Geomatics Education in Germany

E.2.1 Traditional and Non-traditional Ways

In Germany the academic educational program has the objective to train students able to perform tasks in all fields of surveying, geoinformatics and geodesy so that the engineer in geomatics and geodesy fulfils all prerequisites for all professional activities in theoretical and applied surveying engineering, in geodesy and in geoinformation systems. In our country we did not follow the consecutive system of higher education, which is also called the Anglo-Saxon system. This means that our classical Universities grant a diploma after a minimum study time of 4.5 years (9 semesters). This diploma, called “Diplomingenieur”, is comparable to a master's degree in other countries. Besides the classical Universities there exists a great number of so-called “Universities or Colleges of Applied Sciences (Fachhochschulen)” with a study time of 3.5 years. Their diploma may be compared to the degree of a bachelor at honours level. The diploma at these institutions is also called “Diplomingenieur”.

The education of geomatic engineers at the Universities of Applied Sciences (Fachhochschulen (FH)) differs from that at the Universities in the following principal characteristics: The solution of practical problems is strongly emphasized in teaching, i.e. the education at FHs has a very strong practical basis. The time spent on practicals and exercises is over 35% of the total contact time. Relevance to practice is a strong criterion in the selection of study content. The teaching of the theoretical scientific principles can therefore not be done with the same intensity as it is provided at the Universities. The courses, which normally include one or two practical semesters as well as the completion of a diploma thesis, take four years to complete as a rule. Over 90% of students complete the course within this time frame. This is only possible because the organization of the curriculum is somewhat rigid and allows the students less freedom than is found in the university courses. Apart from the formal course, students are required to have at least 13 weeks' practical experience in surveying firms, offices or institutions, 8 weeks of which have to be completed before the course can be commenced.

However, there are, since 1998, possibilities for both the classical Universities and the Universities of Applied Sciences to develop both kinds of programmes leading to Dipl.-Ing. TU or Dipl.-Ing. FH, or to BS and MS degrees. At a first stage the new courses will be introduced on a trial basis besides the existing ones. A final decision will be made after completion of this test run. The Universities are individually responsible when to put the change into effect. A very few have already chosen to go this way. The majority is waiting and observing how this new approach will be accepted. For instance the University of Bonn is introducing a MS-course in Geoinformation Systems starting in October 2003.

This complete different approach in our curricula is in accordance with the European Ministers of Education joint declaration (“Bologna agreement”) in June 1999 [European Ministers of Education, 1999] to co-ordinate their policies to achieve within the first decade of the 21st century the adoption of a system of easily comparable degrees consisting of two main cycles:

a) an undergraduate cycle lasting a minimum of three years,

b) a graduate cycle leading to master’s and/or doctorate degrees.

The new courses will have a modular structure and will, as regards content, be measured against an EU-wide uniform system of marks, which can be compared to the Anglo-American “credit-point”-system, that is measuring the various modules in quantity by points and quality by marks. In case the courses fulfil certain minimum requirements, they can be accredited by an accreditation agency. The issuing of accreditations is subject to systematic evaluation. The above agencies obtain the requirements as regards contents and formal procedures from an accreditation council assigned to the Association of Universities and other Higher Education Institutions (HRK). The accreditation aims at securing both transparency and standards of the offered courses and therefore stands beside the state approval of the study courses for the time being. More details are given in the paper of Wehmann, W. and Hahn, M. [2002].

One has to become aware that new technical developments lead to a certain contradiction between the increase of subjects and the intensity to be taught at universities and the time available for studies. The consequences for education are a permanent change of the curriculum. But this task, as far as the diploma-system is concerned, has to be done in the framework of general regulations (Rahmenprüfungsordnung, 1999) for the way examinations have to be handled and what subjects have to be taught in geomatics and geodesy. As far as the subjects are concerned, each university can change one or two of them and can weight them differently. These general regulations were set up by a special commission consisting of members of nearly all Universities and Universities of Applied Sciences where geodesy and geomatics is taught, as well as of members coming from practice, i. e. the president of the association of chartered surveyors, the president (head) of a state government surveying office (Landesvermessungsamt) and further members.

The aim of our academic geomatics education is to provide our students with the necessary intellectual versatility in order to keep up with the future challenges in our profession. The university graduation is therefore not the end in itself but the first step in a lifelong learning process.

E.2.2 Current Accreditation and Certification Initiatives

The accreditation by independent accreditation agencies is the most important instrument of the quality assurance of all bachelor's and master's courses in Germany, Wehmann, W.; Hahn, M. [2002]. As far as courses in Surveying, Geodesy, Geoinformatics and Cartography are concerned, only two agencies are currently prepared to undertake accreditations: These are the “Accreditation Agency for Study Programs in Engineering and informatics” (ASII) and the “Central Evaluation and Accreditation Agency of Hanover” (ZEvA). These two agencies cooperate on the accreditation of courses in civil engineering and surveying, use the same experts as auditors in their audit teams to some extent and use essentially the same list of requirements for bachelor's and master's courses. These minimum requirements for the accreditation of bachelor's and master's courses in the engineering sciences and in computer science were set up for every course of studies by commissions of experts of the ASII on which the following bodies were equally represented: universities of technology or general (classic) universities, universities of applied sciences and commercial associations or technical & scientific organizations and professional associations. Similarly, the audit teams are composed of 4 or 5 experts, with a representative from each of: the general or universities of technology, the universities of applied sciences, industry, a second representative of the university type concerned and, optionally, a student representative. It is desirable that a representative of a foreign university is participating, if international bachelor's and master's courses will be accredited. None of the experts may be employed by the university concerned or have a close relationship to the course of studies to be accredited.

Bachelor and master courses and new diplom courses too are accredited by comparison with defined minimum requirements. These requirements are based on the recommendations of the Kultusministerkonferenz as developed by the Accreditation Council, as well as recommendations of the German Scientific Council. Furthermore the minimum requirements were defined in cooperation with national and international scientific organisations, professional and technical bodies and practitioners. The aim is to make diversity possible in the university sector in Germany and to ensure the quality, transparency and comparability of the education offered and the processes and resource allocation necessary to achieve this. In principle, the accreditation process is independent of the individual field of study, the university and the state. The accreditation is granted in accordance with internationally accepted standards and for a limited period of time. At the end of this period a re-accreditation is required, which includes an evaluation and examines the aims of the course and its translation into practice. To this end the success of the graduates in the labour market is analysed.

Each bachelor's or master's course to be accredited is evaluated according to the following criteria:

— Educational objectives,

— admission criteria,

— curricular requirements,

— extent of study

as well as

— institutional and organizational environment.

E.2.3 Causes for changes in geomatics education at the university level

Beyond any question, the curriculum in geomatics education must be continually re-examined and updated to reflect the changing technological demands and the developments in society and economy. A global perspective is certainly vital for a long-term success. Figure E.1 may give an impression about the different influences concerning our profession and education.

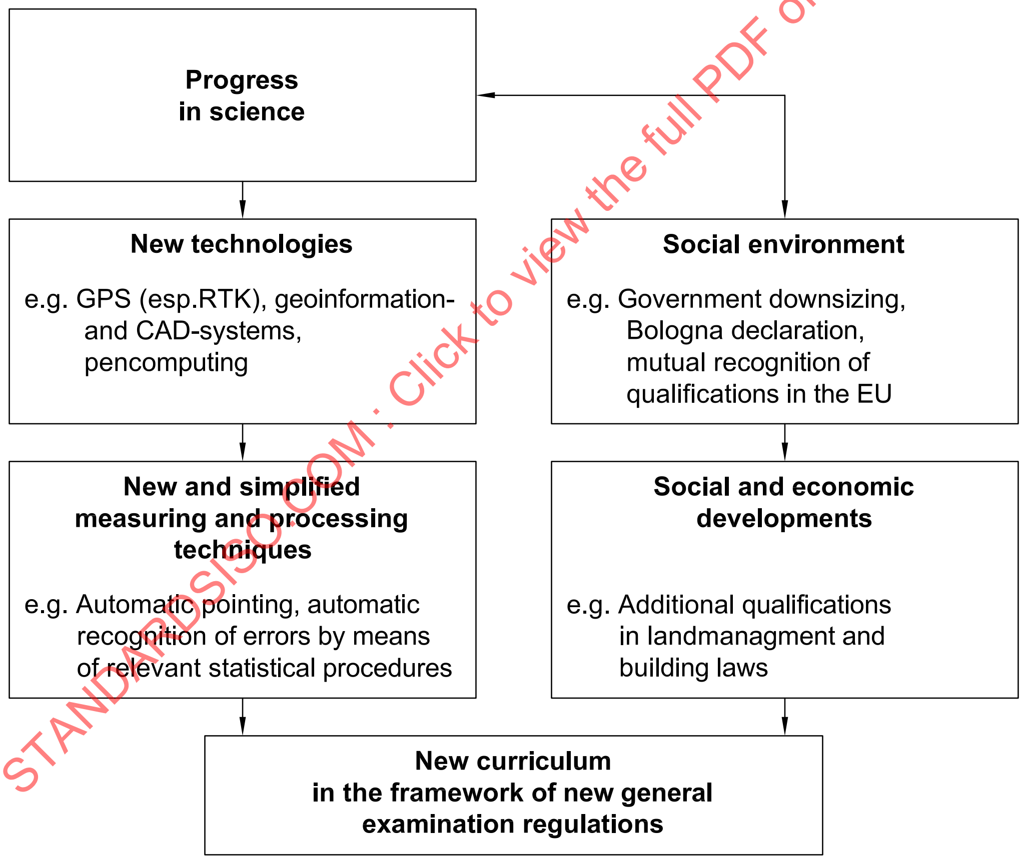

Figure E.1 — Causes for professional changes and their effects on geomatics education

Besides the classical subjects, it is also necessary to teach the principles of law and economics as well as land management. Real estate valuation and methods of local participation are as important as planning theory. Management and marketing skills are required like in other fields as well. The particular universities in Germany have set up different priorities in their curricula.

E.3 Changes in Curricula

E.3.1 General Remarks

Taking these and other professional developments into account and besides the overall political intentions about the university system in Germany and abroad, a curriculum framework and a corresponding set of general examination regulations for the study of geomatics (Rahmenprüfungsordnung) is the result of the special commission. The framework contains basic and compulsory elements for the 9 geomatics departments at the corresponding German universities.

For the first part of the curriculum (first four semesters) the main intention of the commission was to rely on the basics of our engineering background, i. e. mathematics, informatics, physics, geo- and social sciences. The amount of time and the quality of the individual course will differ from university to university. But the commission concluded that these subjects should be the same at each university. The total contact time required to complete all courses of study is about 180 semester hours for the whole curriculum. The time devoted to the different subjects differs from university to university. The second (main) part of the curriculum can be studied after having passed the relevant examinations in the first part. A period of up to six months is prescribed for the completion of the diploma thesis.

The commission on surveying education concluded not to go into specialization but to keep integrated knowledge as the best opportunity for later employment. We believe that for a relatively small group of engineers in comparison to the other engineering disciplines this is necessary in order to be known at all in society.

E.3.2 Example of a Curriculum

Based on the developments reported above, the curricula at the different Universities in Germany have undergone strong changes in recent years. As an example, the new curriculum at the University of Karlsruhe will be elucidated in more detail below.

Starting in Autumn 1999, a new curriculum “Geodesy and Geomatics Engineering” (Geodäsie und Geoinformatik) was introduced at the University of Karlsruhe for the students of the first semester, to completely replace the existing curriculum “Surveying” (Vermessungswesen) after a transition period of five years. Hand in hand with the modification of the name goes a far-reaching shift in the subjects and radical changes in the examination modes.

The reformed curriculum at the University of Karlsruhe is orientated at the vision of the geomatics engineer of the future as a specialist for very precise measurements at the one hand and as an expert for spatial information at the other hand. Even more than formerly emphasis is given to the fundaments in mathematics, physics (orientated to geodetic measurement procedures) and computer science/informatics (with applications to geo-informatics in the second phase of studies). The backbone is still formed by the relevant knowledge in Surveying, Geodesy, Geoinformatics, and Photogrammetry/Remote Sensing.

The following principles have been observed in creating the new curriculum.

- Summary of the contents of lectures considering geodetic methodology. Restriction to common and essential features.
- Exemplary deepening of qualifications without claiming a complete imparting of knowledge of facts.
- Attribution of lectures to mainly four kernel areas:
  - modelling, realization and validation of geodetic models,
  - measuring techniques and sensors,

  - data analysis,
  - presentation and application of geodetic data.
- Strengthening of future-oriented topics in the fields of GIS, GPS and sensorics.
- Maintaining features specific to the University of Karlsruhe such as
  - Remote Sensing and Image Processing,
  - strong cooperation with the other geosciences which are fully existent at the University of Karlsruhe.

The fundamental structure of the former diploma curriculum has been retained. The first phase of studies comprises four semesters and is finalized by a special examination, the "Vordiplom". The second phase consists of two parts, the basic studies in geodesy and geomatics engineering (concentrated in the 5th and 6th semester), and the advanced studies (concentrated in the 7th and 8th semester). The curriculum is finalized by a case study (1 month) and the diploma thesis (5 months), resulting in a total period of 9 semesters. While the subjects in the first phase and in the basic studies are compulsory, the subjects of the advanced studies (minimum of 20 hours per week per semester) can be freely selected from a list of subjects.

According to the principal intentions of the new curriculum, there are a lot of significant changes with respect to the classical curriculum in Surveying. The number of contact hours and the intensity of the subjects in computer science/informatics has been strongly increased. On the other hand, the number of contact hours in the field of planning and law has been reduced in consistence with the specialization in GIS. The course in "Adjustment Theory and Statistics" has been shifted to the 3rd and 4th semester. An introduction into GPS is provided in the lectures "Surveying I" and " Sensorics II", followed by an advanced presentation in "Satellite Geodesy"; practical aspects of GPS are treated in a GPS project in collaboration with a surveying firm or the Ordnance Survey.

Additional "soft" skills such as social competence, ability for team work, foreign language knowledge, competence in oral and written presentation are trained in the project work comprising 7 weeks, as well as in elaborating the case study. Management and structuring of information, especially by using the Internet, and independent personal learning are also emphasized in the new curriculum.

After having passed the examinations (closely joining the courses) the academic degree "Diplom-Ingenieur(in) im Fachgebiet Geodäsie und Geoinformatik" is provided, which is equivalent to the international degree "Master of Science in Geomatics Engineering". Simultaneously with the diploma a transcript of records in English language is handed out. Students from other German or European Universities, studying for one of several semesters at the University of Karlsruhe, can transfer their credits to their home Universities in the context of an ECTS (European Credit Transfer System) agreement; an information package has been prepared for interested students. By these measures it is intended to improve the mobility of students in Europe.

E.4 Final Remarks

Geomatics education programmes are clearly very differently profiled in Europe. This is probably due to the profession requiring different competencies, but also due to the strategy adopted for the study programmes by the Universities. As far as Austria and Switzerland are concerned, their educational programmes are very similar to the German ones. The Austrian Case Study is therefore recommended in order to get more information about the transitional situation in our countries.

What matters in the long term is that the Universities have a responsibility for the future. Finding the right direction is not easy. One way of predicting future needs is by observing the development of the profession, so that decisive changes can be discovered at an early stage and distinguished from more transitory events.

E.5 Acknowledgements

This case study, compiled by Hans Knoop, has been developed by many professional, national and international discussions. Special contributions by Wolfgang Kresse, University of Applied Sciences of Neubrandenburg, Berthold Witte, University of Bonn and Wolffried Wehmann, University of Applied Sciences of Dresden are also acknowledged.

E.6 References

Accreditation Agency for Study Programs in Engineering and Informatics (ASII), [2001]: “Mindestanforderungen und Verfahrensgrundsätze für die Akkreditierung von Bachelor- und Masterstudiengängen in den Ingenieurwissenschaften und der Informatik”, Düsseldorf, 2001, http://sun.vdi-online.de/asii/

Bill, R., [2001]: GIS Education in Germany: a survey and some comments. In: GIS: *A Sourcebook for Schools*, edited by David R. Green, Taylor & Francis, ISBN 0-7484-0270-5

European Council, [1988]: COUNCIL DIRECTIVE (89/48/EEC) on a general system for the recognition of higher-education diplomas awarded on completion of professional education and training of at least three years' duration, *Official Journal of the European Communities*, No. OJ L 019, p. 0016-0023

European Council, [1992]: COUNCIL DIRECTIVE (92/51/EEC) on a second general system for the recognition of professional education and training to supplement Directive 89/48/EEC, *Official Journal of the European Communities*, No. OJ L 209, p. 0025 - 0045

European Ministers of Education, [1999]: Joint Declaration of the European Ministers of Education, Bologna, June 1999, p. 1-3

Hochschulrektorenkonferenz (Association of Universities and other Higher Education Institutions in Germany), [2001]: “Hochschulkompass (Higher Education Compass)”, www.higher-education-compass.hrk.de, last update June 29th 2001

Knoop, H., [2002]: *TC 211 Project 19122, Geographic Information/Geomatics - Qualifications and Certification of Personnal - Technical Report*. XXII FIG International Congress, Proceedings, p. 154-155, April 19-26, 2002, Washington, DC.

Rahmenordnung [1999]: “Rahmenordnung für die Diplomprüfung im Studiengang Vermessungswesen an Universitäten und gleichgestellten Hochschulen, beschlossen von der Kultusminister- und Hochschulrektorenkonferenz am 05. Juli 1999”, www.kmk.org

Wehmann, W.; Hahn, M. [2002]: “On the Introduction of Staged Bachelor and Master Courses of Studies for Surveyors in Germany”. FIG Commission 2, Congress in Washington, D.C., USA

Witte, B.; Heck, B. [2002]: “Changes and Perspectives in University Education for Geodetic Engineers in Germany”. FIG Commission 2, Congress in Washington, D.C.

Annex F
(informative)

National case studies — Japan

F.1 Definitions

F.1.1 General

"GIS is a computer-aided information processing system that integrally processes, manages, and analyses attribute data, including natural, social, and economic data, which have information regarding geographical position and/or space, and that displays the results."

Interim Report by the Liaison Committee of Ministries and Agencies concerned with Geographic Information System, June 10, 1996

F.1.2 Commentary

Surveying and mapping is the fundamental field of the creation of data for GIS. There are many kinds of national legislation for the certification of personnel in Japan in the field related to surveying and mapping as follows:

— Subject domain
Sokuryo (Land survey, including mapping and photographing for surveying)
Organization
Geographical Survey Institute, Ministry of Land, Infrastructure and Transport
Legal basis
Sokuryo-ho (Survey Act)

— Subject domain
Tochikaokuchosa (Land and Building Survey)
Organization
Ministry of Justice
Legal basis
Tochikaokuchosashi-ho (Land and Building Surveyor Law)

— Subject domain
Tochikukakuseiri (Land Readjustment)
Organization
City Bureau, Ministry of Land, Infrastructure and Transport
Legal basis
Tochikukakuseiri-ho (Land Readjustment Law)

— Subject domain
Tochikairyokanchi (Disposition of Substitute Lots)
Organization
Ministry of Agriculture, Forestry and Fisheries
Legal basis
Tochikairyo-ho (Land Improvement Law)

— Subject domain
Gijutsu – Oyorigaku – Chikyubutsuri oyobi Chikyukagaku (Applied Science, Geophysics and Geochemistry)
Organization
Ministry of Education, Culture, Sports, Science and Technology
Legal basis
Gijutsushi-ho (Registered Engineers Act)

F.2 National Professional Associations

There are many professional associations/foundations in relation with surveying and mapping.

Nihon Sokuryosha Renmei (Japan Federation of Surveyors)
Nihon Sokuryo Kyokai (Japanese Association of Surveyors, JAS) (member of JFS)
Kokusai Kensetsu Gijutsu Kyokai (Infrastructure Development Institute Japan) (member of JFS)
Zenkoku Kensetsu Kenshu Senta (Japan Construction Training Center) (member of JFS)
Zenkoku Sokuryo Sekkeigyo Kyokai Rengokai (Japan Federation of Survey and Planning Associations) (member of JFS)
Sokuryo Senmon Kyoiku Senta (Survey Education Center) (member of JFS)
Nihon Suiro Kyokai (Japan Hydrographic Association) (member of JFS)
Nihon Sokuryo Chosa Gijutsu Kyokai (Association of Precise and Applied Technology, APA) (member of JFS)
Nihon Chizu Senta (Japan Map Center) (member of JFS)
Nihon Chizu Choseigyo Kyokai (Mapping Enterprises Association Japan) (member of JFS)
Nihon Fudosan Kantei Kyokai (Japanese Association of Real Estate Appraisal) (member of JFS)
Nihon Tochi Kaoku Chosashikai Rengokai (Japan Federation of Land and Building Surveyors, Associations)
Zenkoku Tochi Kairyo Jigyodantai Rengokai (Japan Land and Water Association, JTL)
Nihon Kensetsu Joho Sogo Senta (Japan Construction Information Center)
Rimotosenshingu Gijutsu Senta (Remote Sensing Technology Center of Japan)

The following are more academic associations

Chiri Joho Shisutemu Gakkai (Geographic Information Systems Association)
Nihon Shashin Sokuryo Gakkai (Japan Society of Photogrammetry and Remote Sensing, JSPRS)
Nihon Sokuchi Gakkai (Geodetic Society of Japan)
Nihon Kokusai Chizu Gakkai (Japan Cartographers Association)
Nihon Rimotosenshingu Gakkai (Remote Sensing Society of Japan)
Nihon Chiri Gakkai (Association of Japanese Geographers)

F.3 Current Qualifications and Certification Initiatives

There are many kinds of legal qualification and certification related to surveying and mapping. Among them, land survey is the fundamental field for the creation of data for GIS. Surveyors and Assistant Surveyors are entitled to practice public land surveying.

F.3.1 Registering Surveyors by the Geographical Survey Institute

F.3.1.1 Survey Act (Registration of Surveyors and Assistant Surveyors)

Article 49

1) According to the provisions of Articles 50 and 51, a person eligible to be a surveyor or an assistant surveyor shall apply to the Director General of the Geographical Survey Institute for registration. The application must be accompanied by certified qualification documents, providing that he/she wishes to be a surveyor or an assistant surveyor.

2) A register of all surveyors and assistant surveyors shall be deposited for safekeeping at the Geographical Survey Institute.

3) A person wishing to apply for registration in accordance with Paragraph 1 above shall pay a handling fee as defined in the appropriate Government Ordinance.

F.3.1.2 Survey Act (Qualification for Surveyors)

Article 50

A person who comes under any of the following items is entitled to be a surveyor.

1) A person graduated from a university authorized by the Minister of Education, Culture, Sports, Science and Technology with credits in surveying, provided that he/she has practical experience in surveying of more than one year.

2) A person graduated from a junior college or technology college authorized by the Minister of Education, Culture, Sports, Science and Technology with credits in surveying, provided that he/she has practical experience in surveying of more than three years.

3) A person who has obtained the advanced knowledge or skills necessary for surveying for more than one year at a survey technical training school authorized by the Minister of Land, Infrastructure and Transport, provided that he/she has practical experience in surveying of more than two years.

4) An assistant surveyor who has completed subjects designated by the Minister of Land, Infrastructure and Transport and thus acquired advanced knowledge and skills in surveying at a survey technical training school.

5) A successful candidate for the national examination for surveyors conducted by the Director General of the Geographical Survey Institute.

F.3.1.3 Survey Act (Qualification for Assistant Surveyors)

Article 51

A person who comes under any of the following items is entitled to be an assistant surveyor.

1) A person graduated from a university authorized by the Minister of Education, Culture, Sports, Science and Technology with credits in surveying.

2) A person graduated from a junior college or technology college authorized by the Minister of Education, Culture, Sports, Science and Technology with credits in surveying.

3) A person who has obtained the advanced knowledge or skills necessary for surveying for more than one year at a survey technical training school authorized by the Minister of Land, Infrastructure and Transport.

4) A successful candidate for the national examination for assistant surveyors conducted by the Director General of the Geographical Survey Institute.

F.3.2 Voluntary certification

Voluntary certification exists through a professional association.

Subject domain

Control survey, photogrammetry, applied survey, geography, marine survey, map compilation, cartography, digital information, and photographing.
(Restructuring of the domain under consideration)

Organization

Kyoiku Kenshu Senta, Nihon Sokuryo Kyokai (Education and Training Center, Japanese Association of Surveyors)

Annex G
(informative)

National case studies — Korea

G.1 Definitions of GIS

In broad sense, GIS is defined as a computer-aided information processing system that integrally processes, manages, and analyses attribute data, including natural, social, and economic data, which have information regarding geographical position and/or space, and that displays the results. In narrow sense, GIS is treated as just a digital map and attributes.

G.2 Commentary

Surveying and mapping is the fundamental field of the creation of data for GIS. The National Geography Institute (NGI, http://www.ngi.go.kr) is in charge of national legislation for the certification of personnel in Korea in the field related to surveying and mapping.

G.3 National Professional Associations

a) Professional associations/foundations:

— Korea Association of Surveying and Mapping: http://www.kasm.or.kr

— The Korean Association of Professional GIS http://www.gis.re.kr

b) Academic associations:

— Korean Society of Remote Sensing

— Geographic Information System Association of Korea

— Korea Open GIS Research Society

— Korean Society of Geomatics

c) Universities:

— NamSeoul University (GIS department): http://www.nsu.ac.kr

— Inha University (GIS department): http://www.inha.ac.kr

— Inha College (Cadastral department) http://www.inhatc.ac.kr

G.4 Current Qualifications and Certification Systems

A National Technical Qualification Test System for GIS and Surveying has been performed. The national technical qualification test system has been established by the Ministry of Labor (http://www.molab.go.kr) and the National technical qualification certification is issued by the Korea Manpower Agency (http://www.kmanet.or.kr)

Annex H
(informative)

National case studies — Portugal

H.1 Accreditation from the National Mapping Institute

1) There is no general standard in Portugal applied to the personnel involved in Geographic Information/ Geomatics activities.

2) However, 2 laws exist with specific requirements on the qualification of personnel; one is related with cartographic production and the other one with cadastre of real property.

3) The entities involved in cartographic production must have a licence. The Decree-Law No. 193/95, from July 28, 1995, states in its Article 10 that the "conditions for the issue of licence are:

   a) the existence of a suitably qualified technical director;

   b) the existence of permanent technical staff, sufficient both in terms of quantity and quality...".

4) The same Decree-Law No. 193/95 states in its Article 11 that the "…technical director is considered to be duly qualified when he has an educational background and experience suitable for the activities…"; "Suitable education is considered to consist of a first degree in Geographical Engineering or another degree which qualifies the person for the pursuit of cartographic activity."

5) The entities involved in the production of cadastre of real property must also have a licence. The Decree-Law No. 172/95, from July 18, 1995, states in its Article 35 that a licence is issued "…when the following aspects have been suitably checked:

   a) the existence of a permanent technical staff, sufficient both in terms of quantity and quality, including a technical director who holds a higher degree and has the requirements considered necessary for the performance of the job;…".

6) The Article 36 of the same Decree-Law No. 172/95 regulates the accreditation of technicians for the purpose of producing technical documents related to "…surveyed real properties which implies an alteration of positioning of the respective boundaries…" (Maintenance of the cadastre, Article 30). These technicians must "…prove that

   a) they are graduates, having at least a bachelor's degree…

   b) they have suitable experience…"

7) The following table summarizes the above-mentioned aspects.

Table H.1 — National Mapping Institute accreditation

Activity	Task	Requirements for accreditation	Entity responsible for the accreditation	Legal document
Cartographic production	Technical director	– First degree in Geographical Engineering – Experience	National Mapping Agency (IGP)	Decree-Law No. 193/95 July 28, 1995
Production of cadastre of real property	Technical director	– Higher degree – Experience	National Mapping Agency (IGP)	Decree-Law No. 172/95 July 18, 1995
Maintenance of cadastre of real property	Private technician	– Bachelor's degree – Experience – Evaluation of knowledge assessed through theoretical and practical tests	National Mapping Agency (IGP)	Decree-Law No. 172/95 July 18, 1995

8) Finally, it must be mentioned that the Geographical Engineers are (mostly) members of the Order of Engineers. This professional organization also performs the task of accreditation of the first-degree courses in Geographical Engineering.

H.2 Recognition from the National Engineering Association (Ordem dos Engenheiros)

The National Association of Engineers (*Ordem dos Engenheiros*) certificates the title of engineer and also attributes the title of expert in specialized domains. Some activities, such as Civil Engineering, require the affiliation to *Ordem dos Engenheiros*, but for the field of Geomatics this is not required. The National Mapping Institute requirements refer to someone with the degree of geographical engineer, not necessarily member of the *Ordem dos Engenheiros*.

The certification as engineer requires a degree from a school evaluated and certified by the *Ordem dos Engenheiros*. Students with degrees obtained in non-certified schools need to be approved at a written examination. The course of Geographical Engineering is offered in three universities, all of them recognized by *Ordem dos Engenheiros*.

Engineers, independently of the original background, with more than 5 years of professional activity can be considered as “experts in GIS”. A panel of elected experts evaluates the application for the title of expert, based on the curriculum vitae and three selected works. The title does not allow for any special right, it only means that the expert is someone recognized by his peers as a high skilled professional.

H.3 Formal courses in the field of Geomatics

The field of Geomatics is obviously quite horizontal and there are people with very different backgrounds acting as professionals. The courses mentioned below are the ones more directly related with data acquisition (photogrammetry, geodesy and surveying).

H.3.1 Secondary School Level

The school of the National Mapping Institute offers a professional training in photogrammetry and surveying, in a program of three years, integrated with the general program of secondary schools.

H.3.2 Bachelor Level

There are three courses of Surveying Engineering at university level. These courses (3 years) are oriented to professional practice and the graduates are Technical Engineers, not Engineers.

H.3.3 Graduate Level

There are three courses of Geographical Engineering at university level. These courses (5 years) comprehend the fields of Geodesy, Photogrammetry, Remote Sensing, Surveying and GIS. The graduates are considered engineers.

H.3.4 Master Level

There are several Master Courses in the field of Geographical Information Systems (2 years).

This structure with Bachelor, Graduate and Master levels will probably change in short term, according to the policy of the European Union.

Annex I
(informative)

National case studies — Saudi Arabia

I.1 Introduction

Geographical Information /Geomatics is globally viewed as a trend technology. Saudi Arabia was keen to avail of the technology considering its numerous advantages to studies and planning activities in various fields. Several entities created dedicated internal GIS Centers to draw on their resources in terms of planning their programs and projects. The move contributed to sparing significant efforts and conservation of budgets.

Looking from a different perspective, the centers represented multiple sources and production of data. This led to duplication of efforts in building information data bases and discrepancies in specifications. Another consideration is scarcity of qualified manpower in the related specialty field as well as the inadequate number of certification organizations.

Reacting to the situation, King Abdulaziz City for Science & Technology (KACST) solicited formation of a national committee with representatives from major active organizations to look after and develop the area in order to satisfy requirements of the national's developmental plans and keep pace with the international trend. Hence, Saudi Arabia was keen to join the membership of the Technical Committee on Geographical Information/Geomatics (ISO/TC211) to draw on the experiences of developed countries and participate in developing rules for standard international specifications – an issue which ultimately impacts development of national specifications.

This Case Study Paper focuses on a vital aspect of geographical information – namely the Qualification & Certification aspect in Saudi Arabia of workers engaged in this area. The paper begins by citing certain generally accepted circulating definitions of geographical information, including GIS, Remote Sensing and Survey sciences. A brief discussion on the current status of qualifying and certifying entities in Saudi Arabia such as universities and technical institutes is presented, followed by a note on influential major players, i.e. active organizations in the area of geographical information, professional licensing entities, and other concerned societies or committees. Finally, the paper touches on current trends in the field of geographical systems in Saudi Arabia looking ahead and raises suggestions to step up efforts to regulate the Qualification & Certification process.

I.2 Definitions

Concepts and interpretations defining dimensions and topics of geographical information are at disparity, dependent on differences between domains and applied sciences that may have a functional or practical link with this technology. As a result, many recent definitions for this field emerged of which the three most significant are the following ones.

I.2.1 Geographical Information Systems (GIS)

The system is primarily dependent on the computer for capturing, storage, management, analysis and retrieval of geographical information related to anything, be it a natural resource or urban output resulting from the interaction between man and nature. The system allows for translation of large volume, consolidated and sophisticated information drawn from numerous sources and conversion of the information, using automated processing, conversion and matching mechanisms, into a simple form — one that is brief, clear and comprehensive to facilitate and support proper decision-making processes by any officer while tapping available or existing resources or any developmental planning project or problem.

Geographical Information Systems are defined as “a sophisticated technical method which combines the computer and specialist mapping software to compile maps, manipulate their elements and link these to available information, with the functionality to code, store, retrieve and analyse data”. *(Introduction to Cartography, p. 230/Dr. Salma)*.

Another definition of GIS is “the systems composed of hardware, software, graphical and geographical data bases to produce, draw and analyse geo-referenced geographical information by specialists to accomplish user-specific, known objectives and requirements”. *(Introduction to Geographical Information Systems, p. 28/Dr. Kabarah)*.

I.2.2 Remote Sensing and Aerial Photography

The link between geographical information and satellite imaging is very strong. The rapid advancement in remote sensing technologies producing satellite images received from satellites during the last decade triggered a synchronous development in Geographical Information Systems technologies. Information provided by satellite images led to increased reliance on satellite imaging in studying land resources – thanks to the significant benefits in terms of very efficient detection capabilities of landmarks or resources, their distribution and condition. Satellite imaging also spares a lot of time, effort and cost, not to mention the functionality to study locations, which can hardly be accessed and/or studied through conventional methods. The technology provided the means to trace time changes associated with earth changes rapidly compared with other methods. Satellite pictures received from the new generation of satellites can be used to produce maps, correct and/or update existing ones swiftly and accurately. Hence, satellite images became the backbone of any state of the art geographical information system.

Remote Sensing is defined as “a set of scientific means and ways through which information on specific objects can be obtained remotely without direct contact with the object to be studied using reception or photography devices”. *(Science and Technology Magazine, page 4/Dr. Trabzoni)*

Another definition is “a technology that stores and analyses satellite images to study environmental problems such as floods, desertification, shrinkage of forests, urban expansion into agricultural areas and coastal pollution, i.e. the information that can be hardly obtained from a close distance. These information form a grid so that each cell of a segment contains information clarifying the piece of information relevant to the particular cell”. *(Introduction to Geographical Information Systems, page 28/Dr. Kabara)*

I.2.3 Survey Sciences

Survey is considered an essential tool to geographical information because it is directly related to the study of the earth surface and its close relationship with mapping processes. Survey is also considered a cornerstone for many sciences concerned with the studies of earth surface such as engineering, geology, agriculture and others.

Survey is defined as “the science concerned with the delineation and measurement of the earth mass and geomorphology, directions of lines on the earth surface, computation of vertical and horizontal distance between points on earth to high precision standards and determination of coordinates”. *(Introduction to Cadastral Science, page 14/Eng. Shabana - Dr. Dakheel)*

Another definition for survey is “the science which studies the earth measurements and identifies the dimensions, directions and locations of points on the earth surface or adjacent thereto like the dots used in preparing maps, delineating borders and details or those used in conjunction with the construction of engineering projects or definition of military targets”. *(Introduction to Cadastral Science, page 14/ Eng. Shabana - Dr. Dakheel)*

I.3 Qualification (Educational Institutions)

In order to build a comprehensive and accurate geographical information system, it is necessary to begin by qualifying workers practicing in this field through specialist studies adopting academic and practical curricula at the institutions and universities, and to organize short-and long-term courses in various aspects. As far as Saudi Arabia is concerned, qualifying entities are divided into 4 major groups as shown in Figure I.1 – namely:

I.3.1 Universities

A total of 8 universities granting Bachelor degrees in various disciplines operate in the Saudi Arabia. Some universities offer Masters and Doctorate degrees in certain specialties. The universities are

- King Saudi University, Riyadh (http://www.ksu.edu.sa);
- King Abdulaziz University, Jeddah (http://www.kaau.edu.sa);
- King Fahad University for Petroleum & Minerals, Dhahran (http://www.kfupm.edu.sa);
- King Faisal University, Dammam (http://www.ksu.edu.sa);
- Imam Mohammed Bin Saud University, Riyadh (http://www.ksu.edu.sa);
- King Khalid University, Abha (http://www.kku.edu.sa);
- Um Alqura University, Makkah Al Mokarramah;
- Islamic University, Madina Al Munawwarah.

As a matter of fact, these universities exerted some efforts and made certain swift attempts to teach subjects related to geographical information as fundamental courses in several disciplines such as civil engineering, urban and environment planning and geology etc. The current study plan of the said specialties contains some of the following topics:

- Fundamentals of Remote Sensing and Aerial Photography;
- Principles of Survey and Cadastral Imaging;
- Geographical Information Systems.

However, the universities offer two major specialties only that adopt a study plan focused on the geographical information field and other related subjects. These are

a) Survey Engineering;

b) Geography.

Undoubtedly, the two specialties form the kernel of ideal qualification programs of specialists in geographical information, provided the study plan is revised with additional emphasis on specialty and practical subjects to keep pace with scientific and technological advances in this field. There is also the possibility to carry out graduation projects using these technologies under the supervision of specialist professors attached to the said colleges and others. The technologies can also be utilized in postgraduate education programs (MA and Ph.D.) studies.

Officers of King Fahad and King Saud Universities planned to establish a specialist program dedicated to Geographical Information Systems. The program design took into account current scientific and technological advancements in the relevant area. The study period is two years. The program admits high school graduates who are offered a Diploma in Geographical Information Systems on graduation. The program is expected to start running in the next academic year 2002. It will cater to the requirements of many entities, which lack qualified geographical information systems technicians.

I.3.2 Technical Institutions

A number of technical and specialist institutions qualify students for enrollment in the secondary diploma course as survey and mapping technicians or the post-secondary diploma course in various areas of geographical information. The period of study ranges from one to three years.

I.3.2.1 Technical Inspectors Secondary Institute/Survey Section

There is a total of 5 institutes geographically spaced to span the Kingdom. The institutes qualify graduates for the secondary school diploma as survey and mapping technicians. The preparation period extends over three years after completion of intermediate school.

Studies at the institute focus on extensive practical training using various state of the art equipment, theoretical studies and practical training on systems.

A number of theoretical specialist courses are taught such as technical mathematics, technical drawing and cadastral science in addition to applied specialist subjects such as photographic survey, topographic survey, detailed survey, polygons, levelling, geodesy, cadastral measurements etc. Students are also trained on satellite-linked equipment to determine coordinates (GPS) and integrated surveillance and monitoring systems which are manipulated electronically through the computer to analyse, calculate, and retrieve required data. As regard to photographic survey, the workshop is equipped with a large number of systems to train students on the creation and reading of maps from aerial pictures such as PG21, Angled Stereoscopes and aerial pictures reading and interpretation equipment (APT1-APT2). Third year students carry out a comprehensive project of a large area containing mountainous and detailed areas to link Geodesy subjects (triangles grid) to Detailed Topography.

After graduation, the student will be qualified as a competent surveyor capable of using all cadastral equipment and prepare topographic and detailed maps. The student will also demarcate and apply drawings in the field, identify and determine road axles, water and sewage networks, prepare contour maps for locations of dams, reservoirs and compute quantities. *(Secondary Institutes for Technical Inspectors Guide, Page 8, General Organization for Technical Education and Vocational Training).*

I.3.2.2 Military Survey and Geographic Studies Institute

I.3.2.2.1 General

This is one of the specialist and unique institutes that offer long-term courses (15-49 weeks) for various levels and grants qualified graduates a diploma to work in all areas related to geographical information.

Every year, the Institute organizes foundation, specialist and advanced courses in various walks of cadastral sciences, production of maps and geographical information systems and associated applications in order to qualify and train students who join the Institute from various sectors and GCC States, both theoretically and practically. *(Military Survey and Geographic Studies Institute program)*

I.3.2.2.2 Foundation Courses

- General Survey 1, 36 weeks.
- General Survey 2, 36 weeks.
- Ground Survey, 27 weeks.

- Computer Assisted Map Drawing, 22 weeks.
- Aerial Survey, 22 weeks.
- Aerial Photography, 22 weeks.
- Printing and Photographic Imaging, 19 weeks.

I.3.2.2.3 Advanced Courses

- Ground Survey, 25 weeks.
- Aerial Survey, 25 weeks.
- Computer Assisted Map Drawing, 25 weeks.

I.3.2.2.4 Specialist Courses

- General Survey Qualifying Course 2, 49 weeks.
- Computer Assisted Digital Drawing, 15 weeks.
- Field Verification, 15 weeks.
- Remote Sensing, 22 weeks.
- Geographical Information Systems, 20 weeks.

I.3.3 Short Technical Courses

These courses, which range from 1 to 2 weeks in duration, are considered introductory courses to geographical information systems. The courses are offered by the following entities:

- King Fahad University for Petroleum & Minerals, Faculty of Environmental Designs;
- King Saud University, Faculty of Arts;
- Um Alqura University, Faculty of Social Sciences.

I.3.4 Program-oriented Technical Courses

A number of private sector companies and establishments implement program-related specialist courses ranging from 3 to 10 days in duration.

I.4 Licensure

There is one entity, which grants professional licenses to surveyors. The Ministry of Municipal and Rural Affairs conducts a qualifying examination for all surveyors in connection with the filing of applications to establish specialist survey offices in order to verify their understanding of relevant technical aspects and ensure that they keep pace with the latest technical advancements.

I.5 Societies and Committees

The Kingdom is seat for many committees and societies, which are either directly or indirectly involved in the issue of geographical information. Their functions include maintenance and development of the profession. These include

- Saudi Geographic Society (http//www.ksu.edu.sa/societies/sgs);
- Architectonics Society;
- Engineering Committee;
- Geology Society.

I.6 Major Acting Organizations/Influential Entities

On a national level, it should be noted that geographic information systems related activities exist and are effective in several governmental bodies, universities, national and private companies:

- General Survey Organization (Military Survey);
- Geological Survey Commission;
- Ministry of Municipal and Rural Affairs;
- King Abdulaziz City for Science and Technology;
- Riyadh Development Authority;
- Universities;
- National Companies (Aramco, STC, SEC, etc.).

I.7 Looking Ahead

Consequently, it is vitally important to join efforts and conserve costs throught the building of integrated national network consisting of information databases on geographical information systems under national specification covering various sectors in the Kingdom and making these data banks available to all entities to support developmental purposes.

King Abdulaziz City for Science & Technology (KACST) solicited formation of a national committee with representatives from major active organizations to look after and develop the area in order to satisfy requirements of the national's developmental plans and keep pace with the international trend.

Briefly speaking, the implementation strategy should rely on formation of specialist technical committees representing various concerned entities to develop standard specifications and controls and coordinate functions in order to obtain available information to build and establish a national network of geographical information sciences which will facilitate regular updates and information exchange between various entities as well as provision of necessary technical support. It should be noted, however, that every entity shall have its own and private information which cannot be exchanged with or divulged to others.

To wrap up, formation of a committee to study establishment of a national network with representatives from several entities projects is a pressing necessity to serve government sectors and achieve harmony with the goals and functions of the national development plan. This approach will accomplish the contemplated benefits, which can be summarized as follows:

- satisfy the needs of various government bodies in terms of demand on information and the importance of establishing local geographical information systems centers to analyse and exploit data;
- eliminate duplication of efforts as a result of building identical databases by various entities because of their inability to access the required information, this will ultimately reduce costs;
- standardize specifications to ensure flexibility data exchanges between entities;
- develop controls and systems allowing utilization of information as well as a common update mechanism;
- provide technical support and consultation services to all sectors;
- develop qualified, experienced and trained manpower to build a national workforce;
- regulate professional practice in the relevant field;
- grant licenses to individuals and firms engaged in the profession.

I.8 Conclusion

It is noted that the Saudi Arabia started taking the right steps towards qualification and certification of personnel in the field of geographical information systems from an academic perspective, development of a plan to establish specialist colleges (Geographical Information Systems Program) and revision of study plans of certain colleges to introduce geographical information oriented educational curricula. Other steps were taken in the area of licensing, especially after formation of the National Geographical Information Systems Committee to regulate professional practice by individuals and firms engaged in the practice. Additionally, the Kingdom acquired membership of the Technical Committee (ISO/TC211) to exchange experiences and participate in the development of relevant international specifications.

Generally speaking, the National committee will consider several points in terms of the qualification and certification of individuals in this area:

- Saudi universities should step up efforts to revise their educational plans in spite of difficulties presenting in areas such as lack of qualified cadres to specify and teach specialist subjects and the incomplete specialist workshops.
- Expedite establishment of specialist geographical information colleges to teach consecutive serial theoretical and practical subjects, taking into consideration technological advancement and developmental needs applicable to the area.
- Coordinate with international organizations to standardize job titles and qualification requirements.
- Classify workers in the area of geographical information in a manner commensurate with their credentials, develop a program of periodic testing to promote them to higher levels, ensure that they are active practitioners of the profession and that they keep pace with developments. This should ideally reflect the following professional classification scale as shown in Figure I.2:

  1) *Users*: beneficiaries of geographical information who browse and analyse the data;
  2) *Trainees*: individuals who have recently engaged the profession;
  3) *Technicians*: surveyors, data entry clerks/processors and draftsmen;
  4) *Practitioners*: experienced individuals who mastered their jobs after a suitable period of training;

5) *Specialists*: qualified individuals who sub-specialized in a specific area such as programming or design;

6) *Consultants*: qualified sub-specialists with extensive experience in one or more areas.

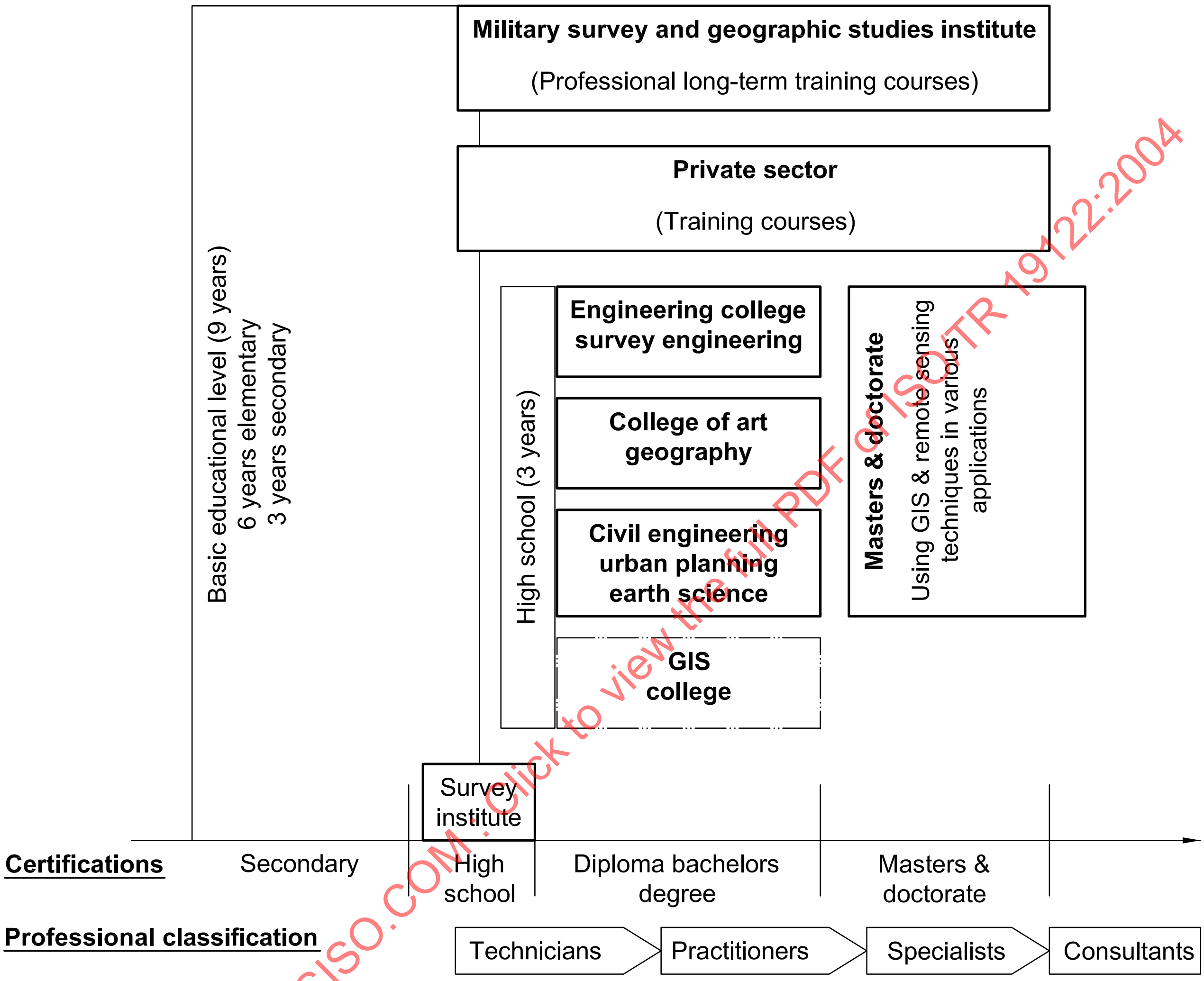

Figure I.1 — Qualification Organizations in Saudi Arabia

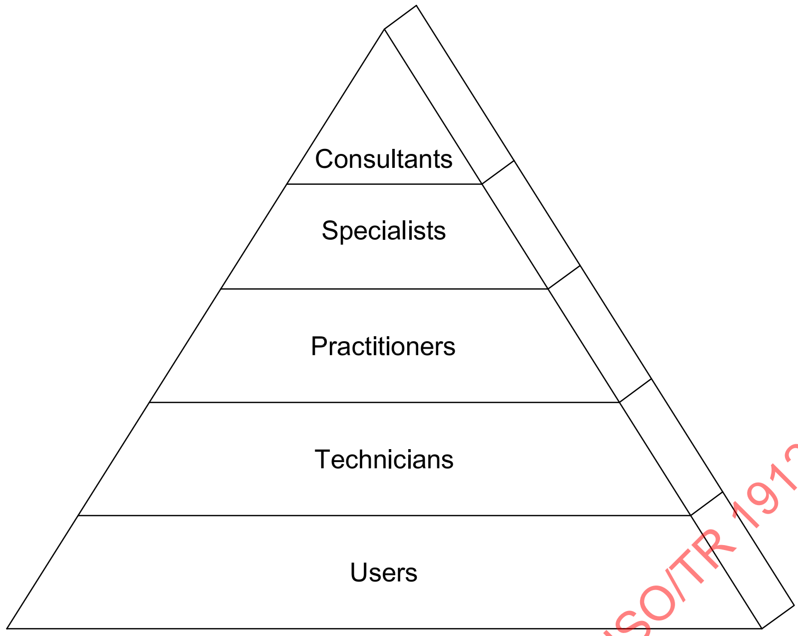

Figure I.2 — Professional Classifications on Geographical Information

Annex J
(informative)

National case studies — South Africa

J.1 Definitions used in South Africa

The following definitions are relevant to the National Qualifications Framework

J.1.1
Accreditation
certification, usually for a particular period of time, of a person, a body or an institution as having the capacity to fulfil a particular function in the quality assurance system set up by the South African Qualifications Authority in terms of the (SAQA) Act

J.1.2
Applied competence
ability to put into practice in the relevant context the learning outcomes acquired in obtaining a qualification

J.1.3
Exit level outcomes
outcomes to be achieved by a qualifying learner at the point at which he or she leaves the programme leading to a qualification

J.1.4
Unit standard
registered statements of desired education and training outcomes and their associated assessment criteria together with administrative and other information as specified in these regulations

NOTE These definitions are as per NSB and ETQA regulations: see http://www.saqa.org.za/.

J.2 The use of the terms geomatics, geoinformatics and geo-information in South Africa

In an effort to group various related disciplines focusing on geographic information, the terms Geomatics and Geoinformatics are now widely used worldwide. A number of universities offering traditional land surveying programmes have opted for the word Geomatics in order to widen the scope of land surveying by including remote sensing, photogrammetry and GIS. At other universities where GIS teaching and research has developed in user-disciplines such as Geography, Botany and Planning, the inclination was to use the term Geoinformatics because the focus was on the analysis of geographic information and not surveying. For instance, the University of Cape Town went from Land Surveying to Geomatic Engineering to Geomatics. The University of Pretoria decided on the term Geoinformatics not only because of the focus on information management, but also because with the closure of the Department of Land Surveying and Mapping, it did not want to create the impression that Land Surveying was still taught at the University.

Some government departments have chosen Geomatics (e.g. Water Affairs and Forestry) and others, Geoinformatics (e.g. Agricultural Research Council).

In practice, there appears to be little distinction that can be drawn between the use of these two terms in South Africa. The only distinction that can be detected is a stronger emphasis on either surveying and photogrammetry (Geomatics) or geographic information management and analysis (Geoinformatics). Comparing the curricula of the Universities of Cape Town and Pretoria, the only difference seems to be the inclusion of cadastral surveying in Cape Town and a greater focus on database management and spatial analysis at Pretoria. Whatever the differences, there is, however, a problem with the confusion it may create amongst the public or clients, as well as for the professional body.

The Geographical Information Society for Southern Africa (GISSA) currently defines geoinformation as “the science and technology of collection, measuring, processing, analysing, interpreting, disseminating, utilizing, evaluating and managing-geographically related and spatially referenced information” (see http://www.gissa.org.za). This definition in fact obscures the distinction between geoinformation as an object, and geoinformation management as a process.

J.3 National Professional Associations

J.3.1 Surveying

The Professional and Technical Surveyors Act (Act 40 of 1984) provides for the establishment of the South African Council for Professional Land Surveyors and Technical Surveyors (PLATO), as well as for the registration of Professional Surveyors, Professional Surveyors in training, Surveyors, Survey Technicians and Survey Technicians in training (see http://www.plato.org.za). The matters dealt with by PLATO include survey education and disciplinary matters.

Voluntary and statutory bodies, in the form of institutes, federations or associations, of members of the profession have existed for nearly 100 years, and in a number of cases, pre-date PLATO. While legislation governing the various institutes of land surveyors was repealed in 1986, these institutes have continued to exist as voluntary societies and represent the interest of their members by promoting the science and development of the profession. Most Professional Land Surveyors are members of one of the five provincial institutes, while FILSA (in full, the Federation of Institutes of Professional Land Surveyors of Southern Africa) is a federation of these institutes. FILSA co-ordinates, recommends action and generally speaks for and on behalf of the Institutes on issues that affect the profession at the national level.

PLATO recognizes the following domains: Cadastral, Minerals, Photogrammetry, Remote Sensing, Engineering, Hydrography, Geodesy, Geospatial Information Management, Cartography, Industrial and Environmental Geomatics.

J.3.2 Geo-information interest groups

Various interest groups such the Photogrammetry Society, as well as sub-national GIS organizations (TAGIS – now GISSA Gauteng, NAGIS, FAGIS, CAGIS) have existed for some time. In 1999, an umbrella organization, the Geographical Information Society of Southern Africa (GISSA) was established, replacing the previous national organization AGISA. There have also been discussions on the affiliation of the South African component of GITA to GISSA. One of GISSA’s main aims is “to strive for registration of all Geo-Information practitioners” (http://www.gissa.org.za/). The registration of Geo-Information practitioners is being explored in association with the South African Council for Professional Land Surveyors and Technical Surveyors (PLATO).

J.3.3 Society for South African Geographers

The Society for South African Geographers has a Commission on GIS. They are represented on the South African National Committee of the IGU.

J.4 Education and training

J.4.1 The National Qualifications Framework

The National Qualifications Framework (NQF) is the set of principles and guidelines by which records of learner achievement are registered, to enable national recognition of acquired skills and knowledge, thereby ensuring an integrated system that encourages life-long learning (http://www.saqa.org.za). The NQF came into being through the South African Qualifications Authority (SAQA) Act (Act 58 of 1995).

The NQF objective of the acceleration of redressing past unfair discrimination in education, training and employment opportunities, means that there is need for the recognition of prior learning. This in part underlies SAQA's outcomes based approach to defining qualifications. The focus on learning outcomes is also reinforced by the aim of ensuring that standards and qualifications registered within the NQF are internationally comparable, as the global trend is moving towards describing qualifications in terms of achieved learning outcomes. Specific learning outcomes are associated to unit standards, and unit standards are grouped to define qualifications.

SAQA has two "arms", namely **Standards Setting** and **Quality Assurance**. The sub-structures in the standards setting arm are the National Standards Bodies (NSBs) and the Standards Generating Bodies (SGBs), while the sub-structures in the quality assurance arm are the Education and Training Quality Assurance bodies (ETQAs). SAQA may choose to appoint moderating bodies if it deems it necessary. The functions of these bodies and their relationships are depicted in Figure J.1 below.

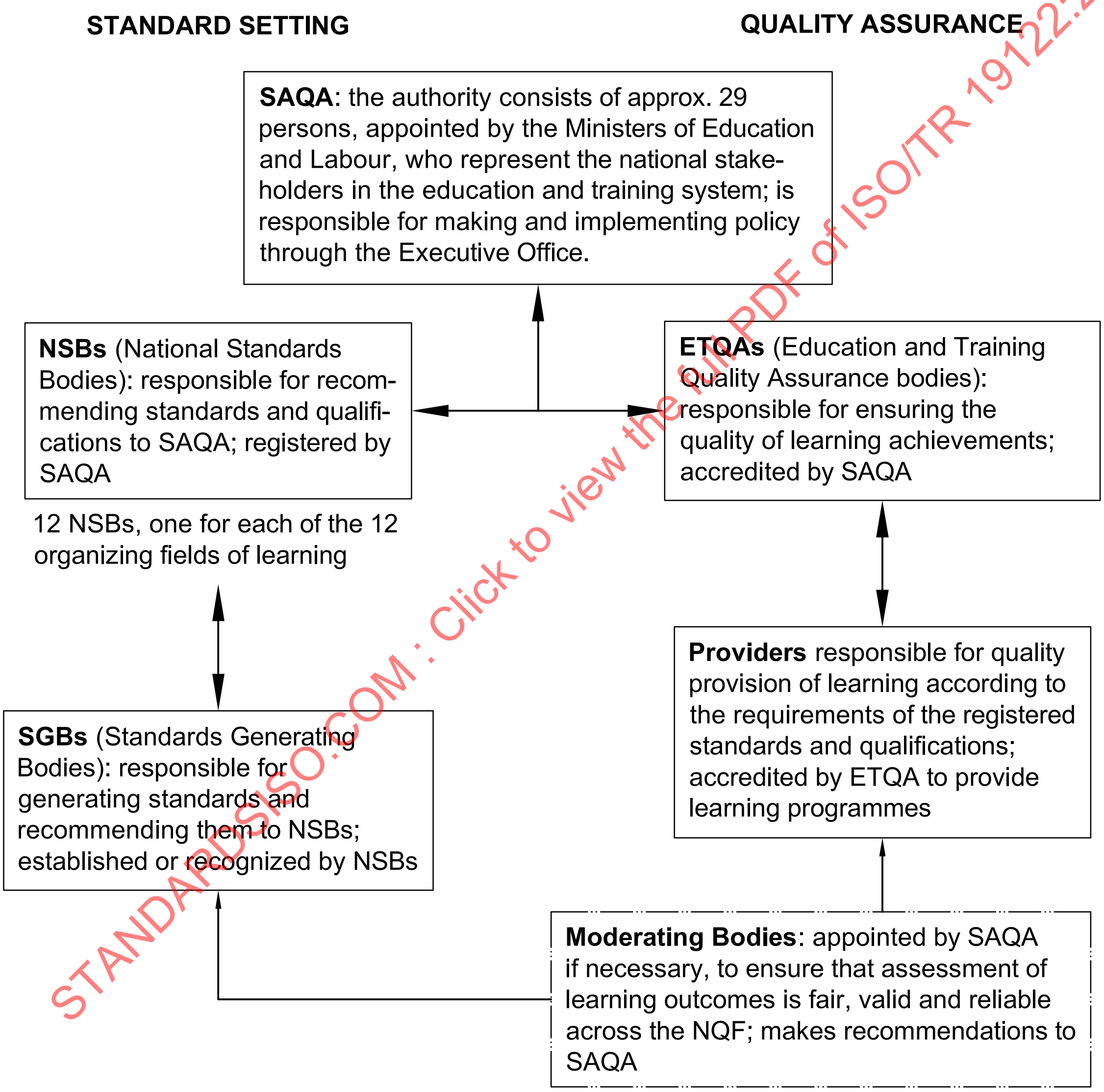

Figure J.1 — The National Qualifications Framework: structures and institutions involved

SAQA has adopted an eight-level framework (see Table J.1 below) for qualification types, with levels 1 and 8 respectively being regarded as open-ended. Level 1 accommodates three Adult Basic Education and Training (ABET) certification levels, as well as the General Education and Training Certificate.

Table J.1 — The NQF's eight levels of qualification types

NQF Level	Band	Qualification Type
8 7 6 5	Higher Education and Training	— Post-doctoral research degrees — Doctorates — Masters degrees — Professional Qualifications — Honours degrees — National first degrees — Higher diplomas — National diplomas — National certificates
Further Education and Training Certificate (FETC)		
4 3 2	Further Education and Training	National certificates
General Education and Training Certificate (GETC)		
1	General Education and Training	Grade 9 | ABET Level 4 ——— National certificates

In the NQF, all learning is organized into twelve fields and SAQA has consequently established twelve corresponding NSBs. The twelve fields are as follows:

— NSB 01: Agriculture and Nature Conservation

— NSB 02: Culture and Arts

— NSB 03: Business, Commerce and Management Studies

— NSB 04: Communication Studies and Language

— NSB 05: Education, Training and Development

— NSB 06: Manufacturing, Engineering and Technology

— NSB 07: Human and Social Studies

— NSB 08: Law, Military Science and Security

— NSB 09: Health Science and Social Services

— NSB 10: Physical, Mathematical, Computer and Life Sciences

— NSB 11: Services

— NSB 12: Physical Planning and Construction

J.4.2 Existing training programmes in surveying, geoinformation and GIS

Training in surveying is provided at 2 universities (degree programmes) and 6 technikons (national diplomas and certificates).

Most, if not all, South African universities would include at least a module on GIS within a batchelor's or higher degree in Geography, although the focus of these modules in the main is on the application of GIS. Many post-graduate courses (i.e. honours or taught masters degrees) in fields such as archaeology, botany or planning also include training in GIS, although this would in general be aimed specifically at equipping students with the rudiments of GIS to enable them to manipulate spatially referenced information pertinent to their field of study. Courses derived from UNIGIS material are provided by the University of Pretoria and Port Elizabeth Technikon. A batchelor's degree in geoinformatics is now also offered by the University of Pretoria.

However, even a decade ago, the inclusion of courses on geoinformatics or GIS in university curriculae in South Africa was not widespread. With the rapid growth in the geoinformation industry, this means that many people whose work entails the management of geographic information have never received any formal training in geoinformatics. These "geographic information practitioners", who have by and large acquired their skills and knowledge "on the job", clearly stand to benefit from the recognition of prior learning and the definition of qualifications in terms of satisfying various learning outcomes, as espoused by the NQF.

J.5 Current initiatives relating to qualification and certification

In recent years there has been considerable discussion about the certification, standardization of qualification and possibly even formal professional registration of GIS practitioners. For instance, the current lack of a standard post type for geographic information experts within the public service in South Africa has lead to the designation of geographic information specialists who are in the public service variously as industrial technicians, data technicians, geographers or planners. The lack of parity of remuneration associated with these post types has meant that it is often difficult to retain staff in a particular component, due largely to an accident of classification of the post type.

The definition of unit standards for Surveying is well under way. The composition of several qualifications in terms of unit standards, with their associated learning outcomes and credit rating, namely the National Diploma in Hydrographic Surveying, the National Diploma in Surveying, the National Certificate in Photogrammetry, the National Certificate in Hydrographic Surveying and the National Certificate in Surveying, may be found on the SAQA web site. The National Certificates correspond to NQF level 5, while the National Diplomas are associated with NQF level 4.

Even though the SGB for Geographical Information Science (GISc) has not yet been formally constituted, work is proceeding on the drafting of unit standards. These range from units focussing on cartography, to the selection of a data structure for a GIS and the capturing of geoinformation from secondary sources. In the Business Plan for the GISc SGB, it is proposed that the development of unit standards for NQF levels 1-4 be prioritised. Targets set include the submission of qualifications based on unit standards for interim registration by SAQA by May 2002 for NQF levels 1-4, and July 2002 for levels 5-8. Following completion of these tasks, all existing unit standards and qualifications in the sector will be reviewed. It is intended that the draft unit standards will be published through the PLATO, GISSA and SAQA web sites, in order to keep the wider community informed and effect ongoing consultation on the development of unit standards and qualifications.

Both the SGB for Surveying and the soon to be formalized SGB for GISc fall under NSB12: Physical Planning and Construction.

J.5.1 Summary and concluding remarks

The geographic information community in South Africa has generally welcomed the implications of the NQF for formalizing and standardizing a qualification system, which has to date been conspicuous by its total absence. As such, the need to develop unit standards and hence standard qualifications corresponding to the 8-level framework of the NQF has been embraced with enthusiasm. The need for ensuring representation of the industry as a whole on the SGB has in fact injected new energy into GISSA, the national geoinformation interest body.

Naturally achieving consensus at the level of detail on unit standards, qualification and even terminology associated with qualifications at various levels will not be easy. There is no clear agreement even on whether the registration of “geoinformation practitioners” should be sought, or whether the development of a code of ethics for members of the national umbrella body GISSA would be more effective and easier to achieve.

There is a further divide in opinion within the community as to whether PLATO represents an appropriate organ for the registration of geoinformation professionals alongside surveyors. The argument here is that geoinformation management is a generic process executed by various specialists in various domains. At present the PLATO domains are cadastral, mining, hydrography and engineering. The domains currently using GIS are far wider, including land management, environmental management, business, utilities and public administration; surveying is only one element in the geoinformation management process.

A suggestion that the SGBs for surveying and GISc be amalgamated was rejected by the GISc SGB. There has even been discussion of the GISc SGB finding a home in another NSB, namely NSB 10: Physical, Mathematical, Computer and Life Sciences, sometime in the future.

J.5.2 Acknowledgements

This case study, compiled by Elizabeth Gavin, drew on the discussion document “On finding a home for the GIS Practitioner” by Prof. Paul van Helden of the Centre for Geoinformation Science, University of Pretoria (see http://www.up.ac.za/gis/gip/gip.htm). Input from Tania Smith, Director: NSIF, Department of Land Affairs is also acknowledged.

Annex K
(informative)

National case studies — United Kingdom

K.1 Introduction

The UK does not support the ISO TC211 Geographic Information/Geomatics working committee 19122 proposal on Qualifications and Certification of Personnel.

In submitting this case study, the UK is not endorsing the proposal, but demonstrating that such proposals are best implemented at the national level.

K.2 AGI — Position on Professional Development

The AGI has considered the role of professional development throughout its twelve years of existence and has been debated at the AGI's annual conferences, at seminars devoted to GI Professional Development and within the Professional Development working groups that preceded the AGI's Continuous Professional Development Committee. (refer to AGI Bibliography)

The AGI policy on professional development has been derived against a backdrop where the following has been recognized or considered:

- the all pervasive nature of geographic information; he demands on the AGI's limited resources and the need for these to be devoted to the higher priority issues regarding geographic information and its exploitation;

- the significant resources required to introduce and maintain a professional development scheme and all that this entails.

As a result the AGI has adopted the following policies:

- it will not become a professional body that provides certification of people and accreditation of educational courses;

- it will not provide any form of certification for individuals to practice.

The AGI policy with regard to supporting professional development is

- to develop and offer a continuous professional development scheme which enables individuals to structure there own professional development and record it in a consistent way.

- to work in partnership with other professional institutions such as the British Computer Society, The Royal Institute of Charter Surveyors, The Royal Town Planning Institute, etc. and learned societies such as the Royal Geographical Society (with IBG), the Geographical Association, etc.

K.3 An Industry Structure Model for the GI Sector

During 1994 and 1995, the AGI ran two professional development workshops that developed a formal specification for job levels and competencies in the field of geographic information. The workshop convenors were the Chair and Vice Chair of the AGI Information and Education Committee Prof David Unwin and Barry Capper.

Representatives from the British Computer Society, the Royal Institution of Chartered Surveyors and the Royal Town Planning Institute were actively involved in the workshops, which took into consideration the various professional development schemes implemented within these disciplines.

The workshops took as the base line the British Computer Society (BCS) Industry Structure model which specifies a set of performance standards covering all functional areas of work carried out by professionals both in and allied to the field of information systems engineering. The BCS model was first introduced in 1986 and the AGI workshops considered release 2 of the model which has ten levels. (Refer to K.18, appendix D.)

The outcome from the AGI workshops was a draft 6 level industry model based on the BCS model but for the GI sector. (Refer to appendix D). The model formed the basis for a paper presented to AGI95 conference by Professor David Unwin and Barry Capper (refer to K.13, AGI bibliography).

The draft model was widely circulated within the AGI during 1996 and 1997 and debated at AGI Council. and was subsequently presented at a seminar in 1998. (Refer AGI bibliography.)

The AGI model is available to all members to apply if they wish and offers it as guidance to other disciplines that use and exploit GI. As the AGI has decided not to implement a professional development scheme, the AGI GI industry model has a status of information only. Due to pressure on AGI resources, the model has not been maintained. The scheme has been subsequently used as a model in similar schemes internationally.

K.4 The AGI Continuous Professional Development (CPD) scheme

In outline the AGI CPD scheme offers AGI members the following:

- formalized methodology to record their professional development;
- CPD manual and logbook;
- CPD registration scheme;
- annual log book validation service.

The scheme has

- low cost of entry;
- AGI CPD logo.

The AGI complements this scheme through

- its event programme by displaying the CPD logo on events that accrue CPD credits if attended;
- by offering an approval service to other organizations that wish to have there events badged with the AGI CPD logo.

The scheme was launched at the AGI annual conference and exhibition in 1999 and was fully implemented in October 1999.

A CPD committee chaired by Professor David Unwin in conjunction with the AGI Secretariat administers the scheme. The committee reports to the AGI Education committee. AGI Council reviews the CPD scheme every six months.

Further details on the CPD scheme can be found on the AGI web site www.agi.org.uk

K.5 AGI Awards Scheme

The AGI runs an annual award scheme to promote excellence and to give recognition to outstanding achievements. The awards are offered for Technological progress, Journalist of the year, Student of the year, outstanding progress in Central government, outstanding progress in Local government. These awards are presented at the AGI's Annual dinner and award ceremony, which takes place after the AGI Annual General Meeting and annual lecture given by a leading dignitary. The awards scheme promotes and recognizes professional development in these sectors.

K.6 Government and Higher Education

There is in place in this Country a comprehensive professional framework within which geographic information and related education fits, much of which has resulted from Government action:

- Quality Assurance Agency – responsible for Benchmark Statement and curriculum content and a rigorous inspection regime related to teaching quality. (www.qaa.ac.uk – note that the survey is covered under Engineering.)

- Research Assessment Exercise – a four yearly peer review and assessment of quality of research output. (www.rae.ac.uk)

- Institute of Learning and Technology – responsible for research and professional standards among educators. (www.ilt.ac.uk)

K.7 GI-related Academic Courses within the UK

The AGI undertakes from time to time a survey of GI-related courses that are offered within the higher education establishments within the UK. The details of these surveys are published by the AGI in its annual Source Book. The last full survey, undertaken in 1997, showed that over 40 Universities within the UK offer Geographic Information courses at under-graduate and postgraduate levels or application-oriented courses that include GI modules. The names of the Universities, the generic course titles and the faculties involved in preparation and presentation of these courses are shown at Appendix C. (Note: the list is not exhaustive.) In the future institutions offering academic GI courses will be able to update the AGI register of courses online via the new AGI web site scheduled to be launched in August 2001.

The teaching of GI is well founded in the UK and the range of courses and disciplines offering GI education has broadened as GI has advanced over the past 30 years.

The AGI has over 30 Higher Education organizations as corporate members. The AGI does not assess or accredited any of the courses offered.

K.8 GI teaching in Schools within the UK

Computerized mapping and GI education is now well established within secondary education and to a lesser extent in primary education. There are indications that in the UK, GI education within schools is extending beyond the original starting point of geography.

The AGI, like many of the Professional Institutions here in the UK, offer educational material and support teacher training colleges, school advisors, teachers and pupils. The AGI now has an active Schools Special Interest Group chaired by Dr. David Green.

Several of the AGI initiatives in recent years have involved schools. An example of this is the AGI/RGS-IBG London Initiative during 1999-2000.

The AGI has over a number of years also presented a Schools prize for innovative GI projects. The announcement of the winner of the Schools prize is made at the AGI Annual Conference and Exhibition.

K.9 Position of Employers and Entrepreneurs

A recent sounding of opinions of the AGI Council and AGI working committee members that employ GI personnel showed that in general employers would take into consideration GI certification at the time of interview. However they would not use it as a reason for not employing a person either full time, part time or on a contractual basis.

Entrepreneurs have also indicated that certification was seen as not relevant when seeking out and exploiting new business opportunities. They consider it could be a hindrance to opening up new GI-related opportunities. Other attributes of the people employed were considered to have a much higher rating than GI certification when building a new business and making it prosper.

The evidence also supports that in times of high employment, organizations will take on employees and undertake their own training and staff professional development programmes to ensure their business objectives are met.

K.10 Cultural Issues

It is widely recognized in the UK that the impediments to widespread use of GI are cultural and organisational rather than technical issues or the lack of qualified personnel.

The Modernizing Government initiatives under way in the UK and across Europe are dependent upon and underpinned by GI.

The UK Government has identified the main challenge to the Modernizing Government initiative as bringing about the cultural change that is required within the public services.

The Government has publicly announced that it sees that in certain sectors the professional institutions themselves are restricting innovation, change and the adoption of new ways of working and implementing government. As such the AGI does not support a certification process that may be seen by the Government as introducing constraints. The AGI firmly believes that the UK society will reap enormous benefits if the Modernizing Government programme uses GI to its fullest potential and has decided to put its limited resources towards achieving this objective.

K.11 GI as Part of the Information Technology Sector

It is widely acknowledged that GI is part of the wider information and communication technology sector and it is relevant to consider the impact of ITC certification by such organizations as the British Computer Society which for over 30 years has had a professional certification scheme in existence. Independent surveys of IT professionals employed within the UK show that only a small percentage actually have BCS creditation.

The above example, which is one of a number, has led the AGI to conclude that its effort should be devoted to supporting the individual with their lifelong development rather than bringing in a creditation scheme. Hence the reason why the AGI has implemented and is building upon its Continuous Professional Development Scheme and actively supports professional institutions in a wide cross section of disciplines and applications with regard to GI professional development issues.

There is no evidence in the UK to suggest that where it is not legally required to be certified, employers have made it a criteria to be met for employment or placing contracts.

K.12 Summary

The AGI believes that when GI is considered in the widest sense, there is little to be gained at this point in time by adopting a global qualification and certification scheme as proposed and being worked on by ISO TC211.

Learning through improved awareness and best practice is considered to be worthwhile by the AGI but not at the expense of addressing other higher priority issues that are impeding the widespread exploitation of GI and the associated technologies.

If the objective is to raise awareness on the various approaches to acquiring academic qualifications and lifelong learning and professional development, then the AGI believes that there are other ways that this can be done which exploits existing structures, e.g. the national GI associations where they exist (here in Europe this is nearly all countries). The information collated at the national level could then be consolidated upwards through the regional GI organizations such as EUROGI in Europe as and when required including further consolidation up to the global level through the auspices of the GSDI rather than through the International Standards making body.

K.13 AGI Bibliography

Ethics and Professionalism – AGI Note 2/94 ISBN 1 874059 12 8

Professional Development for the Geographic Information Industry October 1997

Professional Development in the GI Industry – seminar notes. July 1998.

CPD Manual and Logbook – AGI September 1999

K.14 Papers presented at AGI Conferences

Professionalism in GIS: The Role of the Royal Institution of Chartered Surveyors, Logan.I.T. AGI91, Paper 3.18.

A Young Professional's View of the GIS Industry, Buchanan.H. AGI91, Paper 3.19.

Do GIS Specialists need the Professional Institutions? Kennie.T. & Mather.P. AGI91, Paper 3.20.

GIS Certification, Ethics and Professionalism, Rix.D., & Markham.R. AGI94, Paper 6.2.

Professional Development in the Geographic Information Industry, Capper.B., & Unwin.D. AGI95, Paper 1.9.

K.15 Appendix A to UK Case Study

K.15.1 The Association for Geographic Information (AGI)

The AGI is the National Association which represents all with an interest in the geographic information industry in the UK. This includes users in the public & private sectors, the suppliers of software, hardware, data & services, consultants, academics involved in research on GI issues and interested individuals.

The mission of the AGI is to “Maximize the use of GI for the benefit of the citizen, good governance and commerce”.

Many of the Professional Institutions and Learned Societies are members of the AGI. The RICS has been a sponsor member of the AGI since the AGI’s inception in 1989. The RTPI is represented on AGI’s Council.

The majority of the AGI Council members at anyone time are members of one or more of the Professional Institutions or Learned Societies. As such the AGI brings together a wide spectrum of experience and knowledge.

K.15.2 Background to this document

The AGI Council together with its working committees and the AGI Standards Committee (IST/36) have considered and debated the ISO TC211 proposal for Professional certification for people working with geographic information ever since it was first proposed in 1998/99.

At the AGI Council meeting held in London on 28 June 2000, the following decisions were taken:

— The UK Standards delegation was instructed to vote against the proposal. (Note: The AGI voted against this work programme when it was first proposed. The AGI has responded when requested to the ISO working group's requests for further information such as responding to the questionnaire in 2000 and the current request for country case study material etc.)

— The AGI EUROGI representative was instructed to raise the matter at EUROGI to encourage European action and debate. (Evidence that this took place can be seen on the EUROGI web site www.eurogi.org and also in the EUROGI Executive Committee meetings minutes of 22-23 September 2000 section 2.10.1, 19-20 January 2001 section 5.1 and the EUROGI Annual General Meeting minutes of 20 March 2001 Section 9.4.3 – and that the action is ongoing.)

K.16 Appendix B to UK Case Study

K.16.1 AGI definitions

The AGI has adopted the following definitions, which it promulgates through its awareness programme and web site.

- **Data** "A collection of facts, concepts or instructions in a formalized manner suitable for communication or processing by human beings or by automated means"
- **Information** "Intelligence resulting from the assembly, analysis or summary of data into a meaningful form"
- **Geographic Information** "Information about objects or phenomena that are associated with a location relative to the surface of the earth. A special case of spatial information"
- **Spatial Information** "Information which includes a reference to a two or three dimensional position in space as one of its attributes"
- **Continuous Professional Development** "The systematic maintenance, improvement and broadening of knowledge and skill, and the development of personal qualities necessary for the execution of professional and technical duties throughout one's life"

The following definitions are also offered to place the role of the various institutions and societies that have an interest in GI in the UK into perspective. (Source: Kennie.T. & Mather.P. AGI91)

A Learned Society "A learned society is one where the emphasis is primarily on the exchange of knowledge or information in order to enhance the standing of the subject." e.g.

Royal Geographical Society	www.rgs.org
Geographical Association	www.geography.org.uk
The Remote Sensing and Photogrammetry Society	www.rspsoc.org
The Royal Statistical Society	www.rss.org.uk
The Geological Society	www.geolsoc.org.uk

A Professional Association "A professional association is one where in addition to the characteristics of the learned society there are significant commercial interests." e.g.

The AGI	www.agi.org.uk

A Professional Institution "A professional institution is one where in addition to the characteristics of a learned society and a professional association, there are additional ethical standards to which members agree to adhere. There may also be specific commercial benefits, particularly where membership of the Institution is a prerequisite of practice." e.g.

British Computer Society (BCS)	www.bcs.org
Institute for the Management of Information Systems (IMIS) (which incorporates the Institute of Data Processing Managers)	www.imis.org.uk
Royal Institution of Chartered Surveyors (RICS)	www.rics.org
Institute of Civil Engineers Surveyors (Inst. CES)	
Royal Town Planning Institute (RTPI)	www.rtpi.org.uk
Institute of Electrical Engineers (IEE)	www.iee.org.uk
Institution of Civil Engineers (ICE)	www.ice.org.uk

K.17 Appendix C to UK Case Study

The AGI from time to time undertakes a survey on GI-related courses offered within UK Universities. The detailed analysis published in the AGI Source Book are also now available on the AGI web site. The surveys show the following Universities offer courses at the undergraduate, postgraduate and further education levels. (lifetime-long learning)

K.17.1 Universities offering GI-related courses

K.17.1.1 List of universities

Bath Spa University College
Birkbeck College - University of London
Cardiff University
Chichester College of Arts, Science and Technology
City University London
Coventry University
Cranfield University - Silsoe College
Glasgow University
Keele University
Kingston College
Kingston University
Lancaster University

Leicester University
Liverpool University
London School of Economics & Political Science
Loughborough University, Martin College
Middlesex University
Nottingham Trent University
Oxford Brookes University
Queen Mary & Westfield College
Royal Agricultural College
Sheffield University
Stirling University
Strathclyde University
The Queen's University Belfast
UNIGIS (Manchester Metropolitan University)
University College Chester
University College London
University of Aberdeen
University of Brighton
University of Cambridge
University of Durham
University of East Anglia
University of East London
University of Edinburgh
University of Glamorgan
University of Greenwich
University of Hertfordshire
University of Huddersfield
University of Leeds
University of Luton
University of Newcastle upon Tyne
University of Northumbria
University of Nottingham
University of Portsmouth
University of Salford
University of Sussex
University of Wales Cardiff
University of Wales Swansea

K.17.1.2 GI Course Titles

Remote Sensing and Geographic Information Systems	(BSc(hons))
Remote Sensing, GIS and Geography	(BSc)
Introduction to GIS	(Short Course)
Spatial Information Science	
Principles of GIS	
GI Science	(Masters)
Geographic Information Systems	(BSc, MSc, Mphil, MA, PhD, BTEC HND, BTEC HNC, PgD)
GIS awareness	
GIS Problem solving workshops	
GIS concepts and applications	
Information Systems - Geographic Information Systems	
An Introduction to Spatial Analysis using GIS	

Applications in GIS	
Principles of GIS	
Computing for Geoscience	
Advanced Geographical Information Systems	
Geography & Geomatics	(BSc)
Geographical Information Science	(MSc, PgD, Mphil, PhD)
GIS: Relevant Topics for the Experienced User	
Getting Started in GIS	
Spatial Information Technology	
Advanced Geo-Informatics	
An introduction to low cost GIS	

K.17.1.3 GI Application Course Titles

Marine Geography & GIS	(BSc)
Land Information Management and Mapping	(BTEC)
GIS - Rural Land Use	
Applied Remote Sensing	(MSc)
Environmental Management	(BSc)
Environmental Modelling	(MSc)
Land Resource Management	
Topographic Science (Cartography & Geoinformation Technology)	(MSc)
Cartography & Geoinformation Technology	
Topographic Science	
Environmental Computing	
Cartography	
Historical GIS	
Natural resource management	
Sustainable Agricultural Systems	
Sustainable Rural Development	
Rural Land Management	
Theory and Practice of GIS	
Environmental Biology	(MSc)
Environmental Remote Sensing	(MSc, Dip)
Surveying and Mapping Sciences	(BSc(Hons))
Geographical and Land Information Management	(BSc(Hons))
GIS for Business & Service Planning	(MA)
GIS for Catchment Dynamics & Management	(MSc)
Mapping Science	(BSc(Hons))

Land Administration (Geographic Technique)	
Surveying and mapping Science	
Landscape Ecology	(BSc)
Land Information Management and Mapping	(MSc)
City and Regional Planning - Introduction to GIS	(BSc, MSc)
GIS for Planners	
Land Regional Planning	
Geography with Topographic Science	(BSc(Hons))
GIS for Rivers and Conservation	
An introduction to GIS and Remote Sensing for Rivers and Conservation	
Remote Sensing	(BSc(Hons))

K.17.2 Faculty producing and offering the above titled courses

Applied Sciences
Geography
School of Mathematical and Information Sciences
School of Natural and Environmental Science
Rural Land Use
Agricultural Engineering
Industrial Liaison
Science
Computer Science
Geography & IS
Arts
Computing
Cartography
Rural Economy
Environmental Studies
Art & Social Science
Social Science
School of Surveying
Science and Engineering
Earth Sciences
Geomatics
Geography & Mapping

K.18 Appendix D to UK Case Study

K.18.1 Industry Models

K.18.1.1 British Computer Society (BCS) Industry Model Release 2

The model has ten levels labelled 0 to 9 with the following titles:

- 0 Unskilled entry
- 1 Standard Entry
- 2 Initially trained practitioner
- 3 Trained practitioner
- 4 Fully skilled practitioner

— 5 Experienced practitioner's/Supervisor
— 6 Specialist practitioner/Manager (limited scope)
— 7 Senior specialist/Manager (extended scope)
— 8 Principal specialist/Experienced Manager
— 9 Senior manager/Director

The BCS model defines the word "Manager" as "those functions of management required within the context of planning, developing or service delivery of an Information System for its users".

K.18.2 The AGI Industry Model – Release 1

The AGI model (matrix) has six levels and six streams.

- The levels in the AGI Industry model are

  1) Skilled entry

  2) Initially trained practitioner

  3) Fully skilled specialist

  4) Team leader/Senior specialist

  5) Senior Manager/Consultant

  6) Principal Manager/Director

- The streams in the AGI industry model are:

  - DA Data Acquisition
  - DB Design and Build
  - DM Data Management
  - DV Data Validation
  - GA Geographical Analysis
  - HI Human Issues

- The combination of the levels and streams provides a matrix as shown below:

Level[a]	DA	DB	DM	DV	GA	HI
1	DA-1	DB-1	DM-1	DV-1	GA-1	HI-1
2	DA-2	DB-2	DM-2	DV-2	GA-2	HI-2
3	DA-3	DB-3	DM-3	DV-3	GA-3	HI-3
4	DA-4	DB-4	DM-4	DV-4	GA-4	HI-4
5	DA-5	DB-5	DM-5	DV-5	GA-5	HI-5
6	DA-6	DB-6	DM-6	DV-6	GA-6	HI-6

[a] See list above.

The objectives of defining the matrix are

— to assist employers and individuals in understanding the basic requirements of a particular role in the GI industry field;

— to guide employers and individuals in assessing training needs;

— to assist employers in defining needs in terms of the ability of staff to perform a particular role;

— to assist Professional Bodies to assess members and potential members against a standard matrix.

The model gives particular emphasis on Continuing Professional Development (CPD) and maintaining a personal development plan and record of activities. These are considered particularly important in a developing technology.

The AGI industry model maps on the British Computer Society model as follows:

AGI Level	Description	BCS Levels
6	Principal Manager/Director	Fellow 8/9
5	Senior Manager/Consultant	6/7
4	Team Leader/Senior specialist	Member 4/5
3	Fully skilled specialist	Associate Member, 3
2	Initially Trained practitioner	Associate Member, 2
1	Skilled entry	Affiliate

Annex L
(informative)

National case studies — USA

L.1 Definitions

Given the nature of the American system of government explained in detail below, there are no nationally accepted terms for the fields covered by the domain of TC211. GIS is taught widely across the academic spectrum and supported by a broad range of professional organizations. The various terms used are generally similar to those provided in the Canadian Case Study with the exception of less general use of the term “Geomatics” in the US.

A recent survey of certificate and masters programs offered in the US uncovered the following program titles:

— Certificate in GIS;

— Certificate in Urban GIS;

— Certificate in Geomatics;

— Certificate in GeoTechnologies;

— Certificate in Geographic Information Science;

— MS in GIScience;

— MS in Geo-Information Science;

— MA in Geographic Information Sciences for Development and Environment;

— MS with Concentration in Applications of Geographic Technologies.

These are in addition to regular disciplinary undergraduate and graduate degrees with GIS focus offered by Departments of Geography, Planning, Geomatics or Spatial Information Science and Engineering (the latter two usually former Departments of Surveying Engineering).

Thus, while most of the Certificates in the area of GIS in US universities use some variation of Geographic Information Systems or Geographic Information Science in their titles, there are some significant variations. Rutgers University, for example, has taught GIS in professional continuing education since the 1980s and has had a “Certificate in Geomatics” since 1994. From its inception, this Certificate program has had a strong emphasis in remote sensing, photogrammetry, surveying and global positioning systems. Courses in Geographic Information Systems, CAD, programming and GIScience were added to the Certificate as the program expanded. Thus, in this case, the use of Geomatics rather than System or Science reflects the origins of the program and the composition of its faculty.

With respect to the structure of the academic environment in the US, for the sake of brevity, we refer to the description provided in the Canadian Case Study. Education in the US is organized generally in the same structure as that outlined in Figure C.1 included there. Note that many American universities and colleges offer “Certificates" as options in their continuing education curriculums. The definition and requirements of these certificate programs are self-determined and self-regulated by the individual university or college. So “Certificates in GIS” offered at various US education institutions are not consistent across either the number of courses, specific requirements, or course content.

