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PD ISO/TR 19122:2004

Geographic information/ Geomatics — Qualification and certification of personnel

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National foreword

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TECHNICAL REPORT

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Geographic information/Geomatics — Qualification and certification of personnel

Information géographique — Qualification et accréditation du personnel

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Foreword

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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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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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)

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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.

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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

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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).

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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.

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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).

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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.

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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).

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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

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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

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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.

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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.

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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.

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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.

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- 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

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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.

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— 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

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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.)

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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.

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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.

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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.

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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.

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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

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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.

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— 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

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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

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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.

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