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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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