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P R E F A C E

K. Rinner

The proper training and education of the young is of vital importance in any technical discipline. It must meet the requirements of the present and take into account those of the future. Its objective is to impart theoretical fundamentals, a scientific mode of thinking as well as expert knowledge. For theory is the key to the future, and nothing is more practical than a sound theory.

Because of the immense significance of geodetic activities for scientific development and scientific progress, all international societies interested in the advance of geodesy are also concerned with the question of education and training in geodesy. These are above all the International Association of Geodesy, the Fédération Internationale des Géomètres and the International Society of Photogrammetry and Remote Sensing as well as the International Cartographic Association, the International Hydrographic Organization, the International Society of Mining, and the Cartographic Section of the United Nations. In all these, relevant commissions were established, in the International Association of Geodesy the commission "Education in Geodesy", which was headed from 1972 to 1983 by the undersigned. In this period, working groups were installed for the regions Africa, Asia, Australia and Pacific, Europe, North America as well as South America. These reported on their work at the symposium "Education in Geodesy" 1982 in Graz, in which the above-mentioned sister organizations participated as well. The results of this symposium are contained in the Proceedings (Mitteilungen der geodätischen Institute der Technischen Universität Graz, Folge 42, 1983).

Supplementary to this, Prof. Dr. M.K. Szacherska and Prof. Dr. W.M. Welsch compiled an extensive report on the situation in the European countries. As this contains valuable information for all those interested in the education and training of geodesists and presents from among the multitude of systems used three well-defined systems that have stood their test in many years of practical application, the publication of this works is of great value. The expert world is greatly indebted to the authors for their laborious work and the excellent presentation. It is to be hoped that similar reports will be coming forth on other regions from the respective organizations and that these reports can also be utilized by sister organizations.

ACKNOWLEDGEMENT

Presenting in this volume the results of our common work in Commission IX - EDUCATION IN GEODESY - of the International Association of Geodesy in the years 1979-1983, we express the hope that the data we were able to collect may prove helpful when elaborating proposals for a modernization of the systems of educating geodesists and surveyors meeting the actual needs of our profession and science. We thank all the colleagues who - representing their countries in Commission IX - participated in the activity of the Regional Working Group EUROPE.

The period between the General Assemblies of IAG in Canberra and Hamburg was, also for us personally, of great importance, for we had the opportunity to work under the immediate direction of Professor Dr.mult. Karl Rinner, President of Commission IX. We wish to stress the extraordinary sympathy always shown by Professor Rinner to his collaborators. We also could appeal always for his most valuable advice and help in solving our problems, not only those connected with our activity in Commission IX. We therefore wish to dedicate this volume to Professor Rinner.

CONTENTS

I N T R O D U C T I O N

At the meeting of Commission IX held during the XVII General Assembly in Canberra, 13.12.1979, the appointment of Regional Working Groups for Africa, North America, South America, Asia, Australia with Pacific, and Europe was decided on the initiative of the President, Professor Dr.Mult. K. Rinner. When establishing these groups beginning of 1980, Professor Rinner entrusted M.K. Szacherska (Poland) as Chairman, W.M. Welsch (FRG) and W.D. Bolshakow (USSR) as Assistants, with the direction of Working Group EUROPE.

According to the programme of the activity of Commission IX in 1979-1983, proposed by Professor Rinner at the meeting of Canberra, we adopted the following principal tasks to be accomplished by Working Group EUROPE:

1. to collect detailed information concerning the systems of educating geodesists and surveyors in all the European countries;

2. to characterize the basic educational models in Europe;

3. to define the principles of modernizing the educational system under consideration of the requirements of newly founded scientific centres, particularly in the developing countries.

We were able to perform all these wide-ranging tasks thanks to the helpful advice offered us by Professor Dr.Mult. K. Rinner as President of Commission IX. We benefited also in our work from the cooperation with the representatives of the European countries in our Commission, with the other Regional Working Groups and with the relevant commissions of professional and scientific organizations, particularly with Commission 2 of the FIG. This cooperation contributed to the solution of our common problems.

With regard to the variety of systems of education in geodesy and surveying in Europe, it was our principle task to set up a catalogue of the different educational models as basis for an analysis of the possibility of modernizing the system and of introducing those organizational solutions which proved the most efficacious. We gathered information on the educational system from four sources:

1. replies to especially elaborated questionnaires,
2. descriptions of educational systems, programmes of academic education, correspondence and discussions with colleagues from different countries,
3. published and unpublished papers on education in geodesy and surveying,
4. experience acquired in the course of our personal didactic activity and visits to renowned university centres.

In order to gather uniform material for our analysis we asks the representatives of the European countries in Commission IX to answer two questionnaires concerning:

I. Professional fields of geodesy and surveying,
II. Education in geodesy and surveying.

It was the aim of questionnaire I to define the scope of the rights and duties of geodesists and surveyors of different professional qualifications in different countries. Questionnaire II concerned the levels of education, its organization, the programme of secondary and higher professional schools, as well as academic education. The last mentioned theme has been dealt with extensively. The questions concerned the organization of academic education, the rules of the award of scientific degrees, the programme of studies and of practical training.

We are indebted to the colleagues who sent us detailed and carefully prepared answers. We have to mention in the first place the Professors C.C. Tscherning, K. Borre and Jacobi (Denmark) who returned the earliest precisely filled in questionnaires. We are also particularly thankful to Professor Rinner who, in spite of his numerous duties as President of Commission IX, found the time to prepare, together with Dr.Eng. H. Lichtenegger, detailed data concerning the education in geodesy in Austria.

We have to enumerate the remaining colleagues in the alphabetical order of the countries they represent. We received replies to our questionnaire from the Professors J. Mousset (Belgium), L. Hradilek (Czechoslovakia), E. Hytönen, J. Virta, Martikainen and Kuparinen (Finland), J. Dejeumont (France), D. Möller, W.M. Welsch et al. (FRG), L. Stange (GDR), J. Somogyi (Hungary),

M. Carla (Italy), V. Poos (Luxembourg), J.E. Alberda (The Netherlands), Th. Sømod (Norway), M.K. Szacherska (Poland), L. Pereira Osorio (Portugal), L.E. Sjöberg (Sweden), G. Özgen, I. Yasar and T. Ayan (Turkey), N. Čubranić (Yugoslavia).

The answers to our questionnaires constituted the principal source of information on the educational systems in the European countries. The comments and explanations which Professor C.C. Tscherning (Denmark) and Professor J. Mousset (Belgium) added to their replies were also very inspiring.

The second important source of information were the reports on the organization and programmes of education for which we asked the representatives of the European countries in Commission IX. We think here first of all of Professor Paul-Louis Baetslé who sent us his report in spring 1983 a short time before his sudden decease. We realize with particular emotion and with deep regret that the report on the organization of education in Belgium he prepared for us was one of the latest elaborations of this eminent scientist and very dear friend.

We received also relevant elaborations, especially prepared for the purposes of our Working Group from the Professors L. Hradilek (Czechoslovakia), K. Borre (Denmark), J.E. Alberda (The Netherlands), Th. Sømod (Norway), L. Pereira Osorio (Portugal) and P. Hodacs (Sweden). We thank them all once more. It is obvious that we added also our own reports on education in the Federal Republic of Germany (W.M. Welsch) and Poland (M.K. Szacherska). We also obtained complementary information thanks to our correspondence with the Professors G. Milev (Bulgaria), E. Hytönen (Finland), H.-M. Dufour and R. d'Hollander (France), F. Deumlich (GDR), E. Livieratos (Greece), A. Detreköi (Hungary), R.C. Cox (Ireland), M. Cunietti (Italy), N. Oprescu and N. Zegheru (Romania), M.I. Sevilla (Spain), H. Matthias (Switzerland), G. Özgen, I. Yasar, T. Ayan (Turkey) and N. Čubranić (Yugoslavia).

Our third source of information were publications on the education of geodesists and surveyors. The papers and reports of Professor Dr.Mult. K. Rinner (1975, 1977, 1979, 1982a, 1982b) formed the guide-lines of our work. We found also fundamental information on the organization of education in geodesy and surveying in Europe in the papers elaborated in Commission 2 of the FIG and particularly in the valuable publications presented at the Congresses in Stockholm, Montreux and Sofia.

When systematizing the results of our own work, we could make use of the interesting remarks of Professor T.J. Blachut (1960). A fuller characterization of the educational systems in the different European countries was made possible also by the reports which the representatives of these countries in Commission IX presented at the Symposium in Graz in September 1982. These reports are published in the Proceedings. We should like to mention also the Master's thesis of B. Wirth (1981), in which a catalogue of the educational systems in Europe has been set up.

A fourth source of information is due to immediate contacts with the representatives of the European countries in Commission IX and to visits to different Academic Centres. A special opportunity for such contacts was created by Professor K. Rinner who organized the Joint Symposium of IAG, FIG, ISPRS, ICA, ISM, UNESCO in Graz in autumn 1982. We need not dwell here on the results of the Symposium, as they are discussed in the report of Commission IX. A brief report on the Symposium has been published also in BULLETIN GÉODÉSIQUE (Szacherska, 1983).

It would be too long to enumerate here all the contacts with eminent colleagues and the visits to educational centres. Four of these visits have, however, to be mentioned with regard to their importance for international cooperation in this domain. The visit of W.M. Welsch in China in 1980 on invitation of the National Bureau of Surveying and Mapping (Welsch, 1981) and the participation of M.K. Szacherska in the Workshop on Positioning in Geodesy in 1980 in Lagos on invitation of the Nigeria Association of Geodesy (Szacherska, 1980a, 1980b) made it possible better to get acquainted with the problems of the education of surveyors in Asia and Africa. The cooperation with Commission IX - Geodesy in Africa - was furthermore developed by M.K. Szacherska who prepared a paper for the Second Symposium on Geodesy in Africa held in Nairobi in 1981 (Szacherska, 1981). Szacherska's longer sojourn as visiting professor at the Queensland University in Brisbane in 1981 gave her the opportunity to discuss educational problems with Professor J. Allman of New South Wales University in Sydney, President of the Working Group AUSTRALIA and PACIFIC, and to exchange experiences gained in both Groups.

The results of the analysis of the collected information on the educational systems in the European countries have been discussed in detail in two papers presented at the Symposium in Graz (Szacherska, 1982; Welsch, 1982). These papers were at the same time reports on the activity of our Working Group till

middle of 1982. In connection with the cooperation initiated by Professor Rinner with Commission 2 of the FIG we prepared also an invited paper for the XVII Congress of the FIG in Sofia (Szacherska and Welsch, 1983), in which the results of our investigations have been briefly presented. The final report on the activity of the Regional Working Group EUROPE in the years 1979-1983 was presented and discussed at a special session of IAG Commission IX held during the XVIII General Assembly in Hamburg (Szacherska, 1983).

We decided, nevertheless - with regard to the scope of the gathered data - that it would be indicated to prepare a special, larger publication dealing with the education of geodesists and surveyors in all the European countries and a comprehensive analysis for the relevant system. We offer this volume today to our readers.

Descriptions of the educational systems have been in some cases, as already mentioned, written by the representatives of the relevant countries in Commission IX, in others by ourselves on the basis of the exchanged correspondence. From some countries we did not receive, however, - in spite of our repeated endeavours - all the data we need. In these cases we publish only brief notes, for it is our principle that all the descriptions of the educational systems in geodesy in the European countries should be based on information obtained from the representatives of these countries in Commission IX and revised by them.

In the last chapter of our present publication we endeavour to characterize the principal models of education of geodesists and surveyors in Europe. We also present brief remarks on the organization and programmes of education. References indicating the publications and reports strictly connected with our activity in Commission IX complete the volume. Other publications on the educational system in the particular European countries are indicated in the relevant chapters.

Reports on the geodetic education in South America by A.A. Cerrato, Brazil, and in Asia by A.G. Arur, India, conclude this publication.

The authors are indebted to the Bundessprachenamt for the various difficult translations and to Mrs. R. Zech for the fair copy of all reports.

REMARKS ON THE PRINCIPAL MODELS OF EDUCATION OF GEODESISTS AND SURVEYORS IN EUROPE

We were able - thanks to the helpful cooperation of our colleagues representing the European countries in Commission IX - to gather copious material on the system of education of geodesists and surveyors. We have utilized these data in our studies on the educational systems in Europe and presented the results of the analysis in the already mentioned publications (Szacherska, 1982; Welsch, 1982; Szacherska + Welsch, 1983). Among these results the definition of the principal models of the education of geodesists and surveyors in Europe may be considered important, for it allows to advance some propositions concerning the modernization of the organization and the programme of the educational system.

In order to characterize the educational models various features may be taken into consideration, such as the rules of organization, the levels of education, the types and the number of schools and universities, the professional and scientific degrees, the educational programmes or the scope of the general and special subjects. In our opinion, however, the purpose and the result of the educational process should constitute the fundamental criterion to be applied when characterizing different models of education.

Since the orientation of the educational process towards surveying practice or geodetic research is the decisive factor which determines the character of the respective system, we may, applying this criterion, distinguish the following four models of education in Europe:

1. education of surveyors at professional schools, education of geodesists/geographers at universities;

2. professional and academic education either in surveying or geodesy/geophysics according to the profile of the particular school or university;

3. uniform system of general education in surveying and geodesy concentrated on engineering surveying;

4. uniform system of general education in surveying and geodesy with a developed specialization in geophysics.

Some explanations have to be added to this concise definition of the four principal European models of education.

Model 1. In France, Belgium, Italy and other countries, where this model is in use, there exist two parallel systems of education. This results from the consideration that the country needs a large number of surveyors with basic professional qualifications, while the demand for geodesists/geophysicists prepared for designing and research is relatively limited.

According to this model the task of the surveyors consists in typical measurements, especially cadastral survey and routine measurements for the purposes of civil engineering. This numerous group of specialists is mostly educated at secondary technical schools and professional courses. There are in general no special Departments of Surveying at the universities, but it is possible to specialize in surveying at the Faculties of Civil Engineering. The authorization to independent professional practice as surveyors, particularly in the private sector, is given on the basis of an examination by a State Commission, in which representatives of the professional organizations of surveyors participate. A condition of the admission to these examinations are 2 - 3 years of approved experience in practice.

In the countries, where this model of education has been developed, geodesists/geographers - e.g. in France: ingénieur géographe - form a separate group. Their activity comprises essentially the elaboration of large national networks, geodetic and geophysical research, astronomical observations, cartography and other tasks for which a comprehensive theoretical education, particularly in mathematics and Earth-sciences, is necessary. There are no Faculties of Geodesy at the universities and the above mentioned specialists study at Faculties or Departments of Mathematics, Geography, Astronomy or other related disciplines. Specialized education in geodesy is generally given at a very high level at Military Schools.

An advantage of Model 1 is a considerable simplification of the system of education for surveyors with basic professional qualifications as it enables them to start practical work in surveying after a relatively brief period of not too expensive education. This is advantageous not only for themselves, but also for their country.

Model 2. In this model, represented by Great Britain and the Scandinavian countries, the organization of education at the secondary professional level resembles in its general outlines the above described in Model 1. Characteristics for Model 2, particularly for academic education, is a greater variety of teach-

ing programmes followed in the different schools and universities. Thus the professional instruction of specialists varies according to the university where they have studied; some of them are essentially surveyors, others rather geophysicists.

An academic education orientated towards surveying practice is mostly ensured by Technical Universities, Institutes of Technology or Universities where Departments of Surveying have been founded. Specialists of engineering surveying may also complete their studies at the Departments of Civil Engineering. Academic education in agricultural and cadastral surveying is in particular offered by the Agricultural University of Norway in Ås.

Parallel to the education for surveying practice, an education orientated towards geophysical and geodetic researches is provided by the Department of Geodesy, of Geophysics or Mathematics, generally within the frame of the Faculty of Natural Sciences at the universities. The Universities of Uppsala, Copenhagen, Helsinki, Oslo or Bergen may serve here as example.

The pioneering system of the Aalborg University Centre is a striking example of the individual methods and programmes followed by the universities of the countries where Model 2 has been developed. The programme of the Aalborg Centre is based on the concept of problem-orientated project work and has the objective to educate specialists who are able to cope with a great variety of problems, often of interdisciplinary character (Borre and Tscherning, 1982; Ramshøy, 1981).

The principal advantage of Model 2 is that specialists of different type are simultaneously educated, their cooperation facilitating the solution of complicated professional and scientific problems.

Model 3. The historical tradition of surveying education in Central Europe has led to the development of Model 3 which is applied now with slight modifications in Austria, Czechoslovakia, Germany (FRG and GDR), Hungary, the Netherlands, Poland, Switzerland and Yugoslavia. A similar educational system is in use also in Bulgaria, Portugal and Turkey. A characteristic feature of this model is a uniform organization and a comprehensive programme of general education in surveying and geodesy.

The uniform organization of education comprises in general three levels. Education at the level of secondary schools is given at technical secondary schools, the final certificate of which qualifies for employment as surveying technician or admission to studies at a Technical University. In some countries

education at a general secondary school may be completed at a school of surveying in order to be qualified as surveying technician. Studies at a higher professional school (e.g. Fachhochschule in Germany, Wyższa Szkoła Inżynierska in Poland) lead, after 3 to 4 years to the professional title of Engineer of Surveying. In some countries the degree of Engineer of Surveying may be obtained after completing university studies with a reduced professional programme. Academic education is offered at Universities or Technical Universities, in general by independent Faculties of Surveying and Geodesy or Departments of Surveying and Geodesy at the Faculties of Civil Engineering. The studies last 4,5 to 5 years after which the candidate submits a dissertation and is awarded a degree which may be translated in English as Dipl. Engineer of Surveying or Master of Surveying (e.g. Dipl.-Ing. in German, magister inżynier in Polish).

The educational programme at all the three levels has the objective to train specialists able to perform tasks of different kind in surveying and geodesy, of course within the scope defined by the awarded professional diploma. This concerns professional education in technical secondary and higher schools, but foremost at universities.

Model 3 is distinguished by a remarkable level of education in applied surveying, especially in engineering surveying which is connected with the economic demands of highly industrialized Central Europe. The practical training of the future surveyors is particularly extensive. Professional practice during the vacations is compulsory and included in the programme of all the universities.

The organization and programme in Model 3 serves thus the purpose, in particular at the universities, of preparing highly educated specialists with a solid theoretical background for practical surveying and applied geodesy. This is confirmed also by the choice of the themes and the elaboration of final dissertations which should be applicable in practice.

<u>Model 4.</u> The organization of education in this model is based on similar principles as in Model 3. Model 4 has been developed in the USSR where specific geodetic and geophysical problems are connected with the vast expanse and the structure of the country. An adaptation of the system of education of surveyors, geodesists and geophysicists was therefore necessary.

The academic education in geodesy and surveying is given by the Geodetic Faculties of the Universities and Technical Universities, but furthermore by two Geodetic Institutes in Moscow and Novosibirsk. The programme of academic education in five specializations, i.e. geodesy and astronomy, surveying and

applied geodesy, photogrammetry, cartography, spatial geodesy, is differentiated. In the programme of studies a particular importance is attached in all the specializations to a solid theoretical education, especially in geophysics and mathematics (Bolshakov, 1975).

When analysing the different models of education in geodesy and surveying in Europe, we have to remember that these models are the result of a long historical development. We therefore cannot and do not intend to suggest any radical changes, all the more as we need specialists of various types in our common professional work. From our studies on the models of education in Europe (Szacherska, 1982; Welsch, 1982) which we have briefly characterized here, result nevertheless some propositions, to be taken into consideration when modernizing the educational systems or founding new educational centres, particularly in the developing countries (Coker, 1977; Szacherska, 1981).

We need specialists with a differentiated scope of knowledge, as it is the case in Model 2. It is, however, most important to maintain – by means of the organization and programme of education – a correct ration between the number of highly qualified surveyors, well prepared for professional practice, and the number of geodesists/geophysicists destined to scientific research.

In most of the European countries, especially those where Model 3 is in use, there are three levels of education. This system meets very well the requirements of surveying and geodesy. In order to achieve an effective organization of our work we should, however, define the optimal ratio between the number of surveyors with secondary professional education and specialists with higher professional as well as with academic education.

It is urgent need to develop at present the higher professional education which has become indispensable not only in order to perform the most current surveying tasks, but also for an efficacious operation of modern instruments and equipment. In connection with the actually carried out large surveying and geodetic projects, surveyors with higher professional education are needed as members of working groups directed by specialists with university education.

The education, particularly the academic one, ought to prepare surveyors for the intelligent use of new theoretical and technical achievements. This involves among others a modernization of the course of mathematics by including numerical methods of computations and more extensive instruction in computer

science. The programme of the course in electronics should also be completed in order to enable the surveyors not only to use modern instruments, but permit them also to participate in the construction of new ones.

The increasing tasks assigned to surveying and geodesy by industry, economy and science involve the introduction of auxiliary subjects connected with our discipline or belonging to fields of activity where the results of surveying are utilized, like modern industrial constructions, e.g. atomic power-stations.

The much wider scope and area on which geodetic operations and surveys are at present performed (e.g. continental networks) should be taken into consideration in the programme of education and professional training of surveyors and geodesists.

The practical professional training should occupy an adequate place in all the educational programmes, also at the universities, and ought to be adapted to the different aims and conditions of future professional work. It should foremost prepare the students for independent work, develop their professional responsibility and the capability of taking quick decisions in urgent, difficult cases.

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The Geodetic Education

in the

European Countries

A U S T R I A

1. General

In Austria surveying is divided into the administrative surveying agencies, the civil service and a private sector which is based primarily on the so-called "surveying advisers" (Ingenieurkonsulent für Vermessungswesen (IKfVW)).

The tasks which fall to the surveying agencies are laid down in the Austrian law on surveying and they are as follows: basic surveying (the determination and maintenance of the national horizontal and vertical control networks, astronomic-geodetic work, geophysical surveying), establishment and administration of the boundary cadastre, production of official maps, marking and surveying of federal boundaries. Certain types of boundary survey are conducted by the surveying agencies only if the other statutory tasks are not neglected as a result. Officially performed splitting up of a parcel are only permissible in those survey districts in which no "surveying advisers" have their office.

The tasks of the "surveying advisers" are specified in the law on civilian technicians and, apart from the entire area of surveying, also include tasks pertaining to mine surveying and agriculture. In view of his particular responsibilities self-employed survey specialists must meet special requirements. The "surveying adviser" receives his licence following a five-year course of study at university, five years practical experience and upon passing an oral examination. Licences are issued at the federal level. The "surveying adviser" must have a professional office which is equipped with the necessary technical facilities and manage it personally. The establishment of permanent branches is not permissible.

Apart from the institution of the "surveying adviser" authorized by law there is no legislation in existence which governs any other geodetic activities conducted on a self-employed basis. The self-employed activities may only be practised as a so-called open trade. The range of responsibilities involved is restricted to those survey tasks, the implementation of which is not covered by legislation; in particular, any work is excluded which concerns the cadastre or land register or falls under the competence of the "surveying adviser". The number of persons in this trade is not precisely known but it is at any rate small; as far as their training is concerned they are in the main semi-skilled survey technicians.

Supervision of survey activities is the responsibility of the Federal Ministry for Building and Technology. It functions as a supervisory authority for the Federal Office for Weights, Measures and Surveying and its subordinate surveying agencies as well as for the Federal Chamber of Engineers and its four Chambers of Engineers at the Land level. The Chambers of Engineers are public corporations. The "surveying advisers" are compulsory members of the Chambers of Engineers which simultaneously represent the interests of this profession. Any information of interest to the public and the "surveying advisers" is distributed by the surveying agencies.

The surveying workforce of Austria is employed in the following areas:

in the civil service:

- the Federal Office for Weights, Measures and Surveying – federal survey service,
- Land survey service – agricultural service,
- Service at local authority level,
- Postal and Telegraph Service,
- Austrian Federal Railways,
- (technical) universities;

in the private sector:

- "Surveying advisers",
- Energy producing industry,
- Large-scale industry,
- Building industry.

Expressed as percentages the following picture emerges:

Executive technical service at the Federal Office for Weights, Measures and Surveying	12 %
Executive technical service at other territorial authorities (Land, local authority)	24 %
Research work at university	13 %
"Surveying advisers"	30 %
Other professional fields	14 %
Abroad	7 %

2. Structure of the Educational System

The geodetic educational system in Austria is divided in principle into the training of survey technicians and university graduate engineers in the field of surveying. In contrast to the educational system in the Federal Republic of Germany, no course at a professional college is offered in Austria which leads to qualification as a graduate engineer; the only other possibility open is for a survey technician to take a so-called engineer's examination at a later stage during his career (after five years practical experience) and thus to acquire the professional designation "engineer". However, this opening does not fall under initial training but under advanced and further training.

3. Educational Levels and Qualifications

3.1 School Education

The lowest level of schooling is the primary school which must be attended for four years. This is followed in principle by one of two educational channels:

- The simplest level entails the successful completion of the Hauptschule (school leading to a lower school-leaving certificate which is the approximate equivalent of the British General Certificate of Education Ordinary Level) which is attended for four years and which constitutes the requirement for admission to a training course leading to qualification as a survey technician.

- The higher-level involves attendance at the so-called Mittelschule (school leading to a final school-leaving certificate which is the approximate equivalent of the British General Certificate of Education Advanced Level); schools offering general and vocational education must be distinguished between. The duration of the education at this level is 8 or 9 years following which the final school-leaving examination (Reifeprüfung) is taken. This entitles the student to admission to a course of study at a (technical) university, although it may be necessary for him to sit additional examinations as well.

- A special feature is the course in surveying technology for holders of the final school-leaving certificate which is offered specifically to persons already in employment, with the objective of providing such persons with

higher specialized education. The duration of the course is one school year and it is organized into 20 hours per week primarily in the evening. It is held at a higher technical educational establishment in Vienna. Holders of the final school-leaving examination have little interest in this course.

3.2 Training for Qualification as a Technician

In Austria the training of technicians is divided into two sections, the first for qualification as an assistant technician and the second as a survey technician.

3.2.1 Training for Qualification as an Assistant Technician

School-leavers who have successfully completed the 8th class at the Mittelschule or who have left the Hauptschule may be trained as assistant technicians. The Land Chambers of Engineers organize the formal teaching of trainees employed by "surveying advisers" in various ways. It sometimes takes the form of attendance at a professional school with additional specialized subjects of instruction and sometimes organized courses which are either held throughout the school year or are compressed into a one or two-week seminar which deals with the vital areas of knowledge. These educational opportunities are frequently taken up by trainees at authorities and corporations. The Federal Chamber of Engineers issued in 1976 "National Guidelines for the Training of Assistant Survey Technicians" in order to ensure an uniform standard training.

3.2.2 Training for Qualification as a Survey Technician

The training of survey technicians constitutes a continuation of the course for assistant survey technicians and following a further five years' practical experience a technician's examination is taken.

Furthermore, holders of the final school-leaving certificate may attend a 3-year training course leading to qualification as a survey technician at a Mittelschule which provides vocational education and holds special courses in surveying (in Vienna and Graz).

3.3 University Graduate Engineer

In the Federal Law on the Technical Fields of Study a study period of 10 semesters is laid down uniformly for all fields of study at the Technical Universities in Austria. Each course of study is divided into two parts and at the end of each

the student is required to sit a diploma examination.

The final school-leaving certificate constitutes the admission qualification for a course of study in surveying. The first part (4 semesters) is intended to impart to the student basic general technical knowledge. The major examination subjects for the first diploma examination include mathematics, descriptive geometry, physics, mechanics, geodetic calculation and geodesy I. The second part deals with specialized study. This involves, subsequent to a general reinforcement course (5th to 7th semester), special training on one of the following three groups of optional subjects:

- geodetic survey and geodetic engineering,
- photogrammetry and cartography,
- geodesy and geophysics.

In addition to the selected group of optional subjects, the student must enrol for 15 hours per week in the remaining two groups of optional subjects or complementary optional subjects plus five hours per week in any of the other optional subjects offered.

Upon submission of a thesis this specialized study is concluded with a further diploma examination in which the following major subjects are examined: geodesy, geodetic survey, cartography and the art of reproduction, geodetic engineering, legal provisions and geophysics. A series of preliminary examinations must be passed before the student is entitled to sit either diploma examination. The theme of the thesis is derived from one of the subjects in the field of study concerned.

Upon passing the examination the successful student leaves the university with the academic degree "Diplom-Ingenieur für Vermessungswesen" (university graduate engineer (geodesy)).

4. Other Professional Training and Further Educational Opportunities

4.1 Technician

According to be so-called law on engineers, professional advanced training should provide those persons with the opportunity to acquire the professional title "Engineer" who can furnish evidence of their specialized and general knowledge and at least 10 years' relevant practical experience in Austria. They are

required to sit an engineer's examination at a higher technical educational establishment. Over one quarter of the current survey technicians in Austria are entitled to use the professional title "Engineer".

The majority of those persons who have acquired the title "Engineer" as laid down in the above-mentioned law are employed in the civil service.

4.2 University Graduate Engineers

In Austria the following postgraduate opportunities are offered: after concluding his studies the university graduate engineer may study for his doctorate, upon the successful completion of which he acquires the academic degree "Doktor der technischen Wissenschaften" (Doctor of Engineering Sciences). The presentation of his habilitation entitles him to an appointment as university lecturer.

Following 1 ½ years' practical experience, the university graduate engineer has, furthermore, the opportunity to sit the civil service examination and enter the executive technical geodetic branch as a civil servant in service group A.

In addition, the university graduate engineer may acquire the authority of a "surveying adviser" after a minimum of five years' practical experience, upon successfully sitting an oral examination held by a national commission and upon subsequently talking an oath.

Additional further educational opportunities are provided by further educational courses, professional conventions, seminars and internal administrative courses.

5. Other Educational Opportunities

In addition to the Technical Universities in Vienna and Graz, which offer full-time courses of study, and the University of Innsbruck, where the two-year basic study course may be attended, there is a survey institute at the University for Soil Cultivation in Vienna, which offers courses in the following fields of study: agricultural and water resources management, forestry and farming, agricultural and landscape ecology. A further institute is to be found at the Mining University in Leoben which produces graduate engineers in mining, including mine surveying.

The range of activities of the land surveyor is less varied in Austria than in the Federal Republic of Germany because tasks pertaining to agriculture, land consolidation etc. fall only partially under his competence and planning work not at all.

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B E L G I U M

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1. Non-university level

1.1 The real estate surveyors

The royal ordinance of 18 May 1936 and eight further ordinances define the conditions for the assignment of the title and the diploma of a real estate surveyor.

These ordinances impose:

a) an elimination test before a central commission;
b) a first examination before a "jury central";
c) a second examination before a "jury central";
d) a course lasting two years between examinations b) and c) mentioned above, under the supervision of the governor of the province.

These ordinances specify the knowledges required at the examination but do not organize the education. There are 19 educational institutions acknowledged by the State which cover the entire program required by the ordinances (evening courses).

The program includes branches of mathematics and physics approximately corresponding to the high-school education oriented towards the exact sciences, drawing, profound knowledge of topography, geology, knowledge of materials, etc.

This education does not comprise the thorough study of theoretical geodesy beyond the basic knowledge indispensable for approaching the problems of practical geodesy and topography.

Already several years ago, proposals have been made to raise the education of surveyors to the level of "technical engineer" (4 years of study) placed immediately below the academic degrees, but these steps have to date not been successful.

In order to practise the profession of real estate surveyor, one must be holder of the diploma obtained under the conditions shown above, have completed the 21st year, and have been sworn in.

1.2 Miscellaneous education

Courses in topography are also given by various institutions issuing diplomas of architect, technical engineer in the sectors "construction", "civil engineering", etc. They are not the subject of detailed regulations.

2. University level

In Belgium, there exists no academic title or diploma whose denomination would include geodesy or surveying techniques (e.g., equivalent to Vermessungsingenieur of Survey Engineer).

The education in geodesy and associated sciences appears on the program of the universities but the importance and duration of the course considerably vary from one institution to the other.

A distinction must be made between the departments of natural sciences and those of applied sciences.

2.1 The departments of applied sciences

are those who issue - after 5 years of study - the diploma of engineer in one of the following technical specialties: mining engineer, civil engineer, mechanic, electrician, electro-mechanic, physicist, chemist, metallurgist, agronomist, architect. The studies leading to the degree of mining engineer, civil engineer and agronomy engineer compulsorily include courses in topography.

It is possible that the papers at the end of studies of certain engineer degrees comprise a geodesy problem, but this is rather seldom. At any rate, the normal orientation is the practical geodesy.

2.2 The departments of natural sciences

issue - after at least 4 years of study - the diploma of bachelor of science.

In most of these departments, the education in geodesy is offered (often associated with the course in astronomy) but it is compulsory only for the licence in geographical sciences.

At certain universities, it is possible to study subjects especially oriented towards geodesy (both theoretical and practical) and towards geophysics; as a rule, it concerns licences in mathematical sciences, physical sciences, geological and mineralogical sciences, or geographical sciences.

2.3 The Polytechnic Division of the Royal Military College

has a level equivalent to that of the departments of applied sciences of the universities, and the students graduated from this Division are awarded the title of engineer. The program of this Division comprises a course in theoretical geodesy in the second year, combined with the course in astronomy distinctly oriented towards geodetic fields of application, and a course in practical geodesy and topography in the third year (including photogrammetry). These courses are more developed than in the majority of Belgian universities.

There is also a course in topography at the Division "Toutes Armes" of the Royal Military College.

3. "Postgraduate" studies

3.1 Students having successfully completed the studies listed in paragraph 2 above may acquire a complementary diploma, e.g. that of geology engineer or town-planning engineer; there is also a licence in cartography (Gand et Louvain) and a special licence in geophysical sciences (Université libre de Bruxelles); these studies comprise important complements of geodesy.

3.2 The "third cycle"

The National Belgian Committee of Geodesy and Geophysics arranges every year instructions called "third cycle", subdivided into seven "orientations" corresponding to each of the international associations represented within the International Geodetic and Geophysical Union. This is a highly specialized education covering the most recent progress of the science, and includes courses and seminars. The teachers belong to the universities or associated institutions, or to scientific institutions such as the Royal Observatory of Belgium, the Royal Meteorological Institute of Belgium, the Institute of Spatial Aeronomy of Belgium, the National Geographical Institute.

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B U L G A R I A

1. General

In Bulgaria the geodetic tasks are executed by official authorities. The responsibility lies with the Central Administration for Geodesy, Cartography and Cadastre and its geodetic departments. Geodetic work is also carried out by specific institutes, agencies and offices of the state-controlled commercial enterprises.

Besides large-scale topographic mapping (1 : 5000) of the whole country and the geodetic tasks in construction engineering, industrial plants, settlements, etc., the establishment and maintenance of the cadastre belong at present to the most urgent duties of geodesy in Bulgaria.

In 1979 a law relating to a homogeneous and standardized cadastre was enacted. This law results in an essential improvement and an extension of the former cadastre. Moreover, it is of particular importance due to its function as land information system in connection with the so-called "Uniform Territorial Developments Plan" (ETUP). This plan represents a long-term complex program as a basis for decisions concerning the use of the land as urban, rural or natural land, urban and regional planning, environmental decisions etc.. There is an interrelationship between cadastre and ETUP. The cadastre and its plans, maps, land information, documentation, register etc. represents the most relevant and reliable source of information required by the ETUP. The decisions of the administration concerning the ETUP are documented subsequent to their realization in the cadastre. Thus the cadastre is the inventory of the development and improvement of the ETUP.

It may be mentioned that in this context the Bulgarian surveyor plays an important role as a specialist for environmental development and protection.

2. Structure of the Educational System

The Bulgarian educational system distinguished between technicians trained at technical schools (technicon) and university graduate surveyors.

3. Educational Levels and Qualifications

3.1 School Education

School education in Bulgaria commences with the eight-class primary school. At the age of 14 years the pupil must already decide whether he wants to attend a technical school or a secondary school (gymnasium) for three years. The final school-leaving certificate constitutes the admission qualification for a course of study in surveying at a university.

3.2 Training Leading to Qualification as Technician

Upon completion of the primary school the training at a technical school extends over four years at the end of which the qualification as a survey technician is obtained. At present a change of the educational system to qualifications in three levels is considered.

3.3 University Graduate Engineer

The academic education takes place at the "Higher Institute of Architecture and Civil Engineering" in Sofia. The admission requirement is either the final school-leaving certificate or the successful completion of the education as a survey technician. The course of study is 5 years and leads after final diploma-examinations to the qualification as a "Geodetic Engineer".

4. Further Professional Training

As mentioned above, the survey technician has the opportunity to attend the university study course.

The university graduate engineers can obtain the following academic degrees:

- the scientific degree as a Candidate of Science after three years of registration for a doctorate and successful completion of a thesis. As an alternative the degree can be obtained in a two years correspondence, provided the candidate has completed two years of practice as a surveyor.

- the degree as a Doctor of Science exclusively by a correspondence course,

- the scientific degree as a Lecturer or Professor at a university or as a Scientific Assistant (First and Second Grade) at a research institute. Prerequisites for both are the degrees of Candidate and Doctor of Science.

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C Z E C H O S L O V A K I A

L. Hradilek, Praha

1. General

In Czechoslovakia the geodetic, cartographic and surveying engineering tasks are executed by official authorities and national enterprises. The general responsibility lies with the Czech Geodetic Administration in Praha and the Slovak Geodetic Administration in Bratislava. They employ about 47 % of the total surveying work force: In the areas of geodetic surveys and cadastre they employ 11 % of the work force, in map production 22 %, and in special engineering tasks for local authorities, agriculture, industry and services for citizens 14 % of the total work force.

The remaining surveying work force is employed as expressed in percentages in building construction, civil engineering and geology by about 20 %, in transport and communications 7 %, agriculture and forestry 7 %, mining and energetics 4 %, education and research 3 %, local administration and other activities 12 %. There are no self-employed surveying engineers in Czechoslovakia.

2. Structure of the Educational System

The education of survey specialists corresponds to the general system of school education in Czechoslovakia which is given by the following scheme.

- 4 + 4 years of the uniform education at the so called basic school with the optional possibility of extended education in foreign languages;

- 4 years of secondary general education at the so called gymnasium;
  or secondary vocational education at specialized schools;
  or secondary education combined with apprenticeship for some sorts of skilled workers.
  All types of secondary education are completed by a final school-leaving examination.

- 4 – 6 years of university education;

- 3 – 4 years of graduate studies.

Education in Czechoslovakia is free of charge at all levels. All pupils and students receive significant allowances for taking meals at school dining-

halls and for lodging in hostels. All secondary school and university students who cannot be supported sufficiently by their families obtain an adequate social stipend, and all university students whose average of marks ranks within < 1, 2 > receive a significant premium stipend. All pupils and students at secondary schools get textbooks free of charge, university students with significant allowances.

3. Educational Levels and Qualifications

3.1 Training Leading to Qualification as a Skilled Survey Worker

is given occasionally by large survey agencies for their employees.

3.2 Training Leading to Qualification as a Survey Technician

is given at the secondary vocational surveying school in Praha and at surveying divisions of the secondary vocational schools for civil engineering and building construction in Bratislava, Brno, Košice, Opava and Duchcov. The curriculum at all these schools is mostly uniform and contains about 40 % of general education subjects, including history, mathematics, physics and chemistry, and 60 % surveying education subjects with an emphasis on laboratory and field training.

The majority of the mentioned schools offers a five-years education program for extra-mural students who have been employed for several years in geodesy and cartography. Some of the schools offer a two-years education program for students who have completed the secondary general education.

3.3 Training Leading to Qualification as a University Graduate Surveying Engineer

is given at the Technical Universities in Praha, Bratislava, Brno, Košice and at the Mining University in Ostrava (mine surveying). The conditions for the admission for university studies lie in the final secondary school-leaving examination and in the university entrance examination in mathematics, physics and descriptive geometry.

The curriculum of the four-years surveying engineering studies consists of subjects of general theoretical basis including mathematics, physics, applied optics and electronics covering one third of the whole curriculum and the two thirds include professional subjects with the laboratory and field training.

After every semester, up to five intermediate or final examinations are taken. The university education is completed by the submitting the graduation thesis and passing the final state examination.

For individual students, the technical universities offer the additional 5th year of advanced studies in

a) photogrammetry,
b) agricultural resources management,
c) cartography,
d) geodesy and astronomy,
e) remote sensing.

The majority of the universities offers six-years studies program for extramural students who have been employed for several years in geodesy and cartography and have fulfilled the conditions for the admission as given above.

4. Further Education and Vocational Training for the University Graduate Engineers

The Czechoslovak Universities, Academy of Sciences and central research institutes offer three-years of graduate studies leading to the degree: Candidate of technical sciences (surveying engineering) or Candidate of mathematical-physical sciences (geodesy). The scientists who have got an international reputation by their scientific work and fulfilled special requirements may submit their scientific dissertation and obtain a Dr.Sc. degree in technical or mathematical-physical sciences by the State Commission for Scientific Degrees.

The Czech and Slovak Geodetic Administrations and the Technical Universities offer occasionally 2-3 years advanced studies ending with a final examination, or organize - together with the Czechoslovak Society for Science and Technology - education courses concerning mostly new developments in surveying engineering, geodesy and cartography.

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D E N M A R K

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1. General

"The Danish Land Registry Department of the Ministry of Agriculture is concerned with the legislative aspects and the administration of parcelling out and development plans. The Department keeps a central index, the cadastre, comprising a register of the nation's real properties and a system of maps, primarily information on boundaries and title numbers. Apart from the title number, the cadastre contains other data such as the computation of area and a record of restrictive conditions pursuant to agricultural and forestry legislation. The updating of the document of the cadastre is normally effected through private land surveyors.

Specially, local structures exist in the southern part of Jutland, Sønderjylland, where the German-inspired cadastral system from the time before the reunion of North Slesvig with Denmark in 1920 is still functioning, by and large, and in the City of Copenhagen as well as in the municipality of Frederiksberg, an enclave within Copenhagen. These special structures, and conditions in Greenland and the Faroe Islands, will not be discussed in the following.

Surveying in Denmark is monopolized work exclusive to chartered surveyors. There are about 165 surveyor's offices (1977) employing a total of about 390 chartered surveyors, distributed over the country. Chartered land surveyors in private practice have the sole right to engage in parcelling out and developing and other business that involves mutations (change in the boundaries of land) or adjudication.

The highest authority of registration of titles and deeds is the Ministry of Justice. Changes of identification, ownership, and title are recorded in the registers of title kept by the lowest tier of courts, approximately 85 in all.

Besides there exists a comprehensive registration of real property with the country's 275 municipalities, with populations in order of 5 to 10.000. Together with the newly established building and housing register the index is used, among other things, as the basis of valuation and tax assessment.

Denmark's 14 district councils (or counties) with populations typically at 200.000 to 300.000 perform essential duties in the field of physical planning, in this connection often involving registration of data on area, but the unit subjected to registration is usually different from the legal entity, i.e. the real property, and these registrations bear no relation to the cadastre.

Denmark has been mapped partly by cadastral maps on the scale 1:4.000, partly by a number of topographic maps. Topographic mapping is exclusive to the Geodetic Institute under the Ministry of Defence. Since about 1930 co-operation has been established between the Geodetic Institute and the Land Registry, mainly concentrating on the control networks. Maintenance and dating-up of maps and charts, however, is dealt with separately". Quotation from STUBKJÆR (1981).

Today about 700 chartered surveyors (landinspektører) are actively employed. The distribution on different areas of occupation is as follows, all figures in percentage:

		1982	1972
Private practitioners		40	45
Employees at the above	11		
Unemployed	3	14	20
Employees at the State	16		
Employees at counties or municipalities	19		
Employees at private firms	8		
Unemployed	3	46	35

Traditionally the chartered surveyors in private practice form the main part of the profession and thus outlined its profile. But as a consequence of the economic regression, the crisis in the building area, etc., the scarcity of work has lately changed this picture drastically. For instance, the number of new parcels in 1973 was about 40.000 and in 1981 only 14.000, i.e. a fall in the register activity of 70 % within 8 years. Besides this, some structural changes of the Land Registration Systems have led to troublesome times for the private practitioners. They have reduced the number of employees by 40 % during the last 4 years. So the situation is serious although lately some people expressed a certain optimism.

On the contrary, the number of public employed surveyors has increased by 25 % in the period 1978-82. So the point is that the professional fields have widened especially by appointments of young candidates in public administration (within planning and administration of real estate) and furthermore in more untraditional jobs like off-shore survey and planning of heating distribution.

This section is a translation based on ENEMARK (1982).

2. Educational Levels and Qualifications

2.1 The Training as a Survey Technician

Survey technicians have during a longer span of years been trained in the offices of the private practitioning chartered surveyors. Since 1975 a special training programme was set up at Horsens Technical School. The programme consists of a 2-year training as a technical assistant, 1/2 year in practice, preferably at the office of a chartered surveyor, and finally 1/2 year specialized studies. The specialization includes practical as well as theoretical training in surveying, cadastral and legal matters.

The number of graduates is 10-12 per year.
During the later years almost all technicians have got some sort of public employment. For the time being the training programme is under revision.
This section is partly a translation from ENEMARK (1982).

2.2 The Training as a Chartered Surveyor

Since 1974 the training as a chartered surveyor has taken place at the University of Aalborg. The study is connected to the Faculty of Technical and Natural Sciences. The teachers of the study are part of the Institute for Development and Planning which at the same time is responsible for planning education of civil engineers and others.

There are five professorships in: surveying, photogrammetry, cadastral science, physical planning, and jurisprudence. Further 15 lecturers are associated with the training programme.

The pedagogical concept is characterized by problem-centered and project-organized studies. The time of study is equally distributed between course

and project work. The latter takes place in groups of 4-6 students allocated their own room and with a certain teacher as advisor. In the project work the students are occupied with problems within the various professional fields of a chartered surveyor. The project work as well as the general courses are evaluated currently and at the end of each term (5 months), normally by faculty of the University and marked according to the pass-fail system.

The aim of the training may be divided into two parts, namely

(i) to give the students qualifications which in general cover the professional functions of the chartered surveyor. These are especially connected to the regulation and registration of real estate, cadastral and engineering survey, cartography, planning, and administration of the environment, and

(ii) to enable the students to analyse coherences of social and technical nature in the connection with the concerned occupational functions. Further, on this background to propound solutions for these problems.

The first part has to do with the demand that all candidates shall have the possibility of achieving authorization as a chartered surveyor.
This authorization may be obtained after finished training plus three years' employment at a private practitioner's office.

The second part is a result of the broadening of the surveyor's occupational functions during the last decade. It is impossible for an individual to reach a high professional level in all subjects. Therefore the training programme opens up for a certain degree of professional specialization within the last four semesters.

The relative weightening of the subjects surveying, cadastral science/jurisprudence, and planning is 2:1:1. The compulsory contents are

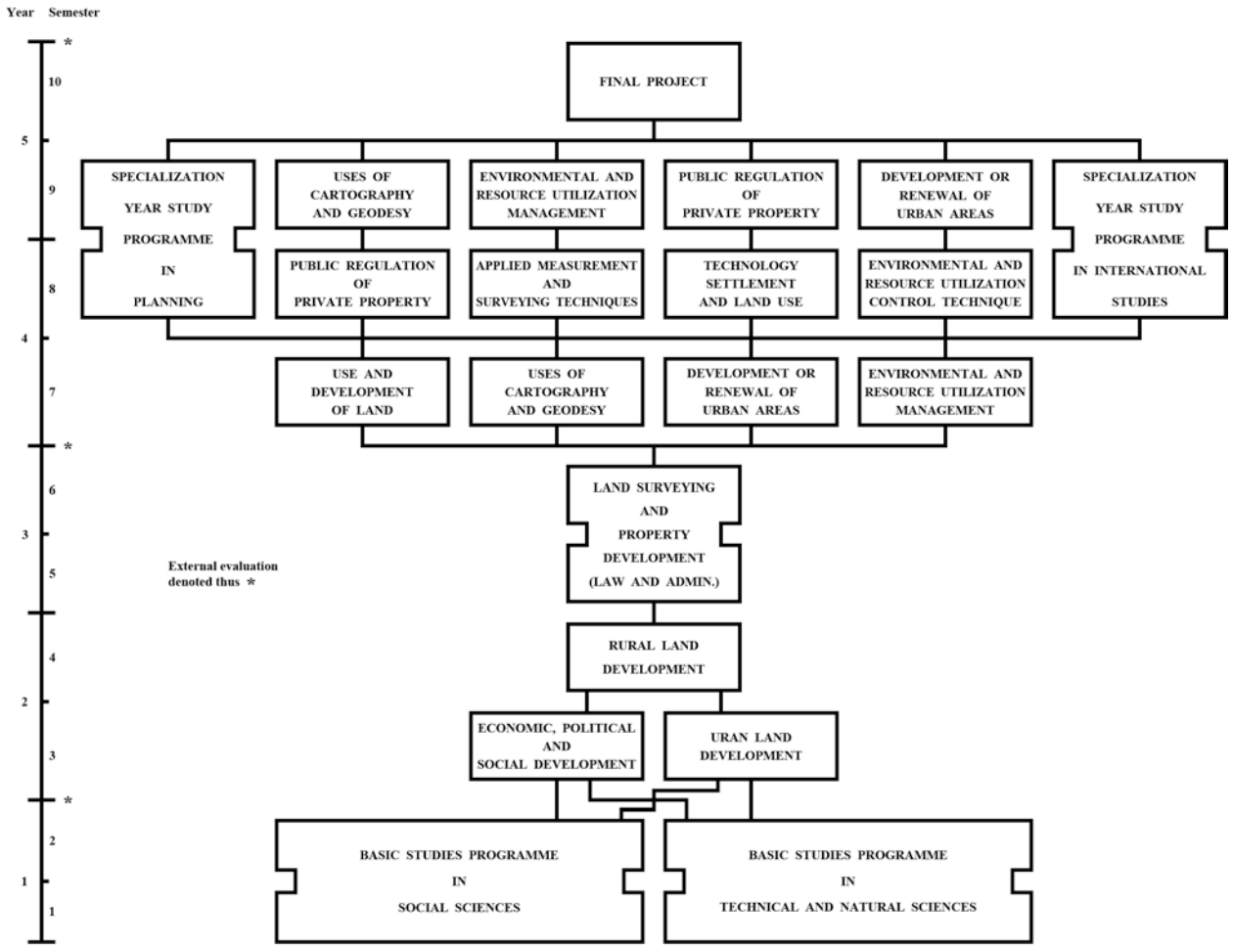
Surveying
Surveying and setting out; Network densification; Theory of errors, adjustment, and computation; Detail survey; Levelling; Computation of areas; Instruments.
Theoretical photogrammetry, map production, and coordinate determination.
Computer science, cartography, drawing, and reproduction; Exercises.

Cadastral science/jurisprudence
The assumptions and the legal basis for public as well as private regulation of the use of real estate; Land registration and cadastral work.

Planning
Physical planning at the levels of counties, municipalities, and parishes, and its connections to sector and economic planning.

The total time of study is 5 years. The first year constitutes the so-called basic year, while the 2nd and 3rd years contain the above-mentioned compulsory subjects. The last two years allow for choosing between the themes indicated in the figure. It shall be stressed that there does exist a great deal of flexibility in the actual choice of project within these themes. Therefore, the students, who aim at a specialization, can do so to a high degree during the whole curriculum.

The interested reader can in RAMHØJ (1982) find a much more detailed description of the system used in Aalborg.



The number of study places is limited to 36. In 1972 there were about 70 applicants, while in 1982 there were only 40! The admission qualification is either a Higher School Certificate of a "Higher Preparatory Certificate". In practice nearly all students have a Mathematical Higher School Certificate.

Yearly about 30 candidates pass the final exam. The table demonstrates how many a year. The number in paranthesis indicate the number of female candidates - far and away!

Year	No. of cand.s		Subject for thesis		
	VAC*	UA	Surv.	Cad.sc.	Plann.
1972	28(1)				
1973	26(1)				
1974	26(1)				
1975	31(2)				
1976	29(3)				
1977	21(4)	8(3)			
1978	9(3)	22(4)			
1979		32(4)	8	19	5(4)
1980		19(4)	4	12(4)	3
1981		34(5)	16(2)	10(3)	8
1982		33(5)	8	17(3)	8(2)

* Till 1974 the training took place at the Royal Veterinary and Agricultural College, Copenhagen.

Furthermore, in the period 1972-82 6 persons have finished the studies with a licentiate degree.
Much material in this section is a translation from ENEMARK (1982).

2.3 The Training as a Geodesist

Geodesy is in Denmark only taught at the University of Copenhagen. Here, the field (mainly of historical reasons) is located in the Central Institute of Mathematics of the Faculty of Natural Sciences. This Central In-

stitute encompasses mathematics, computer science, actuarial science, and mathematical statistics. The University has only one full-time position (as a professor) in geodesy (vacant at the moment) and three so-called external lecturers who are all full-time employees of Geodætisk Institut (the Danish Geodetic Institute, in the following abbreviated DGI). Their collected teaching obligations correspond to six lecture hours per week during a semester.

The students within the Faculty of Natural Sciences follow, during the first three years, various "lines" with mainly obligatory contents, combining fields such as mathematics and physics or physics and astronomy. If all the obligatory courses have been passed (e.g. in mathematics), the students after graduation will have the permission to teach in the Danish high school system or at teacher training colleges.

A further specialization is performed in the "second part" which may last 2-3 years. One of the accepted fields of specialization is geodesy, and the students are accepted if they have passed the exams after the courses belonging to any "line" which includes physics, mathematics, statistics, astronomy, computer science, or geophysics.

The reason why this broad spectrum of background training is accepted is due to the experience that in practice, we need geodesists who have a very good basic knowledge in many different fields. So, instead of having a training as a geodesist, which comprises everything (and will last 15 years), we have chosen to train geodesists in a manner depending on their actual background from the first part of their studies. That this is possible in practice is due to the very limited number of students.

The limited number of students has also put restrictions on the number of lecture hours offered to the students.

They may in several cases be asked to study a field on their own. There has for example never been given formal courses in cartography, photogrammetry, or instrument design to the students. For the courses given we try to follow a three-year cycle so that most of the following fields are covered in that period:

geodetic differential geometry, followed by or mixed with:
- geometrical geodesy (ellipsoidal geometry)
- celestial mechanics - satellite geodesy

geodetic measuring methods:
   astronomy, ed, levelling, doppler techniques (but not gravimetry)

potential theory, followed by:
   physical geodesy, gravimetry

geodetic statistics

geodetic computer science.

In all the courses we try to take advantages of the rather strong background the students have in mathematics and physics. The number of classroom hours will be constant, but more or less material will be covered. We have found it extremely important that the students have a strong mathematical basis. Some of the courses may and have been offered to students in geography (map projections), in mathematics (mathematical methods in physical geodesy), or in geophysics (physical geodesy, gravimetry, and "geostatistics").

Some of the courses are combines with practical exercises in the field and in computing.

The instruments and computational facilities needed are made available by the DGI, and most students are, during their studies, part-time employed by the Institute as assistants in field or research projects.

The last 1/2-1 year the students will write a thesis. The thesis work has frequently been related to research in progress at the DGI.

After the exam the students will carry the title of candidate of science, where the title obtained earlier was the old magister of science (which had slightly different exam rules than those now in force).

The education as a geodesist is, from a didactic and pedagogic stand-point, rather traditional. However, the close connection with the DGI, the connection to the Central Institute of Mathematics, and the many opportunities, the students have to do practical and computational work, help to make the education more effective and inspiring than could be expected otherwise. The relation to the DGI also helps to bring in new fields and new knowledge at the earliest possible stage.

Most of the graduates in geodesy have for some years been employed at the DGI. Since 1982 they are about 40 in number and half of them have stayed there per-

manently.

This section is part of BORRE, TSCHERNING (1982).

3. Further Educational Training

At the Technical University of Denmark (DTH) and the Danish Engineering Academy (DIA), Copenhagen, courses in land-surveying and photogrammetry are offered to students at the civil engineering departments.

The courses are an integrated part of the civil engineering education and they are given by staff members of the Institute of Surveying and Photogrammetry, that is a common institute for the two institutions.

There are 1 professor and 7 assistant/associate professors employed at the institute.

The total time of study at DTH is 5 years giving a degree of M. Sc. and at DIA 3 1/2 years, where the students obtain a B. Sc.

The number of courses given and their titles are shown on the following list. Each course corresponds to 3 weeks of full time work or approximately 135 hours.

Surveying, field course
Surveying, theory

Network planning
Surveying and EDP
Photogrammetry, theory
Photogrammetry, lab./field course
Digital mapping, digital terrain models
and remote sensing for mapping purposes.
Equipment for automatic map production and interactive graphics.

Thesis

Every year the surveying courses (field course and theory) are taken by approximately 200 students. They are given after 1 year of study at DTH or DIA. These elementary courses are compulsory courses at DIA while 90 % of students at the civil engineering department at DTH take the courses.

The field course is given in June - July and August and takes 3 weeks of full time training.

The main topis, covered by the course are:

Network planning. Measurements and Computations.
Setting out. Levelling. Control measurements.
Detail Survey. Map Construction.

The theory course is a theoretical standard course with lectures and exercises one afternoon a week (14 weeks).

The course mainly deals with:

Elementary Photogrammetry. Theory of Errors and
Adjustment techniques. Network. Map Production.
Surveying and EDP.

The courses give necessary qualifications to the students to take advanced courses in photogrammetry, network, digital mapping and remote sensing.

These courses represent a specialization in the training of civil engineers, and they are each followed by 5-25 students. In addition, individual courses in special topics are offered to students with a specific interest in surveying, photogrammetry and remote sensing.

It is possible to graduate in surveying or photogrammetry. 1-3 students are doing so every year. The thesis is often related to research programs at the institute and will normally involve a good deal of computational work.

Within the last 10 years 5 students have finished their studies with a licentiate degree (Ph.D.).

Students who have graduate in surveying or photogrammetry at DTH or DIA are employed by private engineering companies, the Danish Geodetic Institute, computing companies and the government.

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Also at 5 engineering schools in Copenhagen, Esbjerg, Haslev, Horsens, and Odense some courses in surveying are offered. Unfortunately no further information is readily available.

ACKNOWLEDGEMENT

Dr. Chr. Tscherning has to be given thanks for working out the questionnaire.

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F E D E R A L R E P U B L I C O F G E R M A N Y

1. General

In the Federal Republic of Germany surveying is conducted by both the survey authorities and self-employed land surveyors. This is the case in most of the states of the Federal Republic although the division of the tasks differs greatly.

The official survey tasks incorporated essentially the establishment and maintenance of geodetic fundamentals (vertical, horizontal and gravimetric control), the production and updating of official map series of various scales together with specialized maps, the maintenance of the land register and tasks pertaining to planning and land organization (land consolidation and regional planning).

The law provides that in the Federal Republic of Germany surveying is the responsibility of the states, i.e. each state issues the appropriate laws and regulations. The survey work which arises is carried out by the State Survey Offices (Landesvermessungsämter) and Cadastral Survey Services (Katasterämter) as well as the Öffentlich bestellte Vermessungsingenieure/ÖbVI (approximate equivalent of the British "chartered surveyor"). Those entrusted with such tasks enjoy public confidence and are therefore required to have special qualifications. With the exception of the Free State of Bavaria (where cadastral surveying is the preserve of state bodies) an ÖbVI may, in principle, work on a self-employed basis in any of the states. He must fulfil the conditions for obtaining a licence in the state concerned. These conditions as well as the legal procedures differ, however, from state to state.

In addition to the strictly survey authorities there is a whole range of authorities entrusted with special survey tasks:

Land Consolidation Authorities, Road Construction Authorities, German Federal Railways, Waters and Shipping Authorities, Federal Armed Forces, Local Survey Offices and Survey Services of the Forestry Authority.

In the Federal Republic of Germany approx. 15 % of all land surveyors work as an ÖbVI in commercial survey offices or in larger industrial enterprises and

associations:

- Öffentlich bestellte Vermessungsingenieure (ÖbVI): They have the same authority as the Cadastral Survey Services to conduct cadastral surveys which serve the preparation and maintenance of the land register. They are further authorized to draw up land deeds.

- Commercial survey offices: As a rule they are headed by engineers, although this is not a condition. The designation "commercial" indicates that such private offices are subject only to the general provisions of the Industrial Code as is the case with all commercial enterprises.

  Some office proprietors are appointed experts for construction or engineering survey. Since the commercial survey offices are not permitted to conduct cadastral surveys their area of work embraces primarily engineering survey, which sometimes incorporated photogrammetry and planning work.

  In the Federal Republic of Germany there are approx. 240 commercial survey offices which employ approx. 3.000 people. These offices are concentrated in Bavaria where an ÖbVI cannot receive a licence. The professional organization "Arbeitsgemeinschaft selbständiger Vermessungsingenieure e.V. (AsV)" (Federation of self-employed Land Surveyors) together with its associated organizations has approx. 160 members.

- Industrial enterprises and associations: They employ almost 100 university graduate engineers, approx. 550 engineers and approx. 430 survey technicians. Industry carries out primarily its own survey tasks, whereas the associations, some of which have the latest equipment, also work for third parties.

  Some of the self-employed land surveyors have formed joint associations which permit the partners to accept survey work for which the capacity of the individual office is insufficient (so-called consulting firms).

The survey personnel employed in science, research and education constitutes a further branch of surveying in the Federal Republic of Germany. In addition to the universities, technical universities, professional colleges and technical school, the Deutsches Geodätisches Forschungsinstitut (German Geodetic Research Institute) with departments in Munich (theoretical geodesy) and

Frankfurt (applied geodesy) and the Bayrische Kommission für die Internationale Erdmessung (Bavarian Commission for International Geodesy) are particularly worthy of mention.

The survey personnel is divided approximately as follows:

Survey Area	University Graduate Engineer	Engineer	Technician	Total
Geodetic survey and cadastre	4 %	21 %	24 %	49 %
Land consolidation and special authorities	3 %	19 %	12 %	34 %
Research and Education	1.3 %	0.5 %	0.2 %	2 %
Private sector				
- self-employer	1.4 %	0.6 %	-	2 %
- employee	0.7 %	5.3 %	7 %	13 %
Total	10.4 %	46.4 %	43.2 %	100 %

There are a total of approximately 3.500 university graduate engineers, 16.000 engineers and 15.000 technicians in the Federal Republic of Germany (survey work force of 34.500 = 100 %).

The Deutscher Verein für Vermessungswesen (DVW) (German Survey Association) constitutes the scientific umbrella organization of the land surveyors.

The survey authorities of the individual states are amalgamated at the national level to form the "Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland (AdV)" (Association of Land Survey Authorities of the Federal Republic of Germany) which, however, can only issue recommendations to the states.

The "Bund der öffentlich bestellten Vermessungsingenieure (BDVI)" (Federation of Chartered Surveyors), a registered association, encompassed all self-employed land surveyors. It is divided into separate state groups which are all organized on similar lines.

2. Structure of the Educational System

Geodetic education in the Federal Republic of Germany comprises essentially three levels:

1. Training leading to qualification as a technician
2. Training leading to qualification as an engineer
3. Training leading to qualification as an university graduate engineer.

The fact that students who have qualified at a Fachhochschule (professional college), i.e. the former "graduierte Ingenieure" (graduate engineers), are now awarded the title Dipl.-Ing. (identical to the title awarded formerly to university graduate engineers only) does not affect the three levels of training. In the last analysis these two types of training, both leading to qualification as an engineer, differ with respect to duration of study, subject matter and subsequent employment prospects. Students at a Fachhochschule, learning the techniques of surveying engineering, receive a practice-oriented training whereas university training is practice-oriented too, but concentrates on a more markedly scientific and intensive theoretical approach, and impartes the fundamentals of science. The total field of geodesy and surveying engineering including both theory and practice is covered by university graduate engineers.

3. Educational Levels and Qualifications

3.1 School Education and Admission Qualifications

The following school education is in each case to be considered the minimum prerequisite. It is, of course, possible to commence any geodetic training course with higher school qualifications.

1st Level:

The requirement for admission to a training course leading to qualification as a survey technician is the completion of the 9th class at a Hauptschule (secondary-level primary school) or comprehensive school. The successful conclusion of the 10th class at a secondary school reduces the duration of vocational training by half a year to two and a half years.

2nd Level:

Requirement for admission to a course of study at a Fachhochschule is the "Fachhochschulreife" (admission qualification for a professional college which is obtained at school). There are several ways of obtaining this qualification:

- Move from the 12th to the 13th class of a grammar school (counts as Fachhochschulreife). The reform of the senior classes has, however, introduced a few changes in this respect.

- Upon completion of a ten-class Realschule (intermediate school) the pupil transfer to a Fachoberschule (technical secondary school). It ends with the 12th class in which the Fachhochschulreife is taken.

- A further opportunity is offered by the so-called alternative educational path. Upon successfully attending a Berufsaufbauschule (vocational extension school) - comparable with the Mittlere Reife (lower school-leaving certificate which is the approximate equivalent of the British General Certificate of Education Ordinary Level) or the final leaving certificate of the Realschule - a pupil can transfer to the 12th class of a Fachoberschule where he can obtain his Fachhochschulreife.

3rd Level:

The requirement for admission to a course of study at a university or technical university is the "Hochschulreife" (admission qualification for university). It is normally attained at a grammar school (Abitur (final school-leaving certificate which is the approximate equivalent of the British General Certificate of Education Advance Level) providing the general Hochschulreife) upon completing the 13th class and passing the written and oral Abitur examinations. By transferring from the 10th class at a Realschule to a grammar school or Fachgymnasium (specialized grammar school) - e.g. Technisches Gymnasium (technical grammar school) - it is also possible to obtain the Abitur or "fachgebundene Hochschulreife" (admission qualification for a limited choice of courses at university) respectively. A pupil who has obtained his apprentices' final examination and attended a Berufsaufbauschule for one year may take the Fachabitur (final school-leaving examination which is the approximate equivalent of the British General Certificate of Education Advanced Level but which

concentrates on a specialized area and is sat at a Fachgymnasium) providing the fachgebundene Hochschulreife upon completion of the 11th to 13th classes of a Fachgymnasium.

3.2 Training Leading to Qualification as Technician

Training which leads to qualification as a technician constitutes in the Federal Republic of Germany the lowest training level in the area of surveying. A survey technician (apprenticeable occupation) used to be trained exclusively at state survey agencies and the training took the form of a three-year apprenticeship. Today there are also technicians who, having completed their training at a Technikerschule (school for technicians), become state registered survey technicians.

3.2.1 Training Leading to Qualification as a Survey Technician

The vocational training leading to qualification as a survey technician lasts three years. If the trainee has successfully completed the 10th class at a secondary school or an equivalent training course the duration of the training is reduced to two and a half years. The training takes the form of a dual system, i.e. employment by an agency which provides on-the-job training (survey authority, survey office) on the one hand, and the regular attendance of a vocational school on the other. Special training courses frequently supplement the training offered at the school and agency. The vocational training, which is conducted in accordance with a basic training plan, provides by means of a systematic course of training basic vocational instruction and imparts the specific technical skills and knowledge which are required for a skilled job.

At the end of the first year of training an intermediate examination must be taken. It examines the skills and knowledge attained during the first two phases of training, each lasting six months, and takes the form of two practical tests and a written test lasting approximately two hours.

The final examination tests both the skills and knowledge stipulated in the basic training plan and the material covered in the vocational school insofar as it is of importance for the vocational training. In the examination subjects the science of mensuration, cartography, administration and business administration in addition to general jurisprudence and social

studies the examinee's is tested in a written and oral examination.

A qualified survey technician is a specialist in middle management, which is demonstrated by his regular and frequent employment in an independent and responsible position as head of a survey team and working group.

3.2.2 State Registered Survey Technician

Since a survey technician without Abitur or Fachhochschulreife, who has qualified by means of this initial vocational training course, has no opportunity to embark on further studies a yawning gap developed over the last 10 years between technician and engineer. In order to eliminate this fault in the system and to offer the survey technician and possibility of obtaining further professional qualifications, most states have now introduced specialized classes for survey technicians at Technikerschulen.

The admission requirment for the Technikerschule is qualification as a survey technician and a minimum of two years' practical experience or the completion of equivalent training which may be tested by means of an entrance examination. Those who have qualified in related professions, e.g. as mining survey technician, cartographer or construction draughtsman (civil engineering) thus also have the opportunity to embark on further vocational training at a Technikerschule.

Two types of schooling are offered:

- full-time education comprising 4 semester and
- part-time education comprising 8 semester in which classes are held at the weekend.

The full-time training course leading to qualification as a state registered survey technician lasts two years.

In view of the training they have completed to qualify as a state registered survey technician (3 years' apprenticeship, 2 years' practical experience and 2 years' fulltime education or 4 years' part-time education at a Technikerschule) they constitute an important link between survey technician and engineers.

3.3 Graduate Engineer (Fachhochschule)

During the course of 1971 a series of laws or decrees on Fachhochschulen were issued in the Federal Republic of Germany and West Berlin which govern the organization of Fachhochschulen in each respective state. The education task which falls to the Fachhochschule is that of providing, from the very beginning of the course of study, practice-oriented training on a sound scientific basis with particularly strong emphasis on the profession and practical experience. The aim is to develop a synthesis of "theory and practice" from the antithesis of "theory or practice". This new form of training, which exists alongside university courses, constitutes a reform of the institutions of higher education which permits educational paths with different educational accents to be offered side by side. The student with good practical skills should also be able to obtain a qualification at an institution of higher education.

In the Federal Republic of Germany training courses leading to qualification as graduate engineer in surveying are held primarily at 12 Fachhochschulen or Gesamthochschulen (comprehensive universities) respectively. The admission qualification for a course of study at a Fachhochschule is, in principle and uniformly, the Fachhochschulreife. All Fachhochschulen require that a certain period be set aside for a practical, if a semester evoted exclusively to practical work is not planned. The duration of the course of study leading to qualification as a graduate engineer lasts in all cases 6 semesters (excluding the semester devoted exclusively to practical work).

The general subjects of study primarily take the form of lectures and exercises in mathematics, data processing, physics, jurisprudence, science of mensuration, cartography, topography, geodetic survey, science of instruments, geodetic drawing and computation and geology.

In the course of study there are frequently two areas of reinforcement:

- Engineering survey: In this area of reinforcement, in which the emphasis is more on the technical side, subjects such as engineering survey, adjustment calculation, science of mensuration and photogrammetry receive more attention.

- Real property affairs and planning: Here the emphasis is on the less technical tasks in the area of planning and land organization which fall to the survey authorities. Above all, subjects such as administration, land and building rights, land register, planning and valuation are attended.

Admission to be preliminary and final examinations in some subjects contigent on participation in practicals and the submission of reports and term papers.

The preliminary examination, which is compulsory at most Fachhochschulen, consists primarily of written examinations. The final examination, a requirement at all Fachhochschulen, tests the knowledge of the future engineer in written and oral examinations.

The examinee then has to produce a graduation thesis in which a complex subject is treated and which is prepared on an individual or group basis. Graduation an an engineer takes place upon the successful conclusion of the final examination.

Such courses of study are held at the following Fachhochschulen: Berlin, Bochum, Essen, Frankfurt, Hamburg, Karlsruhe, Mainz, Munich, Oldenburg, Recklinghausen, Stuttgart and Würzburg.

3.4 University Graduate Engineer

The admission qualification for a course of study at university is the Hochschulreife (Abitur).

As is the case at Fachhochschulen, a practical is also compulsory in the university sector; duration of the practical is, as a rule, three months. Proof of practical experience is even an admission requirement. Survey authorities, offices of ÖbVIs, in some state major building firms and industrial enterprises are in general suitable for trainee posts.

The organization of the course of study and the examination procedures are governed by the graduation examination regulations in force at each respective university. There is no uniform curriculum which is valid for all

universities. For the latter semester most examination regulations permit a certain flexibility in the curriculum to meet the requirements of the individual: reinforcement areas allow more material to be covered in one or two fields of specialization and thus also a more detailed treatment of the subject matter is possible. The reinforcement areas are, in principle, divided into two branches. The first concentrates on geodesy, e.g. astronomical geodesy and physical geodesy which also include further subdivisions such as engineering survey and photogrammetry; in the second, the emphasis is more on the planning side, e.g. urban development and land organization. It is often possible to combine the two reinforcement areas.

The graduation examination regulations in force at each university all provide for graduation examinations which consists of an intermediate examination and a final graduation examination. 1982 a new skeleton regulation for the graduation examination was settled by the Westdeutsche Rektorenkonferenz and the Kultusminister-Konferenz. The adaption of the local regulations is to date outstanding.

Upon concluding the basic study course the student sits the intermediate examination which tests the candidate's knowledge of the basic principles that are essential for the successful conclusion of a scientific course of study. It comprises written or oral examinations or a combination of both. The examination regulations allow the intermediate examination papers to be spread over several set examination periods. At some universities certain subjects are also examined in semester tests which must be sat within a specified number of semesters. As a rule, the intermediate examination covers the following subjects: mathematics, descriptive geometry, differential geometry, physics, geology, pedology, administration, science of mensuration.

The final graduation examination is taken upon completion of the course of study and establishes whether the examinee has a thorough knowledge of his specialized area and whether he is capable of working independently and applying scientific methods. It comprises a thesis as well as written and/or oral examinations. In the thesis, which is prepared on an individual or group basis, the future university graduate engineer treats a subject - selected from a limited choice - according to scientific principles. As a

rule, the final graduation examination covers the following subjects: science of mensuration, photogrammetry, adjustment calculation, mathematical statistics, mathematical geodesy, astronomical and physical geodesy, topography and cartography, land organization and soil management, planning, science of constructional engineering.

Most of the examination regulations contain the following provisions pertaining to the final graduation examination: The examination papers may by sat one after the other or split into two sections. For the preparation of the thesis a period of 2 - 6 months is provided, which may be taken prior to, between or subsequent to the examinations. Candidates may resit examination papers which they have failed. The provisions governing the procedures for this vary to a certain extent in the examination regulations in force at each university.

The examination results are recorded on the certificate of graduation. Upon passing the graduation examination the student is awarded the academic degree of "Diplom-Ingenieur" in geodesy.

The examination regulations in force at each university stipulate that the course of study must cover a minimum of nine semesters. In each case the course commences in the winter semester. The average time required before taking the final graduation examination is approximately ten semesters.

In the Federal Republic of Germany university courses leading to qualification as a university graduate engineer are held at the following universities or technical universities:

Complete courses of study in geodesy are offered at the following universities: Berlin, Bonn, Darmstadt, Hannover, Karlsruhe, Munich and Stuttgart.

Courses up to the intermediate examination are held at Aachen and Braunschweig.

Officiers who have enlisted for a minimum of 12 years have the opportunity to study geodesy at the Federal Armed Forces University in Munich.

4. Other Professional Training and Further Educational Opportunities

4.1 Survey Technician

Further training opportunities for survey technicians have already been referred to several times in the previous section. The training system, organized to permit step-by-step progression, enables those interested in, and with the aptitude for, further training to move up to the next educational level. The whole range of further educational opportunities offered at this level are thus open to them.

4.2 Graduate Engineer (Fachhochschule)

The most important form of further training is the civil service training for admission to the executive technical class of the geodetic branch:

The training and examination regulations in force in each state govern the admission to the executive class of the civil service (inspector's career). The State Survey and Cadastral Authorities are responsible for the training of civil servants. They transfer the inspector candidates to the institutions of training specified in the training plan. Approximately 85 % of the graduates who have qualified at a Fachhochschule embark on the two-year preparatory period ending with civil servant's qualifying examination which enables the successful candidates to gain admission to the executive technical class of the civil service.

The other multifarious opportunities of further education have not developed into supplementary training courses with a uniform organization and corresponding qualifications. Their distinguishing feature is an extensive mixture of specialization training, training for promotion and adaption training (adaption to technical developments and change in occupation).

An engineer has the opportunity to specialize as a teacher at a vocational school and simultaneously gain promotion into the administrative class of the civil service by completing shortened extension studies. The pertinent regulations in force in each state differ greatly and are in the process of being revised.

In order to gain admission to a career in the administrative class of the civil service a further course of study at a university can be embarked on. The results attained at the Fachhochschule are given different weights when candidates are being considered for admission to a further course of study. With respect to the requirement side, this path is currently problematic, especially if it is being embarked on with the sole intention of gaining subsequent admission to the administrative technical class of the geodetic branch. This can also be achieved in the civil service itself by gaining promotion, although it is less typical.

Technical specialization in conjunction with information on new technical development required for adaption are covered in various types of courses and offered at three levels: as follow-up studies by institutions of higher education, as extension seminars by survey authorities in which the specific tasks of these authorities are dealt with, or by professional organizations and technical/scientific associations.

4.3 University Graduate Engineer

Most university graduates also embark on a civil service career. Their preparation takes the form of a two-year probationary period (as provisional civil servant). The deepened specialized knowledge and knowledge of the administration acquired during this period are tested in the "Große Staatsprüfung" (major state examination). The provisional civil servant who has passed the examination thus qualifies for the administrative technical class of the geodetic branch and is entitled to use the professional title "Vermessungsassessor" (assessor for geodesy). The assessor either remains in the civil service or becomes a self-employed "Öffentlich bestellter Vermessungsingenieur" (chartered surveyor).

Extension study courses which aim at imparting a deeper specialized knowledge upon conclusion of a university course are not offered at federal German universities for geodesy. The land surveyor with an academic degree is, however, free to attend extension study courses in a closely related subject (e.g. extension study course in urban development or economics).

Employment as a scientific research assistant at a university is, to a certain extent, comparable with an extension course. Young graduate engineers who already have a certain amount of practical experience in employment or who have passed the Große Staatsprüfung are particularly suitable for such a position. During this period, limited to 4 - 6 years, they have the opportunity to deepen their technical knowledge and to conduct research in certain areas in addition to fulfilling their function as a scientific research assistant. The opportunity to gain a doctorate and habilitate (qualify for lecturing at university) during the later course of their career usually ensues from such scientific work.

The aim of follow-up studies is to provide those in employment with the opportunity to acquaint themselves in general and systematically with the latest developments in scientific principles and applications. The basic idea is for such a follow-up study course to be held at a university over a relatively long period. The difficulties which those in employment encounter in obtaining leave and also the problem of finance have resulted in most follow-up courses being limited to a few days or weeks.

For a long time now specialized courses have also been organized, often in cooperation with technical organizations. These include conferences, seminars, courses, excursions, visits to exhibitions in addition to major functions (e.g. Deutscher Geodätentag). Colloquiums held at university on the subject of geodesy may be viewed as a further educational opportunity because they are open not only to students but particularly to all those who are interested in the subject. Special qualifications cannot, however, be attained by participating in such professional educational measures. This also holds true for the attendance of extension seminars held by the technical administration branches in which the employment of new technical processes as well as the problems of organization and leadership are discussed.

5. Other Educational Opportunities

In addition to the courses of study in geodesy described above it is also possible in the Federal Republic of Germany to study two related subjects: cartography and mine surveying.

Study courses in cartography are offered at the following Fachhochschulen: Berlin, Karlsruhe and Munich.

In each case the duration of the course is a minimum of 6 semester; successful completion of the course leads to qualification as a graduate engineer (Fachhochschule) in Cartography. The basic study course entails lectures and exercises in mathematics, descriptive geometry, geography, cartography and cartology. In the major studies the emphasis is on map compilation, science of mensuration, thematic cartography, art of reproduction, map editing, graticule theory and photogrammetry.

Courses in mine surveying are held at the following technical universities: Aachen, Berlin and Clausthal-Zellerfeld. Upon completion of a minimum of 8 semester the student qualifies as a graduate engineer (university) in Mine Surveying.

Mine surveying involves the surveying and calculation of mine deposits and the detection of damage caused to the earth's surface by mining operations. A mine surveyor is therefore a surveyor who has specialized in mining.

The basic study course entails lectures and exercises covering the basics of the natural sciences (mathematics, physics, chemistry, mineralogy, geology), technical subjects (mechanical engineering, electrical engineering, processing engineering, survey engineering) and other subjects (jurisprudence and economics). The major studies concentrate more on the mathematical/scientific subjects, such as descriptive geometry, trigonometry, calculus, geology, geodesy, mine surveying and mapping.

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It is without doubt correct to make a distinction between a land surveyor and a geodesist in view of their subsequent employment. The fact that future geodesists and land surveyors attend the same courses is, however, considered to be one of the strengths of geodetic training in the Federal Republic of Germany. In practice this means that a graduate of a German university can seek employment in either engineering or the natural sciences. At university

the student is prepared for future employment only insofar as the principle of each discipline are covered and the major studies lay the foundation stone for specialization. Actual specialization, however, is left to the occupational field.

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F I N L A N D

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Training in surveying is provided in Finland as follows:

- surveying technicians are trained at technical schools,
- academic engineers at Helsinki University of Technology,
- geodesists at the University of Helsinki.

Some 80 surveying technicians complete their three-year training at four technical schools every year. In the first year the training comprises general subjects, such as mathematics and physics, and special vocational subjects, such as real-estate and surveying technics. During the second and third years the proportion of special subjects increases at the expense of the general subjects. Geodetic calculation, surveying technics, property and real-estate technics, photogrammetry, etc., are then included. Further training for surveying technicians is provided on short courses arranged by the surveying institutions.

35-40 surveying engineers graduate every year, and their training aims to provide them with the knowledge required in solving problems connected with land use. Students may choose between two branches:

A. Measuring and surveying technics,
B. Real-estate and community technics.

The number of graduates is distributed over the two branches in the ratio of 1 to 3. The instruction comprises basic subjects that are the same for all, two vocational subjects and a diploma thesis. A trainee period is not compulsory but is considered in the student's favour. The most important basic subjects are mathematics, including linear algebra and statistics, physics, geodesy, real-estate technics and cartography. The branch A courses fall within the sphere of geodesy, photogrammetry and cartography, those of branch B of real-estate technics and planning and right to formation of a real-estate. The courses take 5 years. Further training is given at the technical universities and separate research institutes.

Geodesists graduate at the rate of one a year on average. This low number is accountable to the difficulty of finding employment.

Undergraduates study at the Department of Geophysics of the University of Helsinki. Teaching of geodesy is given in connection with geophysics. The other five subdisciplines are geocosmophysics, geomagnetism, hydrology, physical oceanography and seismology. Many students of other branches of geophysics, geographers, geologists, etc., take geodesy as a subsidiary. They take the lowest course in geodesy, which primarily includes surveying techniques, questions connected with land surveying and calculation exercises. Due to the small number of students, lectures are held up to the middle level. Further instructions and training and practical measuring and calculation work are provided mainly at the Finish Geodetic Institute. Study is aimed at the most exacting measuring jobs and research. Instruction is given mainly in geometric, physical, astro and satellite geodesy, photogrammetry and in adjustment. Study for the master's degree (fil.kand.) takes about 5 years.

The present curriculum came into effect in 1979 at the University of Technology and in 1980 at the University of Helsinki. The training comprises at both Universities general studies, subject studies and deepening studies. This curriculum gives the possibility to aim the studies, better than earlier, exclusively either at the research work or the practical vocation.

By way of illustration the list of the new curriculum at the University of Helsinki is as follows:

General studies (31 sw) are performed according to the curriculum of physics (sw means 40 hours of study work performed):

Subject studies (84 sw)

- Compulsory basic studies in physics 20 sw

- Specific section in geophysics 32 sw

- Alternative study sections
    - Mathematics, electronics, hydrodynamics, instrument technics, optics 16 sw

- Theoretical physics, meteorology, astronomy, geology, teaching in the Technical University of Helsinki 16 sw

Deepening studies (39 sw)

- Specific courses 16 sw
- Training subjects and seminars 5 sw
- Pro gradu 18 sw

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F R A N C E

R. d'Hollander, Paris

1. Introduction

Il convient de remarquer tout d'abord que le mot géodésie a en France une signification plus spécifique que dans d'autres pays européens. On réserve en France le terme "géodésie" à tout ce qui concerne l'établissement d'un réseau de triangulation de densité relativement faible; en raison de la longueur des côtés il est nécessaire de tenir compte de l'excès sphérique des triangles et d'un certain nombre de corrections d'angles et de longueurs.

Dès que les visées deviennent plus courtes et qu'on peut négliger la plupart des corrections précédentes on est dans le domaine de la "topométrie".

Aussi l'enseignement de la géodésie supérieure et de géodésie proprement dite n'est-il dispensé en France que dans peu d'écoles et peu d'universités. L'enseignement professionnel, à l'exception de celui de l'École Nationale des Sciences Géographique, se limite à la topométrie et à la topographie.

2. Organisation du système de formation

La formation en géodésie et topographie présente en France une très grande diversité, due à des causes historiques. Les grands organismes français: Institut Géographique National, Service du Cadastre, Service hydrographique et océanographique de la Marine, font assurer la formation de leurs cadres et de leur techniciens dans des écoles spécialisées placées sous leur autorité. Cette formule présente un avantage: celui de l'efficacité, les personnels formés recevant une formation parfaitement adaptée à leurs futures fonctions; mais cette dispersion de l'enseignement, dispensé par des ingénieurs chefs de département ou de service dans l'organisme concerné, présente aussi un inconvénient certain: de par leurs fonctions très absorbantes ces ingénieurs n'ont guère la possibilité d'associer enseignement et recherche comme dans les universités.

La formation professionnelle des opérateurs géomètres et topographes destinée soit aux collectivités locales, soit à certaines administrations employant peu de géomètres, soit enfin au secteur privé, est assurée:

- dans les lycées techniques,
- par les formations professionnelles non scolaires,
- par la formation professionnelle des adultes.

La formation des géomètres experts fonciers DPLG (diplômés par le gouvernement) est assurée par "l'Institut National des Sciences Topographiques" (ISTP). Avant d'être admis dans cet Institut les futurs géomètres doivent subir un "examen préliminaire" auquel ils se préparent dans 7 lycées techniques.

La formation des ingénieurs autres que ceux destinés à l'Institut Géographique National (IGN) et au service hydrographique et océanographique de la Marine (SHOM) est effectuée dans trois écoles d'ingénieurs:

- "l'École supérieure des géomètres et topographes" (ESGT) rattachée à "l'Institut National des Sciences Topographiques", qui lui même est un des instituts de sciences appliquées du "Conservatoire National des Arts et Métiers" (CNAM),
- "l'École Nationale Supérieure des Arts et Industries de Strasbourg" (ENSAIS) - Spécialité topographie,
- "l'École Supérieure de Topographie" de "l'École Spéciale des Travaux Publics, du Bâtiment et de l'Industrie", qui comporte trois autres écoles: travaux publics, bâtiment, mécanique-électricité.

Les deux premières écoles dépendent directement du Ministère de l'Éducation Nationale, la troisième est une école privée.

La formation au niveau doctorat est assurée essentiellement à l'École Nationale des Sciences Géographiques et dans quelques universités.

3. Niveaux de formation et qualification

3.1 Formation scolaire

Dans l'enseignement élémentaire l'instituteur a pour mission de faire prendre conscience aux élèves de leur environnement immédiat. A ce titre les programmes des "disciplines d'éveil" comportent l'examen du cadastre, de cartes à grande échelle et de photographies aériennes de la commune où se trouve l'école.

Le programme de la classe de 6è des collèges prévoit dans le cadre de l'enseignement de géographie une révision de ces notions d'environnement local. Toujours dans les programmes de géographie, au niveau des 5è, 4è et 3è, est

prévu l'enseignement de la cosmographie et la lecture des cartes. En classe de 2è (première classe de l'enseignement du second cycle) les programmes de géographie comportent l'étude du globe terrestre: forme et dimensions, la représentation de la terre, l'étude des projections, la représentation du relief, l'étude des cartes à grandes et petites échelles, l'utilisation de photographies aériennes. Le reste du programme comporte un enseignement de géographie physique, avec des notions de géomorphologie.

3.2 Formation des techniciens

3.2.1 Formation par l'enseignement technique (Ministère de l'Éducation Nationale)

Nous classerons ces différentes formations d'après les diplômes auxquels elles aboutissent.

a) Brevet d'études professionnelles d'opérateur géomètre topographique
Le recrutement s'effectue à la fin de la 3è des collèges; la durée des études est de deux ans. Trente lycées d'enseignement professionnel, comportant des classes d'environ 20 élèves, préparent en France à ce "brevet d'études professionnelles" (B.E.P.).

L'opérateur géomètre-topographe trouve sa place dans les cabinets de géomètres-experts, dans les bureaux d'études topographique, les services publics et collectivités locales et dans les entreprises de travaux publics.

b) Le brevet de techniciens topographe
Deux établissements seulement préparent en France à ce "brevet de technicien" (BT); avec des classes de 20 à 30 élèves.

Le recrutement a lieu à la fin de la classe de 3è des collèges, mais la durée des études est de trois ans, avec un stage professionnel à la fin de la première année scolaire. Les matières d'enseignement général occupent environ 40 % du temps et tendent à amener les élèves au niveau des baccalauréats de techniciens. Le reste du temps est consacré à des cours professionnels de topographie.

Il manque dans cette filière professionnelle un "brevet de technicien supérieur topographe" qui est à l'étude actuellement. La création de ce diplôme est demandée par certains milieux professionnels.

c) Le brevet de technicien dessinateur graphiste maquettiste - option cartographe
Cette nouvelle appellation s'est substituée depuis 1983 à l'ancienne dénomination: brevet de technicien-dessinateur cartographe.

Le recrutement des élèves a lieu à la fin de la classe de 3è; la durée des études est de 3 ans.

Un seul lycée technique disperse cette formation: les classes y ont de 12 à 15 élèves.

Dans le domaine de l'enseignement de la cartographie un brevet de technicien supérieur cartographe est aussi à l'étude.

d) L'examen préliminaire de géomètre expert foncier (D.P.L.G.)
La préparation à l'examen préliminaire est actuellement assurée dans 7 lycées techniques publics et l'établissement privé.

L'examen lui même comporte 2 années d'études, à partir du baccalauréat, et une double formation (technique, juridique).

Il conduit à divers débouchés, parmi lesquels le concours d'entrée à l'ESGT (École supérieure des géomètres et topographes).

3.2.2 Formations professionnelles non scolaire

a) Formation sanctionnée par le "certificat d'aptitude professionnelle" (CAP) d'opérateur géomètre
Ce CAP sanctionne une formation d'apprentissage, qui comporte une partie pratique, chez un employeur, et des heures de cours dans un centre de formation d'apprentis (CFA).

b) Formation professionnelle des adultes
L'Association nationale pour la formation professionnelle des adultes (AFPA) est une association qui fonctionne comme un service public sous le contrôle du Ministère du Travail.

Elle assure à des stagiaires une formation de 10 mois dans deux centres de province (Meaux, Égletons).

Le diplôme de l'AFPA est reconnu apte è remplir les fonctions de "technicien supérieur en topographie".

Les débouchés des diplômés sont principalement les cabinets de géomètres et les sociétés et entreprises de travaux publics.

c) Le brevet de "chef de brigade géomètre"
Les "chefs de brigade" constituent l'encadrement principal des cabinets de géomètre expert et des cellules topographiques de certaines entreprises de collectivités.

Il n'y a pas d'établissement scolaire préparant à cet examen, mais une préparation par correspondance est assurée en 3 ans par le "centre national de télé-enseignement".

Le calcul professionnel, le report de plan et la topographie regroupent l'ensemble des techniques de base nécessaires à l'exercice de la profession et sont relativement approfondis.

3.2.3 Formations professionnelles spécifiques

a) Formation professionnelle des techniciens géomètres du Cadastre
Les techniciens géomètres du Cadastre sont chargés de l'exécution des travaux techniques, juridiques et administratifs que comportent la confection, la rénovation, le remaniement et la conservation des plans cadastraux et de la documentation littérale du Cadastre.

Ils sont recrutés par concours ouvert aux candidats titulaires du Baccalauréat.

Le cycle de formation des techniciens géomètres dure au total 18 moins. Il comporte un enseignement de topographie et des techniques juridique du cadastre.

b) La formation des techniciens d'études et de fabrication (T.E.F.) hydrographes destinés au Service hydrographique et océanographique de la Marine (SHOM)
Les T.E.F. sont répartis entre plusieurs spécialités, qui correspondent aux techniques mises en œuvre au SHOM.

La formation, qui dure 2 ans, est assurée par l'École Technique Normale (ETN) de Brest. Les principales spécialités sont la cartographie et l'océanographie.

c) La formation des officiers mariniers de la Marine spécialisée en hydrographie
"L'École des hydrographes" assure la formation des officiers mariniers de la marine spécialisée en hydrographie (contrairement à ce que pourrait laisser croire leur dénomination les officier-mariniers constituent des personnels non officiers de la marine nationale).

Peuvent être admis à l'École des hydrographes les personnels engagés dans la marine et titulaires du brevet d'aptitude technique de certaines spécialités. Les études durent deux ans pendant lesquels alternent des périodes de cours à Brest et des stages pratiques, comportant notamment 4 mois de levés hydrographiques.

d) La formation des "géomètres de l'Institut Géographique National" (à l'École Nationale des Sciences Géographiques)

Les géomètres de l'Institut Géographique National interviennent dans tous les travaux de l'établissement: géodésie, topographie, photogrammétrie, cartographie, télédétection, qu'ils aient lieu sur le terrain ou en atelier.

Les élèves français sont recrutés par concours au niveau du baccalauréat des séries scientifiques.

Les élèves étrangers sont admis après examen écrit passé à l'Ambassade de France de leurs pays.

La durée des études est de deux ans; chaque année scolaire comprend environ 7 mois d'études théoriques et 4 mois de travaux d'application sur le terrain.

Le brevet de fin d'études est le "brevet de technicien supérieur d'études et de travaux géographiques" reconnu par le Ministère de l'Éducation Nationale.

e) Formation de techniciens étrangers par l'École des Sciences Géographiques
L'École Nationale des Sciences Géographiques forme spécialement pour le compte de pays étrangers: des techniciens topographes, des techniciens cartographes.

Le niveau d'admission est celui de la classe de première des séries scientifiques.
La scolarité est de deux ans.

3.3 Formation de niveau école d'ingénieur ou universitaire

3.3.1 Formation dans les écoles d'ingénieurs

3.3.1.1 Écoles d'ingénieurs dépendant directement du Ministère de l'Éducation Nationale

a) École Nationale Supérieure des arts et industries de Strasbourg (ENSAIS), spécialité topographie
La spécialité topographie de l'ENSAIS a été créée en 1897 en étroite liaison avec service du cadastre d'Alsace-Lorraine.

Le recrutement des élèves est assuré par un concours commun avec celui d'autres écoles nationales d'ingénieurs. La durée des études est de trois ans; une vingtaine d'élèves est recrutée chaque année. En ce qui concerne les matières essentielles à la profession on dénombre les disciplines principales: géodésie, instruments, cartographie, photogrammétrie, télédétection.

L'enseignement dure 3 années.

Les carrières offertes sont très variées: exercice libéral de géomètre-expert, services techniques des collectivités locales, topométrie industrielle, enseignement et recherche instrumentale.

b) École Supérieure des géomètres et topographes (ESGT)
"L'École supérieure des géomètres et topographes" dépend de "l'Institut National des Sciences Topographiques", l'un des instituts du "conservatoire nationale des arts et métiers".

Le concours d'entrée à l'ESGT est ouvert à tous étudiants titulaire du certificat de l'examen préliminaire, que nous avons étudié en 3.2.1 d), et âgés de moins de 25 ans.

Les études se déroulent sur 3 années universitaires et se terminent par la rédaction d'un mémoire.

En 3ème année, les élèves doivent choisir 4 options parmi les 7 qui sont proposées: astro-géodésie, photogrammétrie, urbanisme, génie civil, aménagement rural, estimations immobilières, levés aux petites échelles.

Les carrières offertes aux diplômes se répartissent en 2 catégories:
- Profession libérale - géomètre expert DPLG
- Carrières du secteur public, semi-public ou privé.

3.3.1.2 École supérieure de topographie de l'École spéciale des travaux publics (ESTP) - école d'enseignement supérieur privée, reconnue par l'État et placée sous la tutelle du Ministère de l'Éducation Nationale

Le recrutement des élèves s'effectue par un concours du niveau de mathématiques spéciales, uniquement écrit. La durée des études est de trois ans dont un stage obligatoire de six mois exécuté en fin de 2è et 3è années.

Les carrières offertes en fin de scolarité sont les même que pour les 2 écoles précédentes.

3.3.1.3 Écoles de formation des ingénieurs des grands organismes publics

a) École Nationale des Sciences Géographiques (ENSG). Cycle des ingénieurs géographes
Ce cycle constitue une des écoles d'application de l'École Polytechnique: les élèves sortis de cette école et ayant choisi la carrière d'ingénieur géographe (Institut Géographique National) effectuent deux années d'études dans ce cycle.

Ce cycle est accessible aussi aux ingénieurs des travaux géographiques et cartographiques de l'État ayant subi les épreuves d'un concours d'admission.

Enfin ce cycle admet des candidats étrangers, à la suite d'un examen d'admission du niveau de la Maîtrise des Sciences.

Il y a 2 années de scolarité, consacrées essentiellement à toutes les disciplines qui concernent l'établissement et l'exploitation des cartes et photographies aériennes: géodésie, astronomie, topographie, photogrammétrie, télédétection ... etc. Un stage de 4 mois est prévu sur le terrain en première année, et un stage de 6 mois, en deuxième année, dans un organisme ayant une vocation de recherche.

Les ingénieurs géographes sont destinés à occuper des fonctions de responsabilité au sein de l'Institut Géographique National: direction d'une division, d'un département ou d'un service.

b) ENSG. Cycle des ingénieurs des travaux géographiques et cartographiques l'État (ITGCE)
Les élèves ingénieurs des travaux sont recrutés par un concours commun avec celui des élèves ingénieurs des travaux publics de l'État, au niveau de Mathématiques Spéciales.

L'enseignement, qui porte sur toutes les techniques aboutissant à la carte, se déroule dur 3 années.

Les ingénieurs des travaux ont vocation à diriger des missions sur le terrain, à être chefs d'atelier ou de division, au sein de l'Institut Géographique National.

c) La formation hydrographique des ingénieurs
Nous avons déjà évoqué en 3.2.3 b) la formation des techniciens spécialisés dans les travaux hydrographiques de dessin et de calcul (École technique normale) et en 3.2.3 c) la formation des hydrographes (École des hydrographes).

Deux autres écoles du Service hydrographique et océanographique de la marine forment des ingénieurs.

c1) L'École Nationale Supérieure des techniques avancées (ENSTA):
option environnement marin
L'ENSTA est l'école d'application des ingénieurs militaires sortis de l'École Polytechnique. Elle est aussi accessible à des élèves libres par concours ou sur titres.

La durée des études est de deux ans.
Deux enseignements concernent la géodésie proprement dite:
- la géodésie marine qui étudie essentiellement les méthodes de détermination d'un point à la mer au moyen de propagation de signaux radio-électriques
- l'océanologie spatiale.

Cet enseignement de la géodésie au sens strict est complété par des cours sur les techniques en environnement marin: hydrographie, cartographie marine, télédétection, photogrammétrie, géophysique marine que l'on peut rattacher aux techniques géodésiques.

c2) L'École Nationale Supérieure d'ingénieurs des Études et Techniques d'armement (ENSIETA) – option hydrographie, océanographie
Les élèves sont admis par un concours portant sur le programme des classes de mathématiques spéciales. La durée des études est de trois ans.

L'enseignement dispensé porte sur les disciplines de spécialité suivantes: géodésie, hydrographie, cartographie, astronomie, marées, radiolocalisation, photogrammétrie, océanographie, géophysique, techniques et systèmes.

Les ingénieurs des Études et Techniques d'armement (IETA) hydrographes occupent à la terre comme à la mer des fonctions d'encadrement diverses.

3.3.2 Écoles ou Instituts assurant une formation comparable à celle d'ingénieur

a) Institut National des Sciences Topographiques
Peuvent s'inscrire à l'Institut National des Sciences Topographiques les candidats titulaires d'un certificat de l'examen préliminaire (voir 3.2.1 d)) et inscrits au registre des géomètres-experts stagiaires.

L'enseignement comporte trois cycles de trois mois de cours à plein temps et trois périodes de stages professionnels pratiques de 6 mois.

b) École Nationale du Cadastre - formation professionnelle des inspecteurs du Cadastre
Outre la formation des techniciens géomètres du Cadastre (voir 3.2.3 a)) "l'École Nationale du Cadastre" a pour mission de former les "inspecteurs des impôts du Cadre A - spécialité cadastre".

Les inspecteurs élèves sont recrutés par concours ouvert aux candidats titulaires d'une licence et d'une maîtrise scientifique.

La cycle de formation dure au total 18 mois et comporte notamment des cours de topographie et des cours juridiques.

3.3.3 Formation post-ingénieur ou post-maîtrise, niveau doctorat

a) Le diplôme d'études approfondies et le diplôme de docteur ingénieur en sciences géodésiques délivrés par l'École Nationale des Sciences Géographiques (Institut Géographique National)
Le "diplôme d'études approfondies (DEA) en sciences géodésiques" est délivré conjointement par l'École Nationale des Sciences Géographiques et l'Université Paris VI, le responsable de ce D.E.A. étant un professeur de cette université.

Les candidats titulaires d'un diplôme d'ingénieur français sont admis sur titres: les candidats titulaires de diplômes étrangers sont admis à un examen probatoire du niveau maîtrise, subi en principe à l'ambassade de France du pays concerné.

La préparation du diplôme s'effectue en une année et comporte:
- des enseignements théoriques répartis en trois options
- une initiation à la recherche.

Les trois options sont: géodésie, photogrammétrie, télédétection.

Après obtention de ce DEA les ingénieurs peuvent préparer un "diplôme de docteur ingénieur en sciences géographiques", en accomplissant deux années de recherche dans un laboratoire de recherche de l'Institut Géographique National.

Le diplôme d'études approfondies et le doctorat d'ingénieur en sciences géodésiques sont les seuls diplômes de 3è cycle en France couvrant l'ensemble des sciences géodésiques.

b) Enseignements universitaires comportant de la géodésie supérieure, de la cartographie ou de la télédétection

b1) Enseignement préparant à un diplôme d'études approfondies (DEA):
- Sciences géodésiques: Paris VI et ENSG
- Géophysique appliquée et géophysique interne: Paris VI
- Méthodes physiques en télédétection: Paris VII, ENSG, École Nationale Supérieure des Mines, École des télécommunications
- Sciences et techniques spatiales: Université Paul Sabatier (Toulouse III)
- Physique spatiale - option télédétection: Université Paul Sabatier (Toulouse III).

b2) Enseignement divers dans certains centres universitaires et écoles d'ingénieurs
concernant la gravimétrie, les marées terrestres, les mouvements récents de l'écorce terrestre à:
- l'Institut de physique du globe de l'Université Paris VI
- l'Institut de physique de globe de l'Université de Strasbourg
- le centre de géologie et de géophysique de l'Université de Montpellier
- les Universités de Clermont-Ferrand, Grenoble, Nantes

concernant la mécanique spatiale (satellites artificiels):
- École supérieure de l'Aéronautique.

b3) Enseignement préparant à une d'études supérieures spécialisées (DESS)

Le DESS sanctionne une année d'études spécialisées après la maîtrise:

- Télédétection: Université de Paris VI et ENSG
- Cartographie: École Supérieure de cartographie (Université de Paris VI et Paris I).

4. La formation continue

Il serait très long d'énumérer ici les différentes actions de formation continue organisées en France en matière de géodésie et de topographie. On peut dire que la quasi totalité des organismes de formation initiale organisent des sessions de formation continue.

Un recrutement exhaustif des formations continues a été réalisé par l'Association française de topographie et figure dans le n^{O} 14 du bulletin XYZ édité par cette association. Un colloque organisé par la même association a eu lieu à Orléans en décembre 1983 et a été consacré uniquement à la formation continue des topographes. Les exposés effectués à l'occasion de ce colloque figurent dans le n^{O} 19 de bulletin XYZ.

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- Formation et débouchés en hydrographie et en océanographie
  Service hydrographique et océanographique de la Marine (SHOM)
  3, Rue Octave Gérard - 75200 Paris Naval

- Notices sur les différents niveaux de formation de l'École Nationale des Sciences Géographiques
  2, Avenue Pasteur - 94160 Saint-Mandé

- Notices sur les formations de l'École Supérieure des géomètres et topographes et de l'Institut National des Sciences Topographique
  Cours de l'Orme à Martin, Quartier des Passages - 91000 Évry

- Notice sur l'École Supérieure de Topographie de l'École Spéciale des Travaux Publics (ESTP)
  57, Boulevard Saint-Germain - 75240 Paris Cedex 5

- Notice sur l'École Nationale des Arts et Industries de Strasbourg (ENSAIS) - Spécialité topographie
  24, Boulevard de la Victoire - 67084 Strasbourg Cedex

- Notice sur l'École Nationale du Cadastre
  76, Chemin du Calquet - 31081 Toulouse

- Notice sur la formation professionnelle des adultes - Topographie Centre AFPA
  70, Avenue de la Victoire - 77109 Meaux

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GERMAN DEMOCRATIC REPUBLIC

1. General

Surveying, mapping and charting in the German Democratic Republic are characterized by a strong association with, or subordination to, overriding social goals based on the socialist order of society.

The educational laws of the German Democratic Republic assume a basic concurrence between the goals and interests of society, the state and the youth, and set the primary tasks of educating all young people to be good citizens. This objective was also incorporated in the 1976 curriculum for the basic field of study of geodesy and cartography.

The students are taught and trained to be socialists who, on behalf of the working class and its party and with a high sense of identification with the state, are able to contribute creatively to the enhancement of the material and cultural quality of the life of the people, the increasing application of modern science and technology in production, the increase in labor productivity, socialist economic integration and the continuous development of social life in their spheres of activity.

On principle, no survey work is done privately in the Democratic Republic; the entire survey personnel is, on account of the socialist state and social order, employed in the state sector either directly or indirectly in the administration, in production plant, in the building industry, water supply and distribution, transport or in scientific institutes of research and teaching. Ninety percent of the university graduates are employed in the economy, in other words in state surveying, mapping and charting activities and the other economic branches referred to above. Education is therefore primarily directed at productive employment. Only the most able students come into consideration for employment as graduates in research and development, i.e. 10 % on average.

In keeping with the basic laws of the socialist economy, the economic plans include figures for the number of places and students who qualify. The course of the study is planned and organized rigidly for the year in order to achieve the best results in the minimal period of 4 1/2 years, which includes time spent on the thesis. A similar procedure is followed in all other educational institutes for geodesy.

A further feature of geodetic education in the German Democratic Republic is the marked emphasis at all educational levels on practical work in preparation for

future employment. For example, the future land surveyors spend the final phases of their education at the enterprise where they will subsequently be employed. It is here where they are familiarized with the particular problems and tasks of the enterprise, thus ensuring a smooth transition from training to professional life and consequently a higher rate of productivity.

2. Organization of the Educational System

Qualified personnel in the field of geodesy and cartography are organized along three levels, the educational objectives of which are laid down in terms of three qualification levels and in each case the successful completion of a 10-class comprehensive polytechnic secondary school is a requirement.

- Skilled workers in surveying or mapping and charting constitute at present, and will continue to do so, the major share of those employed in the field of surveying, mapping and charting in the German Democratic Republic. They are production workers capable of completing subtasks within the working group under supervision.

- Engineers in the branches of geodesy and cartography are employed first and foremost directly in the production process. They are specialists who are able to prepare and implement, without assistance, any geodetic or cartographical tasks, to head survey teams and similar working groups and to provide the subordinate skilled workers with direct supervision for the implementation of their tasks.

- University graduate engineers in the branches of geodesy and cartography are qualified persons able and prepared to function as managerial and executive personnel who head sizeable geodetic or cartographical working groups or to contribute to research work or other scientific tasks aimed at the further development of geodesy or cartography, or to work in the field of training and follow-on training of geodetic and cartographical skilled workers/specialists.

Specialists on each of the three qualification levels have tasks to fulfil which are clearly distinguished from each other.

3. Educational Levels and Qualifications

3.1 School Education

Education in geodesy may commence upon the successful conclusion of the 10-class

comprehensive polytechnic secondary school (comparable with the British "General Certificate of Education Ordinary Level"). The school-leaving certificate at this level constitutes the minimum requirement for embarking upon formal training required for qualification as a skilled worker and for admission to a course of study at the Engineering School.

Following an additional two years, building on this school-leaving certificate, the final school-leaving examination (approx. the British "General Certificate of Education Advanced Level") may be taken at a grammar-type school. The final school-leaving certificate is required for admission to a course of study at university.

An unusual feature is the training as a skilled worker and the simultaneous acquisition of the final school-leaving certificate; it is the objective of this method to recognize technical talents in good time and send suitable school-leavers to university.

Furthermore, holders of the final school-leaving certificate, who as so-called late developers strive for a higher qualification level several years after leaving school, or skilled workers holding the 10-class school-leaving certificate and subsequently the matriculation standard, have the opportunity to be delegated to a (correspondence) course of study at university if they excel the enterprise where they are employed.

3.2 Skilled Workers in the Field of Surveying and Cartography

The requirements for admission to a training course as a skilled worker in the field of surveying and cartography are, in addition to the successful completion of the 10-class comprehensive polytechnic secondary school, good to very good results in the following subjects: drawing, technical drawing, geography and mathematics.

Training is offered at central industrial training schools which belong directly to the corresponding hiring enterprises. Attached to these schools are boarding school-type trainee hostels in which the accommodation of trainees is free of charge.

It takes two years to train as a skilled worker; if the final school-leaving examination is also strived for the training lasts three years. The simultaneous attainment of the final school-leaving certificate and the craft certificate is only possible, however, in Dresden.

During the training, theoretical lectures continuously alternate with practical exercises or work directly in the enterprise. The vocational training thus comprises approx. one-third theory and two-thirds practical work.

In addition to the geodetic subjects of instruction, general subjects such as civics and sports are also attended. At the end of the training course an examination for qualification as a skilled worker is taken which results in the awarding of the craft certificate either with or without the final school-leaving certificate.

The successful trainee then commences his work in the enterprise which will now employ him, for which his 3 - 4 week practical work has already prepared him.

3.3 Engineers in the Branches of Geodesy and Cartography

In the German Democratic Republic training courses in engineering have been centralized and held at the Engineering School for Geodesy and Cartography in Dresden since 1953. Admission to a course of study in engineering is regulated very precisely because of the capacity of this training - as is the case with all other types of education - is arranged according to the long-term requirements planning and the needs of society and accepts the requirements which are given major emphasis.

In addition to the successful completion of the general polytechnic secondary school and the training course for skilled workers in surveying and cartography, the prospective student must also produce a notification of delegation from the enterprise in order to be allowed admission to the Engineering School.

The period of study is 3 years.

In accordance with the study guidelines solid and applicable knowledge based on social, technical und natural science is to be provided. Subjects are Marxism-Leninism (306 hours), physical training (180), Russian (108), English (optional), German (36), theory of culture and esthetics (36), science of work (54), socialist industrial management (162), mathematics (324), physics (180), chemistry (36), electronic data processing (90), information, documentation, standardization (36), socialist jurisprudence (72). These basic courses are regarded as supposition for a special training bound for practice and for availability in the profession.

The 1. to 5. semester last 18 weeks each covering 36 hours per week. There are separated studies in geodesy and cartography.

The special training in geodesy offers the following subjects: descriptive geometry (36), error analysis and adjustment calculation (144), surveying (594 including 270 hours laboratory work), topography (72 incl. 10 lab.), photogrammetry (162 incl. 54 lab.), engineering surveying (144 incl. 36 lab.), cadastral surveying (54).

In the 5. semester, in accordance to his future field of work, the trainee has to choose 21 hours of reinforcement out of the following subjects: geodetic control networks (horizontal networks, leveling and gravitational networks, topography), large scale surveys, topography and photogrammetry, engineering surveying (engineering surveying, construction engineering, railway construction and operating techniques), mining geodesy (mine surveying, mine geology, mining industry: opencast mining and underground exploitation), cadastral and agricultural surveying (cadastral surveying, land rights, land improvement).

The special training in cartography involves the following special subjects: descriptive geometry (36), geography (108), surveying (144 incl. 72 lab.), photogrammetry (126 incl. 54 lab.), map designing (252 incl. 144 lab.), cartographic techniques (252 incl. 144 lab.), mathematical cartography (108 incl. 36 lab.). In the 5. semester the fields of reinforcement (17 hours) are topographic cartography (topographic cartography, topography), thematic cartography (thematic cartography, geography).

After five semesters training at the engineering school the 6. semester is devoted to a practical course at an enterprise. On that occasion a thesis has to be prepared and to be uphold in the presence of representatives of the engineering school and the socialist practice.

Upon successfully upholding his final paper, the student is awarded the title of "Engineer".

3.4 University Graduate Engineers in the Branches of Geodesy and Cartography

Study courses for university graduate engineers (Diplomingenieur) are held at the Department of Geodesy and Cartography at the Technical University of Dresden. Application for and admission to a course of study are governed by the rulings laid down by the Ministry for University and Professional College Education (Ministerium für Hoch- und Fachschulwesen). Requirements for admission to a course of study are the final school-leaving certificate acquired after attending a grammar-type school for twelve years or the completion of a vocational

training course plus final school-leaving certificate. Only those holders of final school-leaving certificates are enrolled for geodesy who receive a Grade 1 or 2 in mathematics and physics and who have a good overall mark. Applicants without previous professional experience and knowledge have to perform a 1-year practical course, and male applicants have to complete their period of military service prior to commencement of studies. Approximately 30 - 40 % of the intake have usually qualified as a skilled worker in geodesy and cartography.

Since 1975 the total duration of the course of study has been increased from 4 to 4 1/2 years. The extension benefits primarily the practical work as engineer in enterprises in the field of surveying, mapping and charting during the 7th semester.

A subdivision of the period of study into a basic study course and professional studies does not exist. From the very beginning the training of geodesists and cartographists is separated. The overall time-table for the study is organized as follows: Social science, science of work, jurisprudence, languages, sports (25 %), mathematics, natural sciences including computer science and automation (24 %), technical and professional education (47 %), adjacent sciences (4 %).

The following educational objectives are concentrated on:

- a good general education; this includes proficiency in Russian and one other foreign language
- knowledge of and proficiency in socialist productive performance and in Marxism-Leninism; by this is meant a comprehensive knowledge of the management sciences (business administration, personnel management and leadership, etc.)
- knowledge of and proficiency in mathematics and the sciences
- representation methods as well as geodetic and cartographical techniques and technology.

Upon conclusion of every semester, up to five intermediate or final examinations are taken. At the end of the 2nd semester there is a four-week practical exercise in surveying and geodesy respectively. Following the 4th semester a complex problem (i.e. large-scale survey or real estate) is to be solved which takes the form of a two-week exercise.

A three-week complex practical work is incorporated in the 6th semester which is held in the test area of the Department of Geodesy and Cartography and covers

geodetic survey work (triangulation, triliteration using electronic distance measurement, precision levelling) including astronomic-geodetic and gravimetric work. The detailed evaluation of the measurements is the requirement for the major certificate during the 8th semester.

Special significance is attached to the engineering practical exercises during the 7th semester in the enterprises active in the field of surveying, mapping and charting. Its aim is to constitute a decisive phase in the further development and consolidation of the student's independence, sense of responsibility and ability to cope with engineering problems. During the engineering practical work it is intended that the students apply in the enterprise the knowledge, abilities and skills gained and learned during their studies. They become involved in the social life of the workers' collective and in the fulfilment of the goals set by the plan for the enterprise. Upon conclusion of the 8th semester major examinations are taken in the following subjects: Marxism-Leninism, geodesy and engineering geodesy. The examination of the remaining subjects takes the form of certificates, attestations and final examinations following the completion of the pertinent semester. The thesis is prepared and its contents upheld during the 9th semester. The themes of the theses are virtually exclusively subproblems within the field of research.

Those students who successfully uphold their thesis and pass the major examination are entitled to use the professional title "Diplomingenieur" (university graduate engineer).

A particular feature of university education in the German Democratic Republic is the furtherance of the most gifted students for the purpose of which two channels are open. The best students either receive a special curriculum for the latter semester or they remain a further three years at the university as research students. To a considerable degree the special curriculum takes into account the subsequent involvement which is envisaged in research work at the Technical University of Dresden, at the Zentralinstitut Physik der Erde der Akademie der Wissenschaften (Central Institute for Physics of the Earth of the Academy of Science) in Potsdam or at the Forschungszentrum des staatlichen Vermessungs- und Kartenwesens (Research Centre for State Surveying, Mapping and Charting) in Leipzig. Above all, however, the curriculum is adapted to the suitability of the student for theoretical and experimental work.

The research student commences his work at a research collective at the university immediately after the major examination. A subtheme for his dissertation is selected from his research area. In this way the time required for gaining his doctorate is considerably reduced. A suitable research grant helps encourage students

to opt for this educational channel.

Both students with the special curriculum and research students who are particularly interested in science are given every opportunity to deepen their knowledge of mathematics, physics, information sciences and other specialities at the Technical University and thus to extend their basic knowledge which will be useful for subsequent work in theoretical and experimental research.

4. Further Vocational Training and Further Education

An intensive course of further education/training is offered at all three levels of the educational system described above. In this connection it is the task of the industrial training schools to provide all skilled workers of the enterprises concerned with further training as far as production requirements necessitate. Of particular importance is the familiarization of all skilled workers with new instruments, equipment, processes, technology and regulations.

As already mentioned, skilled workers with particular qualifications have the opportunity to be delegated to a direct or correspondence course at the Dresden Engineering School.

The further training of production engineers aims at

- continued production orientated education at enterprises, "Kombinate" and educational institutions
- continued education for selected fields of science at special courses at universities, technical colleges and schools
- part graduate education with special certificate. Courses last one to two years and are offered at universities, technical colleges and schools.

University graduate engineers in the field of geodesy and cartography may gain further degrees as follows:

Doktor-Ingenieur (Dr.-Ing.), Doctor scientiae technicarum (Dr.sc.techn.).

The degree "Doktor-Ingenieur" is awarded for a dissertation as the result of a "doctorate procedure A".

The highest academic degree " Doctor scientiae technicarum" is awarded as a result of "doctorate procedure B". Among the requirements for the awarding of this degree are:

- positive valuation of the dissertation B on which higher demands are made than on a dissertation A
- successful management of a scientific working group
- positive evaluation of the dissertation.

Furthermore, regular further education courses for graduate engineers (Diplom-Ingenieure) have been offered during the last few years at the Department of Geodesy of the Technical University of Dresden. They usually take one of the two forms: either a one-year post-graduate correspondence course or intensive courses lasting one to two weeks.

The Chamber of Technology (Kammer der Technik), the socialist organization of engineers in the German Democratic Republic, plays a major role in the continuous process of further training. The enterprise sections of the Chamber of Technology organize excursions, courses and lectures. Participation in the numerous professional conventions organized by the organization of engineers and participation in international conferences both serve the further training of specialists.

5. Special Features of the Country

The educational system of the German Democratic Republic has a series of special features which are briefly considered below.

In the German Democratic Republic the various educational channels for skilled workers, engineers and university graduate engineers are organized centrally. Both the Technical University and the Engineering School, where the university and professional college cadres in the field of geodesy are educated, are to be found in the same city. This permits close cooperation as a result of the joint coordination of the curriculae, the joint use of teaching facilities and the employment of teaching personnel by both educational institutes, with the result that a tightly-knit interweavement has emerged.

A further characteristics of education in surveying in the German Democratic Republic is the parallel training of geodesists and cartographists at all levels.

Particular significance is attached at all educational levels to the ideological indoctrination of the students and to an education in the interests of the working class. The basic course of study in social science was thus introduced in 1951 with the objective of imparting to all students the required scientific

knowledge of Marxism-Leninism.

Correspondence courses are of great importance to geodetic education. They are offered both to prospective non-university and university graduate engineers. At the university the correspondence course lasts 5 1/4 years. Upon conclusion of the lectures in the 10th semester the thesis is prepared and upheld in the 11th semester. The admission requirements are the same as those for regular study. In the case of correspondence courses, knowledge is acquired by means of private study with the aid of correspondence lessons, textbooks and study guidelines. Skilled workers who produce good work may also attain the title of engineer by taking a correspondence course at the Engineering School level while continuing to work; in this instance the training lasts five years. The value of this type of study is proven by the fact that 35 % of all students successfully completing their studies at the Engineering School have done so by means of a correspondence course, while the proportion of university graduates in the field of geodesy who took a correspondence course has nevertheless reached 23 % during the last 25 years.

It continues to be remarkable that the percentage of female students is exceptionally high, i.e. approx. 40 % in geodesy and 80 % in cartography.

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G R E E C E

1. General

Unfortunately there is nothing official published about the geodetic educational system in Greece. The following remarks are based on personal correspondence.

2. Structure of the Educational System

3. Educational Levels and Qualifications

University Graduate Engineers

A complete geodetic - surveying university level education is given at two universities in Greece. At the

- National Technical University of Athens, and at the
- University of Thessaloniki.

At both universities there exist complete 5 years studies, forming the faculties of so-called "Rural and Surveying Engineering", providing after 5 years of studies and after carrying out a diploma thesis, the degree of Dipl.Eng..

The courses in these 5 years studies cover the fields of surveying, geodesy, photogrammetry, cartography, geodetic astronomy, cadastral and land consolidation as well as engineering courses in highway engineering, hydraulics, constructions, mechanics. The study plans (curriculum) at both universities are quite similar.

As far as the geodetic part of education is concerned, the following chairs are teaching and doing research at the two universities:

National Technical University of Athens:

Chair of Geodetic Astronomy
Chair of Higher Geodesy and Cartography
Chair of Photogrammetry
Chair of General Geodesy

(plus other chairs for the rural part).

University of Thessaloniki:

Chair of Geodetic Astronomy
Chair of Higher Geodesy and Cartography
Chair of Topography
Chair of Photogrammetry
Chair of Cadastral and Land Consolidation
Chair of Geodetic Statistical Methods

(plus other chairs for the rural part).

There are also three other chairs of surveying for civil engineers which are teaching an one year course at the University of Patras, University of Thrace and also at the University of Thessaloniki. These chairs belong to the faculties of civil engineering and not at those of rural and surveying engineering which are the basic institutions for geodetic education.

4. Additional Professional Education

Almost 700 students are studying in all years at both universities, and after concluding successfully their studies and diploma thesis, they are given extended examinations in order to get their professional permission as rural and surveying engineers and to become members of the Technical Chamber of Greece, which is the highest association of Greek engineers.

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H U N G A R Y

1. General

The state surveying authorities are primarily responsible for the so-called basic national tasks, i.e. the development of the horizontal and vertical control as well as the production of base maps. The basic national tasks also include science, research and development which are the responsibility of the universities and academic institutes or research.

Half of the surveying engineers work in the official state authorities, while the others are employed in the various areas and establishments concerned with building construction and civil engineering, the water system and transportation in planning, execution, maintenance and supervision of technical objects. There are no self-employed surveying engineers in Hungary.

2. Organization of the Educational System

There are three types of survey specialists in Hungary: survey technicians, graduate engineers and university graduate engineers. The relationship between university graduate engineers, graduate engineers and technicians who have completed the pertinent educational level is approximately 1 : 2 : 5. The Hungarian educational system is based on the fundamental principle that it is possible to attain the highest level having started out from any educational institute at a lower level. It therefore follows that the possibility exists for all three types of specialists to acquire a higher qualification or to specialize in a particular field either upon completion of training or during employment.

3. Educational Levels and Qualifications

3.1 School Education

School education in Hungary commences with the eight-class primary school. At the age of 14 years the pupil must already decide which further educational channel he wishes to pursue. If he intends to study at university he may either change to a grammar school or attend a secondary school

which concentrates on preparation for a particular type of professional training. Both types of schools are attended for four years, at the end of which the pupil sits the final school-leaving certificate or the technical final school-leaving certificate (both qualifications are the approximate equivalent of the British General Certificate of Education Advanced Level). If the pupil who has completed primary school wishes to embark upon vocational training leading to qualification as a survey technician he may attend a higher technical school for four years at the end of which he may also sit the school-leaving certificate.

3.2 Training Leading to Qualification as Technician

Specialists at the lowest level receive their training at higher technical school for surveying; the school-leaving examination is taken at the end of the fourth school year. In order to qualify as a technician the pupil is required to engage in practical work for two years, to acquire further knowledge and to pass the so-called technician's examination. Such courses are offered at 5 higher technical schools of which one is in Budapest and the remaining 4 in major cities of the country.

The survey technician's license may also be attained upon completion of a correspondence course.

3.3 Graduate Surveying Engineers

The graduate surveying engineer constitutes the intermediate educational level. The admission requirement is either the final school-leaving certificate acquired at a higher school or the successful completion of the course at a higher technical school and the passing of an entrance examination. The course of study is offered both at the University for Forestry and Timber Industry in Sopron and the University Faculty for Surveying and Land Redistribution in Székesfehérvár and lasts 3 years. In addition to these intramural studies it is in this instance also possible to take a correspondence course.

The study course leads to qualification as a graduate engineer. A graduate engineer who passes the major diploma examination with at least "Good" may continue his studies at university by means of a correspondence course.

3.4 University Graduate Surveying Engineers

University graduate surveying engineers receive their training in the field of surveying in the Faculty for Civil Engineering and Building Construction at the Technical University of Budapest. The admission requirements are the same as those for the Engineering School and the objective of the study course is to produce highly qualified scientific personnel for the areas of geodesy, photogrammetry and cartography.

The duration of the course of study is 5 years and it is divided into 10 semesters. In this particular case it is also possible to choose the path of a correspondence course.

The curriculum of the basic study course envisages for the first four semesters joint classes in the four specialized subjects offered in the Faculty for Civil Engineering and Building Construction (specialized subjects pertaining to road and rail construction, hydraulic engineering, bridge construction and surveying). During this period and within the specialized area of surveying a considerable amount of time is dedicated solely to instruction in field surveying, while instruction in mechanics is kept to a minimum. In the latter years it is possible to specialize in two directions:

In the one direction it is the basic national tasks which are emphasized and in the other engineering geodetic tasks. In Hungary it is, however, assumed that a relatively small country with a low number of university graduate surveying engineers cannot afford to have geodesists who have specialized in the basic tasks and are not able to cope with engineering geodetic tasks whenever the circumstances so dictate.

The subject matter covered is organized as follows:

Basis subjects (25 %), geodetic subjects (47 %), other technical subjects (10 %), economic, legal and organizational studies (6 %), subsidiary subjects (foreign languages, etc.) (12 %).

During the 8th and 9th semesters 11 to 12 % of the hours available are dedicated to specialization; this means, in fact, that only 7 % of the total period of instruction is spent on specialization.

Upon passing the final examination and preparing the thesis, the successful candidate is awarded the title of university graduate civil engineer in the specialized area of surveying.

3.5 Future Types of Education

In view of the various difficulties and problems which have arisen in the Hungarian educational system attention has been turned during the last few years to the refinement and improvement of the multi-level system. Difficulties have been encountered in deciding on the content of the curriculum at the higher technical schools. On the one hand they should train technicians but on the other prepare pupils for study at the engineering schools and university. This discrepancy necessitates a revision of the curriculum at higher technical schools.

A considerable problem is posed at the university level by the fact that a number of students who have qualified at the three-year engineering school wish to continue their studies at university in order to attain a university engineering degree. This is only possible by means of a correspondence course and, although such students have already partially completed their specialized studies, the duration of the course of study is four years because of the important basic subjects, in particular mathematics. In other words, such non-university graduate engineers require a total of seven years in order to attain a university degree whereas students who commence their studies from the outset by taking the correspondence course at university acquire the university engineering degree after six years.

Reforms, which however will initially affect only the correspondence courses, are in preparation in an effort to eliminate this inconsistency. The aim is to introduce two-tier training in accordance with the so-called "Y Model". The stem of the Y denotes joint classes for 6 semesters; during this period the abilities of the student must be assessed and a decision reached about the tape of training he is to pursue. If he wishes to take a course of study leading to qualification as a (non-university) graduate engineer he selects the shorter arm of the Y and qualifies after a further two semesters. If he wishes to qualify as a university graduate engineer

he selects the other arm of the Y which entails a further six semesters and is awarded the university engineering degree after studying for a total of 12 semesters.

The curriculum for the 7th and 8th semesters in the case of graduate engineers is organized such that practical knowledge in the specialized areas is emphasized whereas the university graduate engineers deepen their theoretical knowledge in the corresponding phase.

Since the organization of the instruction in the correspondence course is based on conferences lasting two to three days which are generally held five times per semester, approximately 600 study hours are necessary for attaining the graduate engineer level. University graduate engineers are required to attend 900 hours in order to acquire their degree. In both cases additional time must be spent on the preparation of the thesis.

4. Other Professional Training and Further Educational Opportunities

All measures aimed at imparting new knowledge, methods and tasks on the level of the training already completed, thus constituting further education, are in principle coordinated by the "Council for the Education of Engineers" in which both the universities and the interested ministries are represented. At the Technical University of Budapest an institute of further education has been set up for the further education of survey specialists which holds, at irregular intervals, courses lasting about 14 days and covering certain subjects.

Correspondence courses are also held here for specialist engineers by means of which approximately 20 students are trained in specialized areas for the duration of two years.

Furthermore, events are still organized within the framework of "postgraduate study" by the Institute for the Education of Engineers and Executives of the Ministry for Agriculture and Food.

Lectures organized by the Hungarian Association for Geodesy and Cartography and courses held by geodetic enterprises in Hungary for their own employees, each having their own objectives, complete the wide range of opportunities offered for the further education of geodesists and cartographers.

5. Other Educational Opportunities

In addition to the study courses leading to qualification as a university graduate engineer, there is also the possibility of studying to qualify as a cartographer at the Budapest Roland-Eötvös University. Cartography does not, however, constitute an independent subject at this university; it is rather more a field of study. In other words, students who study the subjects geography/philosophy, geography/mathematics, geography/biology and geography/history in the third year may, if they drop the second subject, select cartography as a specialized area of study and upon successfully completing both disciplines receive a university degree in geography and cartography. Geology and geophysics students may take up cartography as a supplementary subject in their fourth or fifth year of study and thus acquire a university degree in geology/cartography or geophysics/cartography. The student is required to pass an examination before being entitled to commence cartography and the total duration of the course of study is 10 semesters.

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I T A L Y

1. General

According to the Italian law officially registered surveyors must own a diploma, issued by a state school after having passed an examination, approved by the "Consiglio Nazionale dei Geometri" (National Council of Italian Surveyors). The activities of a surveyor are governed by an essential factor: the size limitation of a project to be operated; the limits depend on the size of the area to be mapped, on the size of the town and buildings where a surveyor may give advice on planning. In case that a project exceeds these limits, the surveyor is obliged to cooperate with other colleagues under the responsible management of a civil engineer or architect.

The tasks of a surveyor are exactly defined by law. Surveyors work in the civil service as well as in free occupation or they are employed by others.

The surveyor's activities include the domain of topography, valuation, cadastral survey, hereditary affairs, property sharing, furthermore the surveyors have a function of a jurisdiction and assurance specialist, of an advisor and construction supervisor for public and private projects and of a manager of consulting and civil engineering companies.

The national mapping agency (Istituto Geographico Militare - IGM) produces maps with a largest scale of 1:25 000. Mapping at scales of 1:5 000 and larger is carried out by the Regional Districts ("Regioni") and other territorial institutions in cooperation with private companies (where many "Geometri" are employed), according to clear specifications laid down by the public authorities or other customers. Municipalities have no own offices of surveying and mapping except in the large cities. Land consolidation is a serious problem in Italy.

2. Structure of the Educational System

In Italy the geodetic education is almost exclusively given by 300 technical schools (Istituto Tecnico per Geometri) where a surveyor may achieve a so-called "Diploma di Perito").

One may also study at an university, but no geodetic faculties are offered. Only surveying courses can be subscribed in connection with architect-engineering and geological education.

The graduates of a university have the title of "Dottore" and they can be admitted to pass state-engineer examination.

The actual survey work is done for the 80% by the "Geometri".

3. Educational Levels and Qualifications

3.1 School Education

A five years elementary school visit is followed by a three years secondary school visit. Then one may attend a technical school. After the secondary school one may enter a higher school.

3.2 Geodetic Education

Approximately 300 state technical schools offer the education for surveyors; about 400 students are trained per year, secondary school finals are compulsory for the admission.

The study takes five years. The curriculum of the surveying schools essentially includes following subjects:

- mathematics, physics and chemistry
- construction technology
- agriculture
- construction planning
- surveying and photogrammetry.

One written and some oral examinations besides continuous tests and the final examination in different subjects have to be passed. The examinations are executed by qualified officials and some selected teachers. The National Council of the Italian Surveyors is also represented in the examination board.

After all passed examinations the "Diploma di Perito" is awarded.

3.3 Geodetic Courses at Universities

Following universities offer one year photogrammetric courses during the study of architecture and civil engineering:

- Politecnico di Milano
- Politecnico di Torino.

The whole study takes five years and leads to the title of a "Dottore".

Every Faculty of Engineering (12 in Italy) provides courses in Surveying for students in Civil Engineering.

Furthermore many organizations provide special surveying courses for surveyors and university graduates.

Today in Italy a three years new course ("Dottorato di Ricerca") for university graduates has been set up by law. Two centres for holding the courses of "Dottorato di Ricerca" in geodetic and cartographic sciences are foreseen.

4. Additional Professional Education

After two years of professional practice a state-examination can be passed and the title of an "Iscrizione Alto Professionale" (charted surveyor) can be acquire.

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Y U G O S L A V I A

St. Klak, Zagreb

Annotation

A detailed report on the geodetic education system has not been obtained for this publication. Therefore a shortened version of Prof. Dr.-Ing. St. Klak's paper (1977) is presented in the following.

The training of geodesists in Yugoslavia takes place at secondary and higher schools as well as at universities. There is one Faculty of Geodesy and 3 departments of geodesy at the Faculty of Civil Engineering. After graduation from secondary geodetic schools the degree of surveyor (geodetic technician) is awarded, after graduation from a higher school that of geodetic engineer and from a university that of dip.geodetic engineer.

Secondary geodetic schools last 4 years, higher geodetic schools 2 years and university courses last 4,5 - 5 years. There are also post-graduate courses in the duration of 2 years; after post-graduate studies the M.S. degree is awarded, which is a precondition for the awarding of the doctoral degree.

Graduate courses are of a general nature while post-graduate courses are divided into several specialized fields: higher geodesy, geodesy, cartography, photogrammetry, engineering geodesy, polyvalent cadastre. The condition for entrance into a secondary school is 8 years of primary school; applicants for higher geodetic schools must have graduate from a secondary technical school and for the university either from a secondary technical school or from a general secondary school (gymnasia) or a higher technical school.

University students attend about 30 hours of teaching a week, of which 50 % are lectures and the rest seminars, work in the field etc. The curricula of the 3 basic degrees do not contain specialized fields but only the essential elements of each course. An integral part of the teaching in these stages is practical work during the vacations either under the guidance of the teacher or in firms without the teacher.

Each academic year is divided into two and in some departments into three terms. Examinations at higher schools and university departments take place after the end of the term or during the term and in secondary technical

schools in accordance with the established system of work in such schools. Students can sit for an examination three times. In higher schools and universities students are required to have passed all, the examinations set for an academic year in order to be enrolled into the next year. This rule aims to prevent prolongation of university studies. Students are supplied with enough technical literature in their mother tongue; schools and universities have their own instruments for practical work and exercises and in some cases borrow them from various firms.

The fact should be mentioned that a new conception of training in all fields is being worked out at present which would provide for training combined with practical work. Instead of the established professions a new classification scale consisting of 11 degrees would be introduced. In it the IV. degree would correspond to the surveyor (secondary school), the VI. degree would replace the title of geodetic engineer, the VIII. degree that of dip.geod. engineer, the X. degree that of M.S. and the XI. degree that of doctor of engineering.

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L U X E M B O U R G

1. General

Since Luxembourg is a very small country the education of geodetic specialists is mainly carried out in the adjoining countries.

Topographical mapping is carried out by the IGN (France) with control and completion by the Luxembourg Cadastre and Topographical Survey Department.

All surveying specialists - with only some exceptions - are employed in civil services, as for instance at the administration of the cadastre and topography and at the town surveying, public work and railways.

2. Educational Levels and Qualifications

2.1 Survey Technician

The permission for cadastral administration work is granted by school leaving certificates of secondary general education schools. After 2 - 3 years of approved experience in practice the position of technician can be achieved.

2.2 University Graduate Engineer

Education is at a university or similar establishment in France, Switzerland or Germany. Today students do not study in France because of the difficulty in passing the concourse. They now prefer Lausanne, Bonn or Karlsruhe.

3. Further Educational Opportunities

Graduate engineers who were educated at universities abroad have to pass two approved years for recognition by State for cadastre. A practical examination has to be passed after these preparatory studies. Then cadastral work protected by law can be carried out.

ACKNOWLEDGEMENT

The authors are indebted to Mr. V. Poos for answering the questionnaire and his informative correspondence.

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THE NETHERLANDS

J. E. Alberda, Delft

1. General

In the Netherlands the majority of the survey specialists is employed by official agencies (state, province, community). In the private sector there are several firms which deal exclusively with survey work. Furthermore, various engineering offices or large firms which are also involved in building, agricultural engineering, aeronautics or in offshore industry have a department which functions as a survey company. Insofar as boundary survey and administrative processing are involved, cadastral surveying is implemented solely by the national cadastral service. The Dutch cadastre was originally a tax register but is now of a much greater significance with respect to legal guaranty, although from a legal point of view the geometric cadastral records constitute only a statutory presumption. The owner is responsible for the maintenance of boundary marks. The cadastre is responsible for the basic geodetic surveys (primary triangulation with densification levels of up to an interval of approximately 2.5 km between the control stations). Also falling under the competence of the cadastre is the production of large-scale thematic maps (1:1 000, occasionally 1:500) which are the result of project cooperation with the communes, provinces and other users (e.g. water, electricity and gas supply companies) effected on a contractual basis. The technical work is frequently implemented by private firms.

The responsibility for the national level control lies with the Ministry for Traffic and Hydraulic Engineering which has a large Survey Service. This Service likewise uses private firms to conduct some of its survey work.

In addition to the types of education in the specialized area of surveying which will be mentioned below, surveying is also taught at 15 higher technical schools in the form of field surveying for civil engineers. As of 1982 surveying will be virtually eliminated from the curriculum for civil engineers at the Technical University of Delft. The course of study for mining engineers at Delft comprises an elementary course in surveying.

The International Institute for Aerial Survey and Earth Sciences in Enschede (ITC) constitutes a special educational institute. This unique Institute is financed by the Ministry for Development Aid and has Major Departments for photogrammetry (including aerial photography and cartography), National Resources

Surveys in addition to Social Sciences and Integrated Surveys. A course in Mineral Exploration and Exploration Geophysics is also offered at the Institute. Most of the students come from developing countries. The courses lead to qualifications as operator up to Master of Science.

It is not necessary to have either a licence or to have passed a special examination to be eligible to conduct survey work in official authorities or on a self-employed basis. It is the objective of the national organizations of surveying engineers and survey technicians to promote surveying and its applications and to look after the general interests of the profession or of the members. These organizations have no authority or responsibility with respect to the implementation of surveying other than, for example, in the case of the Organization of Cadastral Surveyors, concerning themselves with working conditions and regulations within the cadastre.

2. Organization of the Educational System

In the Netherlands technical training is offered in general at four types of educational institutes:

LTS (Lower Technical School)
MTS (Intermediate Technical School)
HTS (Higher Technical School)
TH (Technical University).

At the lowest level, i.e. the LTS, no instruction is offered in the field of surveying. "Permeability" between these educational institute types is vertical.

The cadastre provides its own training course for cadastral technicians which is restricted to office work (drawing, calculation, administration). This particular training course will be discontinued in a few years because since 1976 the MTS has offered a training course which now produces the survey technicians for the work in question.

The foundation "NLF-Examens" was set up by four Organizations of Surveying Engineers and Survey Technicians with the objective of providing those persons who have received no school education in surveying with the possibility of acquiring a generally recognized diploma. For those persons who have found employment in a survey office in spite of the fact that they have received no technical training this opportunity is of special importance. The foundation does not offer training courses; it only holds examinations in which not only theory but

practical abilities are thoroughly examined. It awards the following diplomas:

- survey technician
- draftsman
- calculator
- survey assistant.

A Commission set up in 1981 is looking into whether the content, organization, finance and social significance of the examinations are in keeping with today's needs and possibilities. The examinations were introduced several decades ago by the NLF (Nederlandse Landmeetkundige Federatie). Following the discountinuation of the NLF in 1970 the name "NLF-Examens" (NLF Examinations) was kept as a generally recognized concept.

3. Educational Levels and Qualifications

3.1 School Education

School education commences at a 6-class primary school (for children aged 6 to 12 years). School is compulsory up to the age of 15. With the exception of those who attend lower technical schools, vocational schools, etc., pupils receive a general education. Subsequent to a transitional year the pupil chooses one of the following paths according to his interests and abilities:

1. MAVO (Intermediate general education)
   Duration (including transitional year) 4 years. As far as technical instruction is concerned this is followed by the MTS.

2. HAVO (Higher general education)
   Duration (including transitional year) 5 years. As far as technical instruction is concerned this is followed by the HTS.

3. VWO (Preparatory scientific instruction)
   Duration (including transitional year) 6 years. This is followed by university.

These three types of schools are usually accommodated together in a school centre. "Permeability" between the schools is both horizontal and vertical. A general "middle school" may yet be introduced in the future; this will depend very much on political developments.

3.2 Specialists with NLF Examination

There are no formal educational requirements for participation in NLF examinations. It is, however, desired that survey technicians, draftsmen and calculators have reached the MAVO level (incl. mathematics). The candidates must prepare themselves for the examination by means of private study, private lessons or correspondence courses. Proof of practical experience is required for entitlement to participation and this may be furnished in the form of a statement issued by the employer or instructor:

- Survey technicians: 100 days in the field as head of a survey team (horizontal control, property surveying, location survey, leveling)
- Draftsmen: 200 days of survey drawing
- Calculators: 100 days of computation
- Survey assistant: 2 years as survey assistant.

3.3 Qualification at Cadastral School

Training at the cadastral school lasts 1 1/2 years and concentrates on drawing, computation and administration tasks, i.e. all that is required for the cadastre. The admission qualification is the MAVO diploma. A small number of cadastre officials who have received this preparatory training at the cadastral school continue their studies at a later date by taking a course for survey technicians. Both types of training are in the process of being rescinded.

3.4 Qualification at the MTS

As a result of a proposal put forward by the NVG (Nederlandse Vereniging voor Geodesie) surveying was introduced in 1976 as a field of study at MTS level and has hitherto been offered as an alternative after a joint year covering construction of routes and hydraulic engineering. Instruction in surveying is offered at the MTS schools in Hengelo, Arnhem, Breda and Groningen. They hope to introduce independent departments for surveying. MAVO constitutes the necessary preparatory training. Duration of the course of study is four years of which the final year is spent on practical exercises.

3.5 Training Leading to Qualification as HTS-Surveying Engineer (ing.)

This training is offered only at the HTS in Utrecht. In principle, HAVO suffices as admission qualification but in practice it is barely adequate. Appro-

ximately 20 % of the incoming students have reached the VWO level. If a student who has qualified at the HAVO level receives a good report he may, upon conclusion of the first year at the HTS, be admitted to the first year at the Technical University in Delft. This "horizontal permeability" in the field of geodesy has to date not been possible in practice. The duration of the training course at the HTS is four years of which the third year is spent on practical work. The emphasis of the training is on the practical side and the qualification attained is the approximate equivalent of the Bachelor of Science in English-speaking countries. The teaching material is in general distributed throughout the course of the study as follows:

Languages (Dutch, English, German), physical training:	11 %
Mathematics, statistics, data processing, physics, error theory and adjustment:	18 %
Surveying, civil engineering, cartography, photogrammetry, land information systems, planning, land redistribution, jurisprudence, business management:	71 %

In the fourth year the student has a limited amount of choice.

Since 1980 the HTS in Utrecht has offered a special course in cartography which is organized in cooperation with the School for Graphical Professions in Utrecht. The first year takes the form of joint classes for cartography and surveying.

3.6 Education Leading to Qualification as Geodetic Engineer (ir.)

Courses of study in this field are offered at the Technical University of Delft. In 1948 the existing course leading to qualification as "civiellandmeter" (3 1/2 years) was extended to form a course of study in engineering. The Subdepartment for Geodesy, which was then created within the Department for Construction of Routes and Hydraulic Engineering was transformed into an independent department of the Technical University in 1975.

A description of the course of study is complicated by the fact that as of September 1982 university education in the Netherlands will be governed by a new law. In general, all academic courses will be divided into two phases. The first phase will last 4 years at the end of which the "doctoral-examen" will be taken. Successful candidates will be awarded the title "doctorandus" (drs.) in the case of (general) universities or "ingenieur" (ir.) in the case of tech-

nical universities. The first phase at the technical university is to constitute a complete engineering course. Graduates who pass the final examination are entitled to study for a post-graduate degree (jus promovendi). Upon completion of these four years most graduates gain employment. Only 20 to 30 % are admitted to the one-year second phase which offers the graduate the opportunity to specialize (e.g. research, design specialist, teacher, special occupations). The introduction of any variants of the second phase requires the specific approval of the Ministry.

The course of study in geodesy has until now lasted 5 years. In the new provisions it is laid down that the first phase (4 years) is to be run using only 70 % of the personnel employed under the 5-year programme to date. The course of study has had to be completely reorganized. As of 1982 the new programme will be introduced year by year; decisions have not yet, however, been completely finalized with the result that the ensuing descriptions are not definitive.

The new law specifies that an examination will be sat at the end of the first year. If the student fails to pass the examination after two years he is required to leave the Technical University. The entire programme of the first phase must be completed in a minimum of 6 years. or the five-year programme hitherto in operation the average time required by students for completion of studies was approximately 6.5 years.

In the new programme the course for "geodetisch ingenieur" continues to be characterized by both technical-mathematical and legal-planning-administrative disciplines. The programme commences with a basic course of study lasting approximately 2 1/2 years in which both groups of disciplines are covered. It is planned that each year shall comprise an average of 1 700 working hours (lectures, practical exercises and private study periods). Thus the basic course of study accounts for about 4 200 hours. A proposal has been put forward that the various groups of disciplines in general be divided as follows:

Basic course of study - 2 1/2 years

1. Mathematics and physics	15 %
2. Ellipsoidal and space geodesy, physical geodesy, marine geodesy	12 %
3. Statistics, adjustment calculation, optimization	14 %

4. Surveying, photogrammetry and remote sensing, science of instruments, physics of measurement	12 %
5. Land information systems, cartography	11 %
6. Planning geodesy, agriculture, town and rural planning	9 %
7. Jurisprudence	11 %
8. Social disciplines	4 %
9. Summer practical exercises, projects, computer practical	12 %

It is proposed that the reinforcement study course of the last 1 1/2 years be organized as follows:

From the geodetic discipline groups 2 to 6 the student chooses 500 hours each for two of the groups. Jurisprudence (7) is always taken with groups 5 and 6. In addition to this the student selects 600 hours for optical subjects and background studies which may be offered by other departments of the technical university. A further 400 hours are necessary for the professional practical work or a project and finally 600 hours for the thesis. In a nutshell:

Reinforcement study course - 1 1/2 years

Subjects from one of the groups 2 - 6	500 hours
Subjects from another of the groups 2 - 6	500 hours
Optional subjects, background studies	600 hours
Professional practical exercise or a project work	400 hours
Thesis	600 hours
	2 600 hours

The second phase will probably comprise two alternatives:

research or further training in technical planning which is to be set up in co-operation with the Department for Civil Engineering and Architecture/Urban Development.

4. Other Professional Training and Further Educational Opportunities

As mentioned above, "vertical permeability" is possible between the various technical education levels.

After several years spent on research and upon successfully upholding his thesis the "geodetisch ingenieur" may acquire a doctorate with the following title "Doctor of Technical Science".

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N O R W A Y

1. General

In Norway official surveying tasks including cadastral surveying are performed by the government, free professional surveying engineers mostly perform non-official surveys (engineering surveys, urban planning and municipal surveys). The free professional work does not require a license. The relation between official surveyors and free professional engineers is appr. 1 : 2,5.

2. Structure of the Educational System

The "Jordskiftetekniker" (surveying technician) demonstrates the lowest level in the Norway geodetic education system.

The "Ingeniør" is on a higher level and is educated at a higher technician school (technical college).

The civil engineers hold the highest level with a "Sivilingenioreksamen" as well as the surveyors "Jordskiftekandidat", both educated at universities.

"Cand. real." with a final degree including geodetic topics are educated at the universities in Oslo and Bergen.

3. Levels of Geodetic Education and Qualifications

3.1 School Education

After a nine years primary school there are two ways of further education. The first one leads to graduations as surveying technician or engineer respectively. The other possibility is the attendance at a secondary school with matriculation after three years.

3.2 Training Leading to Qualification as Technician

A two years education at "Jordskifteskolen" joins the primary school. It includes basic knowledge in control networks, topographic survey, geodetic

engineering survey and basic knowledge in photogrammetry. After the examination the title of a surveying technician is awarded.

3.3 Training Leading to Qualification as Engineer

Primary school graduates are educated for an engineer after a three years training at one of the eleven "Ingeniørhøgskoler" (Technical College), which are essentially construction engineering schools including surveying education. Only at one school (Gjøvik) the surveying technical education is considerably deepened by an additional semester. This education includes municipal surveying, laws, mathematics, data processing, general surveying, hydrography, photogrammetry, cartography, practical exercises and various other subjects.

After graduation the title "Ingeniør" is awarded.

3.4 University Graduate Engineer

The academic education is given at The Agricultural University of Norway (NLH), at The Norwegian Institute of Technology (NTH), and at the universities in Oslo and Bergen. Since the studies and graduations are considerably different a separated presentation is necessary.

3.4.1 Candidate of Agriculture

The title of a "Candidate of Agriculture" is to be awarded at The Agricultural University of Norway (NLH) after a five years study. Presumption is the secondary school certificate or the graduation as engineer. A technician needs supplementary studies for the admission to the NLH.

The first study year is a preparatory one which the student spends at an agricultural college outside the Agricultural University. During the first semesters lectures are given on history, chemistry, mathematics, economics, land use planning, geology, statistics, jurisprudence, data processing, land consolidation, surveying, photogrammetry, etc. In the further course of the study the education in surveying, data processing, photogrammetry and also geodesy is especially intensified. Three semesters are particularly reserved for practical surveying exercises. After the fifth semester theoretical geodesy, precision surveying, agricultural and cadastral surveying or photogrammetry can be deepened. The last semester is destined for the preparation of a thesis. Examinations are after each semester.

3.4.2 Civil Engineer

The title of a "Civil Engineer" is awarded at The Norwegian Institute of Technology (NTH) after a four and a half years study. The secondary school certificate or the graduation as engineer is the presumption for it.

The studies are divided into two parts. The first, which takes two years, covers the broad basis of the subjects of study (mainly mathematics and subjects from physics). It is common for all civil-engineering students. The second part, which takes 2 1/2 years, is devoted to a more specialized study. The student is free, within certain limitations, to choose subjects from a more extensive program of civil-engineering and surveying (surveying, photogrammetry, cartography, geodesy, applied geodesy, remote sensing, cartography and automation, etc.). Practical courses are performed in surveying and geodesy. Examinations are after each semester. The study is completed by presenting a thesis.

3.4.3 Cand.mag. (Bachelor of Science) and Cand.real. (Master of Science)

The academic titles of Bachelor and Master of Science are awarded at the universities of Oslo and Bergen by the Faculties of Mathematical and Natural Sciences. These universities do not cover a specific geodetic education, but they are those educational institutions which procure a geodetic education in natural sciences. The secondary school certificate and an examination in mathematics are the presumption for admission. The students are more or less free, depending on their own interests and future plans, to select for their studies subjects amongst a great many variously advanced courses within the range of subjects at the faculty. There is no special professorship in geodesy at the university, the lecturing being incorporated in the division of geophysics, and no fixed duration of the study (as an average 7 semesters undergraduate studies, 4 semesters for graduate studies).

The undergraduate study usually comprises mathematics, physics and geophysics to varying extents. The graduate study is directly aimed at the subject named "main subject", which can be selected amongst for instance: gravity, oceanography, meteorology, higher geodesy and so on, and which

at the final examination results in presenting a thesis. The title of Cand.mag. is awarded after the undergraduate study, the Cand.real. title after the graduate study.

4. Further Professional Education and Advanced Training

Since 1920 the NLH can confer a Doctorate degree: Doctor of Agriculture (Dr. agric.). The degree is obtained on the basis of approval of a thesis on some original contribution of science. No examination are required, but two lectures must be given, and the thesis must be defended.

Since 1979 NLH can confer a new Doctorate degree: Doctor Scientiarum (Dr. scient.).

The candidates must pass examinations in a number of subjects according to a curriculum worked out by a committee especially appointed for this purpose. A thesis must also be written and, subsequently, approved by the committee.

At the NTH there are two following possibilities:

The degree "doktor ingeniør" (dr.ing.) is based on examination and acceptance of a thesis. The course is designed to take 2 1/2 years. Dr.ing. studies began in 1975, and in 1979-80 courses in 184 subjects were offered. These are at higher level than those offered in the ordinary curriculum. In autumn 1980 there were all together 300 dr.ing. candidates at NTH.

To obtain the degree "doctor technica" (dr.techn.) the candidate must prepare a more substantial scientific thesis. This thesis should be an original and independent contribution to the subject. The candidate must also give two test lectures, one on a topic of his own choice and one on a topic named by the university. In addition he must defend his thesis.

5. Further Remarks

State loans are available to students studying abroad and there are special fellowships to assist mature persons to make additional studies some time after qualification.

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P O L A N D

M. K. Szacherska

1. General Information

The actual model of education in surveying and geodesy in Poland is the result of a long historical development. Already at the first university, founded in Cracow in 1364, surveying was taught in the 15th century at the chair of mathematics, since 1450 by an eminent Polish mathematician and astronomer Martin Król, known abroad as Martin the Pole.

The oldest Polish textbooks of practical geometry, that is surveying, where written in Latin but in 1566 a first manual of surveying in Polish was published by Stanislaw Grzepski under the title "Geometry that is the science of surveying" (Geometria to jest miernicka nauka). This useful work, introducing Polish surveying terminology, was soon followed by other textbooks, which cannot all be discussed here.

It is thanks to the initiative to professor Jan Brożek, physician, astronomer, mathematician and geodesist, that a special chair of surveying was founded in 1631 at the University of Cracow. The foundation act establishes the number of lectures and of practical exercises with instruments to be made by the students at convenient places outside the town. It was further stipulated in the same act that the students ought to be taught the newest scientific methods, based among others on the trigonometry of Snellius, whose "Doctrinae triangulorum" had been published only four years earlier.

We shall not dwell here on the further development of surveying education in Poland. We have, however, to mention that the first strictly technical university was founded in Warsaw in 1818. The model of education in sciences and technology elaborated and adopted then, was applied also to surveying and geodesy. This model - modified of course according to the development of technology and changes in the organization of work - is till now actual.

2. Organization of the Educational System

An efficient organization of surveying practice and research requires the training of specialists in all the branches of geodesy and surveying; the level of their professional education ought to be differentiated. These requirements were

taken into consideration when establishing the structure of education in Poland. The general model comprises three levels.

Education at the secondary professional level is given at technical colleges of surveying, the final certificate of which qualifies for employment as surveying technician or admission to studies at a technical university. Education at a general high school may also be completed at a school of surveying in order to be qualified as technician.

Studies at a higher professional school (Wyższa Szkola Inżynierska) lead to the award of the professional title of engineer of surveying (inżynier mierniczy) which in the British system corresponds to the bachelor of surveying. The degree may be obtained also after completing university studies according to a reduced professional programme.

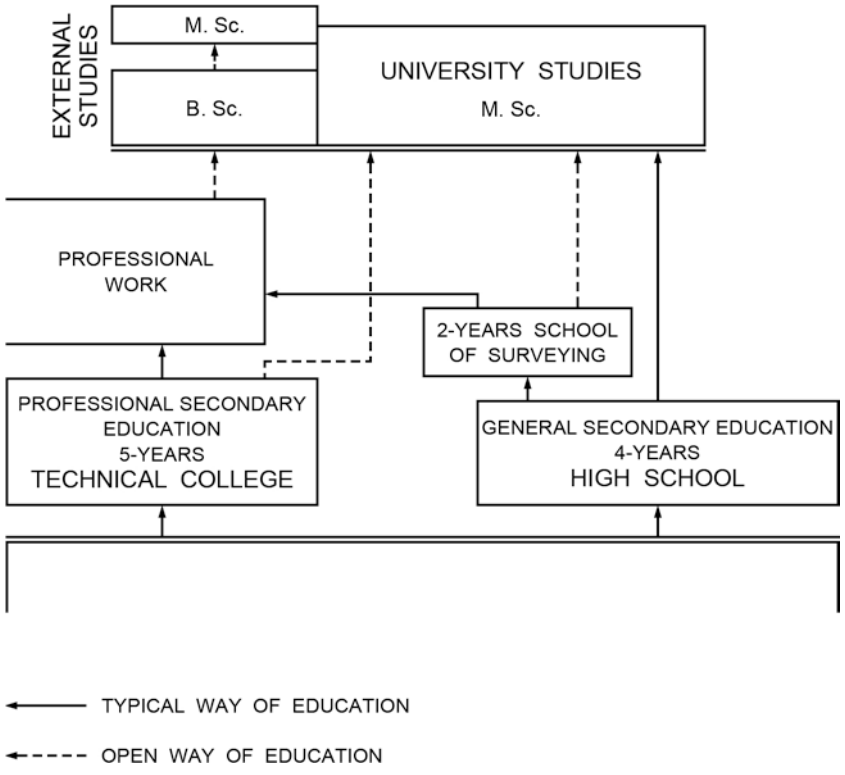

Fig. 1 Scheme of education in surveying and geodesy in Poland

University education is offered at technical or agricultural universities, by independent faculties of surveying and geodesy or departments of surveying at the faculties of civil engineering or agriculture. The studies last 4.5 to 5 years after which the candidate, having submitted a dissertation, is awarded a degree which may be translated in English as dipl. engineer or master or surveying (master inżynier).

Within the frame of this general model certain modification were introduced at different periods in the organizational system of education. The actual organizational system is shown by fig. 1.

3. Educational Levels and Qualifications

3.1 Professional Education for Technicians

The objective of technical colleges is to prepare professionally qualified technicians, able to carry out independently and elaborate simple measurements, as well as to participate as assistants in observations of highest precision and in the mathematical and graphical elaboration of their results. In the programme of these schools emphasis is laid on practical surveying, use of instruments and equipment.

The degree of a qualified technician of surveying can be obtained in two types of schools. The first one is a technical college of surveying of 5 years. The course in such schools lasts a year longer than in general high schools, as professional subjects completed by practical exercises are taught besides the general ones. The final certificate entitles to professional work or to further studies at a university, theoretically at any faculty, in practice, however, foremost at the faculties of surveying or of civil engineering, since mathematics, physics and measuring technique prevail in the programme of the schools of surveying.

About fifteen years ago a second curriculum of training technicians of surveying has been introduced. Young people having finished a general high school of 4 years, may follow a course at a school of surveying of 2 years. This system is convenient for those who have not chosen a profession earlier or are not able to undertake studies at a university. The course gives the same professional qualifications as the technical college and does not exclude subsequent university studies.

The second model of training technicians of surveying is considered at present the more effective, as it secures a fuller general as well as the professional education of the candidates and permits them to make at the age of 19 years a more mature choice of their future career. Technical schools of surveying of one of the above mentioned types are established in several towns (fig. 2), but the second type may prevail in future.

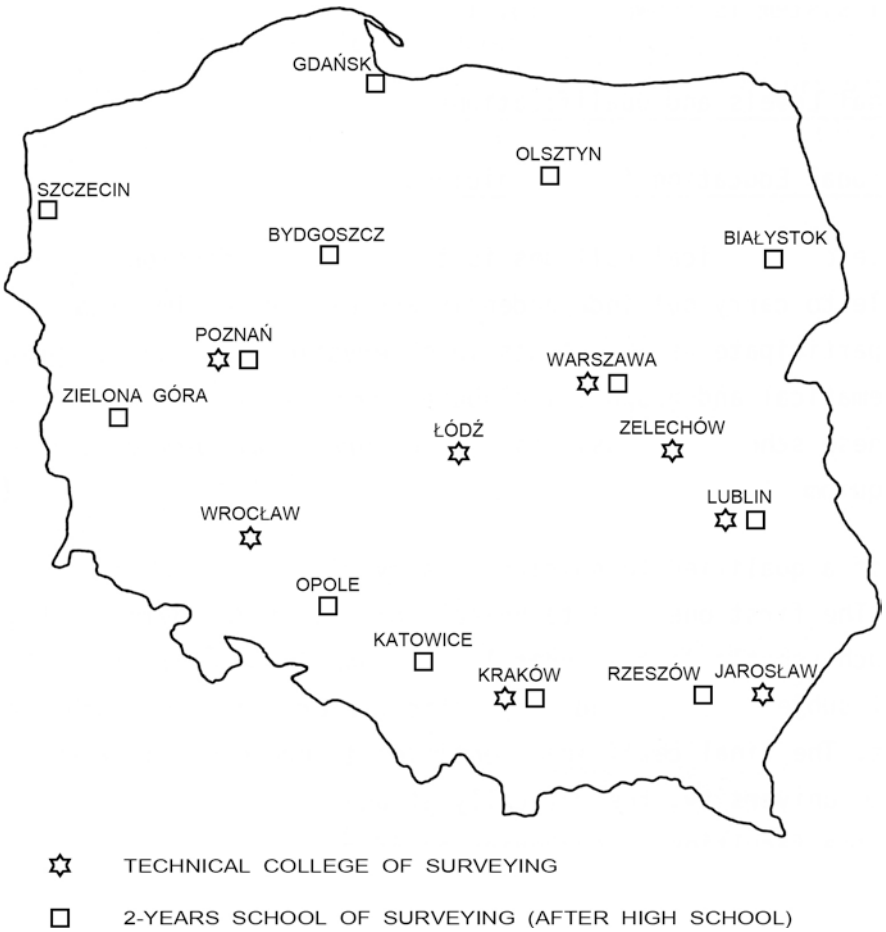

Fig. 2 Professional schools of surveying

3.2 University Education

Education in surveying and geodesy of higher level is provided in Poland by several technical and agricultural universities. We distinguish here the three following forms of organization: faculties, departments and institutes. A faculty of surveying or geodesy is a basic independent unit within the frame of the organization of a university. Such faculties are functioning at the Technical

University of Warsaw, the University of Mining and Metallurgy in Cracow and the Agricultural and Technical University of Olsztyn (fig. 3). Departments of surveying are functioning in two Agricultural and Technical Universities in Cracow and Wroclaw (fig. 3). These departments are, with regard to their organization, subordinated to one of the faculties of the universities. At the institutes of surveying functioning at some other technical universities, generally within the frame of the faculty of civil engineering, the students can specialize in applied surveying.

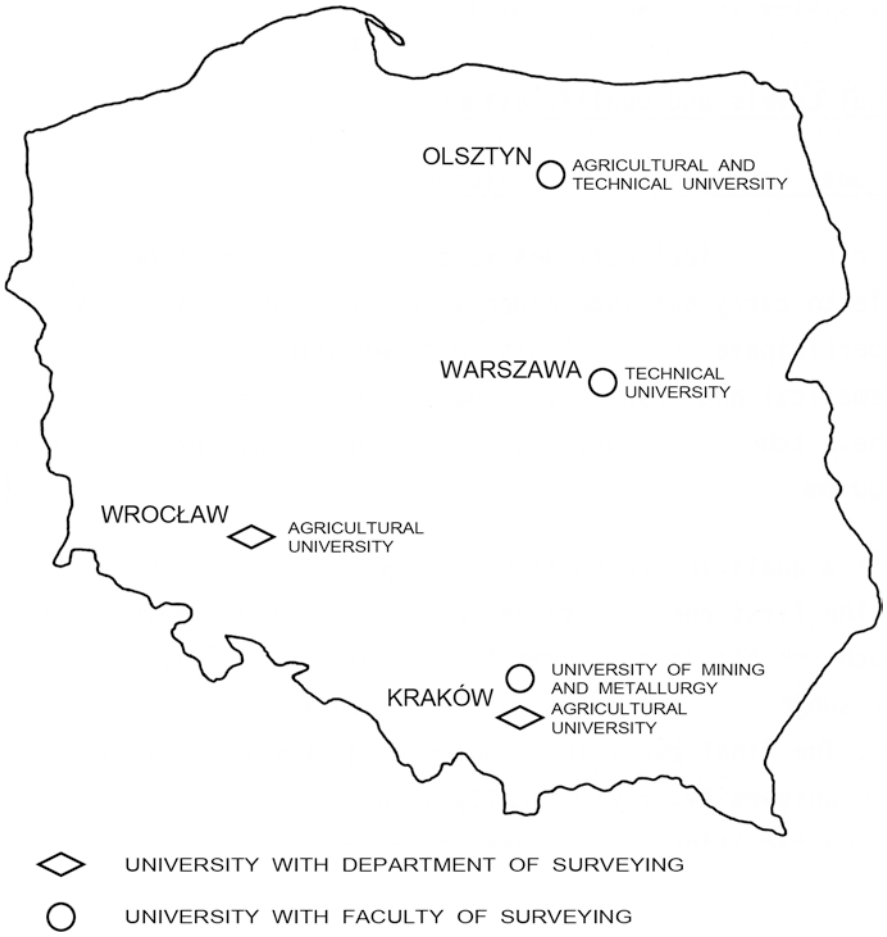

Fig. 3 Universities with faculties or departments of surveying and geodesy

An applicant for admission to university studies must have finished a general high school or a technical college and lodge the relevant certificate. His entry depends on the result of a competitive examination which, for the admission to the study of surveying and geodesy, includes mathematics, physics and a foreign language. A good state of health is also required of future surveyors.

Two types of university education of different levels were established at first. A course of professional study of 4 years led to the degree of engineer (inżynier) corresponding to the bachelor of surveying and qualified for various forms of surveying practice. A curriculum of 5 years was designed to give a broader theoretical and mathematical knowledge to the candidates who, having passed a final examination and presented a thesis, were admitted to the degree of master of science (magister inżynier).

About twenty five years ago the actual continuous course of studies of surveying and geodesy was introduced which extends over 10 or 9 semesters (5 or 4.5 years). The students are required to pass examination in the principal subjects in order to be admitted to every next year. On the basis of a final examination and a submitted thesis they are awarded the degree of master of science (magister inżynier).

As the faculties, departments and institutes of surveying and geodesy are functioning in technical and agricultural universities, their programme depends in some measure on the type of the university. At the particular universities students can specialize in the following branches of surveying and geodesy:

- theoretical geodesy and precision networks,
- photogrammetry,
- cartography,
- applied and engineering surveying,
- mining surveying,
- land planning and cadastre.

The first two years of studies are common to all the students of surveying. Emphasis is laid in the teaching programme on a thorough instruction in the basic scientific subjects, among which mathematics are of particular importance. During the first 2 years all the students pursue also a course of the fundamental knowledge and professional training indispensable to every surveyor.

It is in the third year of the studies that the courses for the specialization begin. Since every surveyor needs a sound background knowledge of the whole field of surveying and geodesy, the courses in the various specializations are planned in such a way that the lectures and tutorials of the early part of the specializing courses are common, as far as possible, to all the specializations. Besides the basic theoretical and strictly professional subjects a number of auxiliary subjects is taught, which are adapted to the needs of different specializations.

Practical exercises and field work ensure the professional development of the students and are therefore important elements of the education in surveying. After every year of the studies, during the long vacations, one month of practical field work in surveying or geodesy is organized and constitutes a condition of the credit for the relevant subject.

The course of studies is crowned by the master's thesis. The teaching staff proposes the themes of the thesis, mostly with regard to the needs of surveying practice. The students choose the themes in the middle of the fourth year of studies.

4. Other Educational Opportunities

Persons who for some reasons are unable to study at a university, having mostly started work immediately after finishing a high school or a technical college, may pursue external studies lasting 4 years (fig. 1). A certificate that the applicant is since several years engaged in surveying practice is therefore required. The external studies are based on consultations and lectures at regular intervals (usually 3 days a month), study guides, reading lists and written exercises. The studies can be thus pursued without interrupting professional work. After a qualifying examination external students obtain the degree of bachelor of surveying.

For the same purpose of broadening the theoretical knowledge and improving the qualifications of engineers of surveying with practical experience gained during many years of professional work, complementary external studies of 2 years were established (fig. 1). The course is organized as the above mentioned one. An examination and the submission of a thesis lead to the degree of master of surveying.

5. Professional and Scientific Degrees

Table 1 contains a list of the professional and scientific degrees and titles awarded in Poland together with the corresponding ones in English and German. In this table the conditions to be fulfilled by the candidates for the professional and scientific degrees are also enumerated as well as the employment to which the particular degree entitles. The two lower degrees of bachelor of science (inżynier, abbr.: inż.) and of master of science (magister inżynier, abbr.: inż.) are obtained on the basis of professional external or university studies, the programme of which has been already discussed here.

SCIENTIFIC OR PROFESSIONAL DEGREE	REQUIREMENTS	ACCESSIBLE EMPLOYMENT	EQUIVALENT TITLE	
			U.K.	F.R.G.
DR. HABIL. INŻ.	10 SCIENTIFIC WORKS PUBLISHED SINCE Ph.D.; PUBLISHED DISSERTATION (ORIGINAL AND DISTINGUISHED CONTRIBUTION TO KNOWLEDGE); PUBLIC LECTURE AND EXAMINATION BY THE FACULTY BOARD	ASOCIATE PROFESSOR (DOCENT) OR PROFESOR AT THE UNIVERSITY	D.Sc.	DR. HABIL.-ING.
DR. INŻ.	SEVERAL PUBLISHED CONTRIBUTIONS; DISSERTATION (BASED ON ORIGINAL RESEARCH) DISCUSSED AT A PUBLIC SESSION; EXAMINATIONS IN SURVEYING SPECIALIZATION, ECONOMICS AND A FOREIGN LANGUAGE	LECTURER (ADIUNKT) AT THE UNIVERSITY	Ph.D.	DR.-ING.
MGR. INŻ.	5- OR 4.5-YEARS UNIVERSITY STUDIES; MASTER'S THESIS AND FINAL EXAMINATION	TUTOR (ASYSTENT) AT THE UNIVERSITY	M.Sc.	DIPL.-ING.
INŻ.	4-YEARS UNIVERSITY STUDIES; PROFESSIONAL THESIS AND FINAL EXAMINATION	PROFESSIONAL EMPLOYMENT	B.Sc.	ING.

Table 1 Scientific or professional degrees and accessible employment

For the scientific degree of doctor of surveying (doktor inżynier, abbr.: dr inż) examination in the chosen specialization, philosophy or economics and a foreign language are compulsory. The candidate is not obliged to purpose a course of study, but his investigations are sponsored by a professor from whom he receives consultations. He must present several published contributions and submit a dissertation based on original research which he has to discuss at a public session.

The higher doctorate - in Poland the degree of doctor habilitatus (doktor habilitowany, abbr.: dr habil.inż) - compulsory for professors, is not preceded by any organized, only personal studies. For the award of this degree 10 scientific works, published after the first doctorate, a dissertation which must constitute an original and distinguished contribution to knowledge, a public lecture and an examination by the Faculty Board are required.

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P O R T U G A L

J.P. Osório, Vila Nova de Gaia

1. General

The studies leading to the University degree of a Surveying Engineer are the main educational scheme in the field of surveying in Portugal. These studies are offered by the Science Faculties of 3 Portuguese Universities: Lisbon, Coimbra and Porto.

An intermediate level diploma in Hydrography and Oceanography may be obtained after a 1 year study at the Hydrographic Institute in Lisbon. A specialization in Hydrography may be acquired at the same institute also after a period of education of 1 year.

Finally, the preparation of technicians takes place at the "Instituto Geográfico e Cadastral" in Lisbon. There are two levels of education corresponding to studies lasting for 1 or 2 years. Admission is restricted to students with a certain level of high school studies.

The "Instituto Geográfico e Cadastral" is the main agency in the country with responsibilities in surveying. Among its tasks are the determination and maintenance of the national horizontal and vertical control networks, the establishment of boundary cadastre, the production of official maps, etc. Therefore, it is the institution that gives more employment to surveying engineers.

The surveying workforce is also employed in other official agencies and public enterprises: Local, Road, Water, Energy, Forestry and Agriculture authorities, Railways, Aeronautics, etc. There is still some private work.

2. Structure of the Educational System

The educational system in Portugal may be divided in the following levels: primary school (4 years), preparatory school (2 years), secondary school (3, 5 or 6 years) and University. Compulsory education takes now 6 years.

The preparation of technicians of surveying takes place after the 9th- or the 11th-class of secondary school.

Finally, the professional title of Surveying Engineer is awarded after 5 years (10 semesters) of studies at the University. A certificate of the 12th-class of secondary school is a required condition for entrance to the University.

3. Education Levels

3.1 School Education

The compulsory education in Portugal comprises mow the 4 years of primary school, followed by the 2 years of preparatory school.

A general course of secondary level can be taken 3 years at the secondary school (approval in the 9th-class) and a complementary course after 2 more years (approval in the 11th-class). For entrance to the University one extra year is required (approval in the 12th-class).

3.2 Training for Qualification as a Technician

As far as I know, the preparation of technicians in areas of surveying takes place only at the "Instituto Geográfico e Cadastral" and at the "Instituto Hidrográfico".

3.2.1 Instituto Geográfico e Cadastral

At this Institute the following courses are offered:

- Survey technician,
- Operator of photogrammetric restitution,
- Topographic and cartographic designer.

These courses, taken by students with certificate of the 9th-class of high school, are organized with time duration of 1 or 2 years, giving rise to 2 different levels of education. In some cases, students should get some practice during a 3-months period in an adequate service of the Institute.

In recent years, the Institute has cooperated with the Ministry of Education in the scope of the 12th-class - professional education, with courses in Topography and Photogrammetry. The duration is 1 year and the courses may be taken by students with certificate of the 11th-class.

3.2.2 Instituto Hidrográfico

A technical 1-year course is also held at the "Instituto Hidrográfico", in the fields of Hydrography and Oceanography. It leads to the Diploma of Hydrographic Technician - level B of International Hydrographic Bureau. Admission condition is the certificate of the 11th-class.

3.3 University

As it was said before, the more specific degree in surveying awarded in Portugal is at the University level, giving rise to the professional title of Surveying Engineer. It is taken after 5-years University studies, and for entrance to the University it is required the certificate of high school 12th-class.

Studies in Surveying Engineering are at present offered by the Science Faculties of Lisbon, Coimbra and Porto. Although some small differences in details, the basic structure of the 3 courses is rather similar: 3 years of basic studies in areas of Mathematics, Physics, Geology, Computation and Astronomy; 2 years of more specialized subjects covering fields of Geodesy, Topography, Geodetical Astronomy, Photogrammetry, Cartography, etc. In some cases a project lasting for 1 or 2 semesters is also included in the last year.

The 3 Science Faculties may also award Ph.D. degrees, after a few years of work leading to an original thesis in a subject of the area of our science. People presenting this habilitation may be appointed as an University Lecturer.

3.4 Other Educational Opportunity

The Hydrographic Institute is also prepared to give a specialization in Hydrography. The corresponding course of 1-year duration may be taken by Naval Officers or B.Sc. degrees in Mathematics, Physics, etc.

THE REPUBLIC OF IRELAND

R.C. Cox, Dublin

1. General

In the Republic of Ireland land surveying is carried out by state agencies, semi-state bodies, and by private firms.

Responsibility for geodetic control, level networks and mapping down to a scale of 1:1,000 in urban areas and 1:2,500 in the remaining areas in the Republic of Ireland falls within the jurisdiction of the Ordnance Survey of Ireland, which itself is responsible to the Government Department of Finance.

Other state agencies involved in land surveying include the Geological Survey, Forestry and Wildlife Service, Office of Public Works and Local Authorities (thirty County administrative areas, together with urban and city authorities in major centres of population such as Dublin, Cork, Limerick and Galway). The Institute for Advanced Studies is involved in gravity measurements. Semi-state bodies exist for the operation of services on a national scale, including electricity, natural gas, peat fuel, rail, road, sea and air transportation, post and telecommunications.

Private surveying is organized in a limited number of small firms working in engineering and developmental projects. In accordance with government policy, the Ordnance Survey Office also bids for contract work in the private sector.

Legislation affecting the right to practice surveying in the Republic of Ireland is restricted to a few mining surveyors.

The Registration of Title system in the Republic of Ireland is administrated by the Land Registry Office of the Department of Justice. The Commissioner of Valuation holds the title of Director of the Ordnance Survey, although the Assistant Director of the O.S. is in practice the administrative head of the national survey organization. The Land Registry uses the O.S. plans as index diagrams and boundary disputes are resolved by ad hoc decisions of the Courts of Law. The nonconclusive boundary system instituted in the nineteenth century has not, as in other countries, required the services of licensed cadastral surveyors. In the absence of "primogenitum" or similar restrictions large scale sub-division of properties is taking place - most sub-division

boundaries being mapped by unlicensed surveyors.

The English "General Boundary Rule" is not part of the Irish legal system - boundaries are termed non-conclusive, as were the English boundaries under the (English) 1875 Act. The Irish Land Commission has had its own land surveyors since 1881 and has had a major role to play with regard to rent-fixing, tenant purchasing, land acquisition, land distribution, etc. on behalf of the state. Over 90 % of the rural land of the state has passed through the hands of the Irish Land Commission since 1881 and is now held in freehold by the occupiers. All lands acquired by the Land Commission under the various Land Acts must be registered at the Land Registry Office. In the case of unregistered land, largely in urban areas, the deed is registered.

Representation of the Republic of Ireland to international organizations such as the FIG and IAG is currently organized either via the Society of Chartered Surveyors in the Republic of Ireland (previously known as the Royal Institution of Chartered Surveyors, Republic of Ireland Branch), the Irish Society of Surveying and Photogrammetry, or the Institute for Advanced Studies.

2. General Structure of Education

2.1 Schools

In the Republic of Ireland 50 % of the population is currently under the age of 25. Education is compulsory between the ages of six and fifteen, with the majority beginning at 4 years; assessment of standards is by means of public examinations and inspection, both conducted by the government Ministry of Education. The system is an 'aided' system in that most schools at first and second levels are owned by private, usually church, agencies though funded predominantly by public money.

2.2 Survey Education

The following remarks pertain only to those branches of surveying covered by the IAG study, described under the various titles - "geodetic, topographic, engineering, cadastral, hydrographic, mining and land surveying". In Ireland the title "geodesy" applies only to "higher geodesy".

Formal technical education in a range of subjects is provided by the following institutions:
(1) regional technical colleges
(2) institutes of higher education
(3) universities.

The Royal Institution of Chartered Surveyors still holds private examinations in Dublin for a small number of Irish candidates.

3. Educational Levels and Qualifications

3.1 School Education is Structured as Follows:

i) six years primary school,
ii) three years junior cycle postprimary taken at a secondary grammar, secondary vocational or a comprehensive school,
iii) two or three years senior cycle terminating in a School Leaving Certificate which provides access to and selection for higher education.

Grades of honours are awarded from C to A in ascending order of quality. A typical third level institution will demand at least five honours (grade 'C' minimum) for entrance to surveying related courses, two of which must be in mathematics and a science subject or their equivalent, although entry to some technician courses may be at a lower level.

Applications from school leavers to enter universities and institutes of higher education and technology are handled by a Central Application Office (CAO) organized by the institutions of higher education. Applicants may be subject to interview and/or aptitude tests by the Departments concerned, which restrict entry to the places available. Entry to regional technical colleges is via a similar, but independent, process.

Primary degrees in the Republic of Ireland are awarded at five different grades in ascending order of merit: pass, third class, lower second class, upper second class and first class. Only the last two classes are generally acceptable for continued studies for Masters and Doctorate degrees.

3.2 Technician Studies

The education of technicians at regional technical colleges, and colleges of technology is organized by Vocational Educational Committees (VEC) and courses are validated by the National Council for Educational Awards (NCEA). Two levels of technicians are identified after two (Certificate) or three (Diploma) years of full-time study or four or six years of part-time study, after passing the Leaving Certificate examinations or equivalent. A number of Regional Technical Colleges provide Certificate/Diploma courses in such areas as Civil Engineering

and Construction, which contain a significant amount of surveying studies. One College of Technology offers a full-time Certificate/Diploma course in Geo-Surveying. Subjects studied include Engineering Surveying, Photogrammetry, Mine Surveying, Computer Applications and Cartography.

Technical training of its survey personnel is currently carried out as needs arise by the Ordnance Survey in its own survey school.

3.3 Universities

Four universities in the state offer primary degree courses (BAI or BE) in Civil Engineering, all of which include courses in Surveying, ranging from one to two years duration. There are currently no specialist primary or graduate degree courses in surveying/geodesy offered by any institution in the Republic of Ireland.

4. Research

The various educational establishments engage in limited research work; students may read for masters degrees in two years or doctorates in three years minimum. Specializations depend on the particular academic staff concerned and studies usually last longer than the minimum period prescribed.

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R O M A N I A

N. Oprescu, N. Zegheru, Bucharest

1. General

In Romania, surveying, mapping and cadastre meeting the present and future requirements, tasks and activities have been established on local and national (central) levels. There is a close connection to our increasing national economic development. Originally, surveying was mainly applied to the field of rural economy. However, since the investments in industry and infrastructure have been developed continuously, the various fields of surveying had to meet a great variety of special demands.

Surveying is applied to almost all realms and stages of the large investments in our country, in order to solve problems and tasks of country mapping, basic topographic plans, triangulation and levelling networks and cadastre. Photogrammetry, cartography and some other specialized techniques have been extensively used for topographic maps as required by the development of a modern agriculture including irrigation and by the planning of cities and other densely populated areas. This field of activity, one of the oldest of all, not only in our country but all over the world, has been constantly developed in Romania as a consequence of the increasing importance of economics.

Monitoring and recording procedures have been established for soil cultivation and natural vegetation, lakes and coastal waters, sea and geothermal resources, deposits of minerals and hydrocarbons, etc. Those procedures are based on various kinds of information systems including satellite remote sensing and automatic compilation of the thematic maps, considering quantitative and qualitative information.

These surveying methods and techniques have been considerably improved. It has been achieved to execute even complex tasks with more precision and better quality in less time.

2. Structure of the Educational System

In Romania the general school education takes 12 years. There is no differentiation during the first 8 years. Then one has to pass an examination to enter either a mathematical-physical and humanistic lycée or a technical secondary

school. After the 10th class another examination has to be passed for entering the 11th and 12th classes; finally, a school-leaving examination completes this education.

Some technical secondary schools are specialized in topography during the 11th and 12th classes with a special curriculum. After the school-leaving examination, the candidate may pass an examination to enter a faculty at the university, civil engineering and higher education institutes.

The faculties are divided into sections and special fields. Geodetic education with a long tradition is a well-established special field and belongs to the higher education branches. Geodetic engineers, cadastral technicians and mining topographic technicians can be educated; they may attend day and evening lectures.

Technical secondary schools, faculties, sections and special fields for agriculture, forestry, construction (civil and industrial engineering, hydrotechnical engineering, railways, roads, bridges, urban engineering) and mining have included topography in their curriculum. Thus the specialists are in a position to carry out basic topographic work for the respective field of activity. Informative topographic and cartographic lectures have also been included into the curriculum of the universities' geographical-geological faculties.

3. Education Levels and Qualifications

3.1 Training Leading to Qualification as Technician

School-leavers of a technical secondary school, e.g. the 11th and 12th classes in topography, are employed as topographic workers. After a compulsory working-period and according to their qualifications, they may promote as topographic technicians.

3.2 Training Leading to Qualification as Engineer; University Graduate Engineer

Geodetic education for cadastral technicians and geodetic engineers is a separate department at the College of Civil Engineering in Bucharest; the education of mining topographic technicians takes place at the Mining Institute.

The undergraduate education takes 3 years: basic knowledge 8.4 %, general technical knowledge 9.4 %, special subject knowledge 31.3 %, general economic and legal knowledge 11 %. The ratio of lecture and practical application activities is 38:62. This ratio may been change to 23:77 if the hours in design and research workrooms, as well as the practice in production are added to the practical courses.

The education of a graduate engineer to be specialized in the field of geodesy takes 4 years with the following structure: Basic knowledge 31.3 %, general economic and legal knowledge 11.6 %. The ratio of lectures and practical application activities is 43:57. If the number of hours in design and research workrooms and productive activities is taken into consideration the ration may rise to 28:42.

The last term in the education of engineers and technicians is reserved for the thesis.

4. Further Vocational Training and Education

After the compulsory probation time in production, the geodetic engineer has the opportunity to make his doctor's degree. It takes 3 years at the university or 4 years for extramural studies.

After the examinations and presentations of the compulsory papers required by the curriculum, the candidate for promotion has to present his thesis. Furthermore, he has to hold an oral dissertation in presence of the commission that award his doctor's degree.

The Geodetic Department at the College of Civil Engineering in Bucharest offers one year's lectures for postgraduates. Two examinations have to be passed at the faculty and a final paper has to be presented to the commission.

Other means to enhance qualification and to improve experience and knowledge are:

- lectureship and special seminars
- technology transfer by specialists, exchange of experience etc.

Furthermore, one may state that the cooperation with mathematicians specialized in computer and electronic science is perfect.

S P A I N

M.J. Sevilla, Madrid

The Spanish educational system in the fields of geodesy and survey is a very simple one. There are, essentially, two levels of professional training:

(1) technician engineers
(2) university graduates (Master of Science degrees).

1. Technician Engineers

The studies for technician engineers are conducted at the Technical Colleges of Surveying. These colleges constitute official training centers under the authority of the Ministry of Education (at present, a nonofficial center is being founded) which are associated with the Polytechnic Universities.

Admission qualification requirements include passing in the universally valid school-leaving examination of a general secondary school plus an orientation course of instruction to be attended at a university.

Professional training covers a three-year period. Subsequent to its completion and the presentation of a dissertation, the student is confirmed as or awarded the certification as Technician Engineer in Survey.

The courses of instruction - each course extending over a one-year period - comprise the following subjects (at the Escuela de Madrid):
Mathematics, Engineering drawing, Physics, Map reading and aerial photograph interpretation, Presentation systems, Topographic surveying instruments and methods, Geomorphology, Geodetic astronomy, Photogrammetry, Mapping and Charting, Cadastre and legislation, Geodesy and map projections, Technical topographical office, Geophysics, Topography of structures, Cartographic techniques.

2. University Graduates

This requires an academic degree in geodetic studies. The studies are conducted in the science (mathematics or physics) departments of the universities, i.e., official centers under the authority of the Ministry of Education.

Admission qualification requirements include passing the universally valid school-leaving examination of a secondary school plus an orientation course of instruction to be taken at a university.

Professional training covers a five-year period. Subsequent to its completion and the presentation of a dissertation, or to the final examination (optional), the student is confirmed as or awarded the certification as graduate scientist (technical specialty: geodesy) (Master of Geodetic Science).

These five courses of instruction are subdivided into two cycles: a three-year cycle for all joint technical specialties of a university department and a two-year cycle of specialized studies.

For example, the mathematical sciences department (technical specialties: astronomy and geodesy) of Complutense University in Madrid offers the following subjects:
Mathematical analysis, Geometry, Probability calculus and statistics, Topology, Astronomy, Equations with partial derivatives, Geodesy, Theory of errors, Cartography, Celestial mechanics.

Institute of technology graduates in topography may attend a fourth course of instruction of the training offered by the mathematical sciences departments (technical specialties: astronomy and geodesy) after having passed, in the respective department, an adaptive course comprising compulsory subjects plus one optional subject.

3. Further Education

Present curriculums of several technical universities include, in various technical fields, such subjects as, e.g., topography astronomy and geodesy, geodesy and topography, which are offered only for four- and/or eight-month periods. Therefore, training of this type cannot be regarded as a component of technical training in geodesy, but merely constitutes supplementary training within the respective technical field.

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S W E D E N

Peter Hodacs, Uppsala

1. Brief History and General

The Swedish Land Survey was founded in 1628 when King Gustaf II Adolf instructed the cartographer Anders Bure to establish a state organization, for the purpose of surveying the entire Swedish Kingdom and investigate the potential for economic development.

Bure started at once with educating a small group of pupils, most of them having studied mathematics, astronomy, geometry and similar subjects at the University of Uppsala.

The first result of the geometric surveying was the Geometric Land Books containing maps of villages and their estate. The maps were made towards the middle of the 17th century and comprised most of the infields of the country.

From the middle of the 17th century a period of intensive geographic surveying followed. Regulations concerning the geographic mapping were issued in 1643. Detailed instructions for geographic mapping followed in 1688. From the first decades of the 18th century the activities of the Land Survey were affected by policy charges which resulted in emphasize being placed on land partition and farm rationalization (ÖRBACK).

The international collaboration and scientific research in geodesy in Sweden was started by Anders Celsius who became professor of astronomy in 1730 at Uppsala University. He began his career with a five years long Grand tour through Europe to study leading observations. When he came from Rome to Paris, there was a great debate regarding Newton's theory of the oblateness of the earth. Here Maupertuis was opposing the Cassinis, whose observations in France had led them to accept a larger diameter at the poles than at the equator.

At the request of Maupertuis, Louis XV now furnished means for an expedition to the far North, to settle the question by comparison with measurements made in Peru. Of the northern expedition Celsius was chosen as a member.

Continuing to London in 1735, Celsius bought geodetic instruments for the expedition. Triangulating from Torneå, at the northern end of the Gulf of Bothnia and northwards to Lat 66° 48', nearly along the meridian, they spent the summer, and the next winter a base was measured on the ice of the Torne River in 1737.

Celsius part in the work was astronomical observations. The result of this arc measurement confirmed the polar flattening. The success of this expedition evidently attracted the interest of Voltaire, who is said to have quipped that the outcome "flattened the poles and the Cassinis".

Astronomers after Celsius at Uppsala university (HJORTER, STRÖMER, MELANDER-HJELM, G. SVANBERG etc.) were also engaged in geodetic research and tasks for the Land Survey of Sweden. Research on the figure of the Earth was also done by several astronomers (CRONSTRAND, SELANDER, LINDHAGEN etc.) at Stockholm Observatory (Royal Academy of Science) (COLLINDER).

In 1725 the land surveyors were charged with the task of carrying out reallotment of land as an official duty. During the course of the industrialization period and the beginning urbanization, new tasks were assigned to the Land Survey. Development proceeded towards the present day engagement in the building up of a modern society.

In 1833 a military mapping organization, "Topografiska kåren", took over the responsibility for geographical mapping from the Land Survey. In 1894 the Geographical Survey Office of Sweden was established and was given the responsibility for the official mapping of Sweden.

A major organisatorial change took place on the 1st of July 1974, when the National Land Survey of Sweden (Statens Lantmäteriverk) was formed by a merger of the geographical Survey Office (Rikets Allmänna Kartverk), the official mapping agency with responsibility for applied geodesy, and the National Swedish Land Survey Board (Kungliga Lantmäteristyrelsen), with responsibility for the supervision of general matters concerning real estate, cadastre and large scale mapping techniques. One basic task for the new organization is the establishment of closer contact between geodetic research and practical surveying (ASPLUND). A review of current geodetic activities of different organizations in Sweden is given in LMV report nr. 4 1983.

The basic education for land surveyors in Sweden under the period 1628-1910 was of internal education type and given by already active land surveyors. The education started with a two years probationership combined with some theoretical knowledge provided by the Land Survey and completed with an examination. A major rise in the standard of education came in 1910 with one year probationership and the introduction of a two years study programme in surveying and cadastre. The education of land surveyors got a modern solution in 1932,

when a surveying study programme was established at the Royal Institute of Technology in Stockholm. The Department of Geodesy there is internationally well known through the work of Prof. A. Bjerhammar in the field of physical and mathematical geodesy.

Today, Sweden has about 1100 active land surveyors. They are divided approximately as follows in areas of

a) national land survey 43 %,
b) land consolidation and special authorities 23 %,
c) municipalities 25 %,
d) private sector 9 % (CARLEGRIM).

At Uppsala university several dissertations in geodesy were held under professors in astronomy during the first half of the 20th century. In 1956 geodesy was established as an independent subject at Uppsala University with its own specific study programme both at undergraduate and graduate level. Geodesists with education from Uppsala are active as scientists at research institutes (geodesy and geophysics, also abroad) and at the National Land Survey of Sweden. Surveying engineers/technicians and other students in geosciences with some courses in geodesy are active in government agencies, schools, private sector and geophysical companies.

The international collaboration, scientific research and education in geodesy at the University of Uppsala were permanented with the foundation of the Department of Geodesy at Hällby in 1962 by Prof. Erik Tengström, just at the beginning of the satellite era in geodesy. The activity at Hällby has kept pace with international developments in the subject (c.f. NAS: Trends in Geodesy). Current research includes monitoring crustal movements, global earth dynamics, lunar and planetary geodesy.

2. General Structure of the Educational System

Education in Geodesy and Surveying in Sweden is mainly organized along three levels:

A) Training on upper secondary school level leading to qualification as:

* Map technician (karttekniker)
* Surveying technician (mätningstekniker)
* Surveying engineer (mätningsingenjör)

B) Training on undergraduate level leading to qualification as:

* Master of Science (MSc) in surveying (Civilingenjör) with specialization in
  a) Surveying and Mapping
  b) Real Estate Formation
  c) Real Estate Economics
  d) Physical Planning

  This study programme is given within the Faculty of Technology at the Royal Institute of Technology, Stockholm.

* Bachelor of Science (BSc) in Physics (Högskoleexamen på fysikerlinjen) with specialization in Geodesy.

  This study programme is given within the Faculty of Natural Sciences at the University of Uppsala.

C) Training on postgraduate level leading to qualification as:

* Techn. licentiate in geodesy	Royal Institute of Techn.
* Techn. doctor in geodesy	Royal Institute of Techn.
* Master of Science in geodesy	University of Uppsala
* fil. licentiate in geodesy	University of Uppsala
* fil. doctor in geodesy	University of Uppsala

3. Educational Levels and Qualifications

3.1 School Education

According to the Swedish education system, all children attend "grundskola" (a 9 year compulsory comprehensive school for 7-16 years old). This is followed by "gymasieskola" (a non-compulsory uppersecondary school for 16-19 years old), which has a wide range of courses varying in length (2 to 4 years). Students who continue their studies after "gymasieskola" enter higher education. The collective name for all higher education in Sweden is "Högskola". The school year consists of two terms, the autumn term and the spring term. The autumn terms runs from end of August to mid January, the spring term from mid January to the beginning of June.

3.2.1 Training for Qualification as a Map Technician (Karttekniker)

School leavers who have successfully completed "grundskola" with a special course in mathematics and with 6 month practical work experience in surveying at a survey office may be trained as map technician at the "gymnasieskola" during one year.

The subject matters (hours per week) consist of Swedish (4), Orientation in working life (1), Drawing (9), Cartography (4), Photogrammetry (1), Cadastre (5), Geodetic calculation (6), Plane surveying (3), Typewriting and technical work in the office (3), Physical training (2).

This training is given at "gymnasieskola" in Härnösand, Kristianstad, Stockholm, Umeå, Uppsala, and Örebro.

3.2.2 Training for Qualification as a Surveying Technician (Mätningstekniker)

The requirements for admission to training for qualification as a survey technician is "grundskola" and at least 3 years practical experience of work in surveying.

The subject matters (hours per week, autumn term - spring term) consist of Swedish (4 - 4), Mathematics (10 - 6), Cartography (4 - 2), Geodesy (8 - 4), Photogrammetry (2 - 4), Survey engineering (6- 8), Real estate planning and economics (2 - 3), Physical training (2 - 2).

The duration of this course of study is one year and is only given at the "gymnasieskola" Åsö in Stockholm.

3.3 Training for Qualification as Surveying Engineer (Mätningsingenjör)

The requirement for admission to a training course leading to qualification as surveying engineer is obtained in two ways.

(1) School leaving certificate from at least two years attendance at "gymnasieskola" and 6 months working experience in surveying.

(2) School leaving certificate from training for qualification as survey technician/map technician from one year attendance at "gymnasieskola".

The subjects of the two years course (hours per week, autumn term - spring term, autumn term - spring term) cover Mathematics (9 - 7, 0 - 0), Physics (4 - 4, 0 - 0), Chemistry (4 - 4, 0 - 0), Ecology + Environment techniques (4 - 3, 3 - 2), Cartography (4 - 4, 2 - 2), Survey engineering (4 - 3, 5 - 4), Geodesy (4 - 4, 6 - 6), Photogrammetry (0 - 4, 4 - 4), Real property registration (3 - 3, 4 - 2), Real estate economy (0 - 0, 6 - 10), Physical training (2 - 2, 2 - 2), Swedish (0 - 3, 3 - 0), English (0 - 3, 3 - 6), Special project work in surveying (0 - 0, 6 - 6), and additional training in the field (practical exercises) during 10 weeks (total).

Upon successfully attending this 2 years course the pupil fulfills the special entrance requirements to the course in geodesy at the University of Uppsala and to the study programme of surveying at the Royal Institute of Technology in Stockholm.

3.4 University Education in Geodesy and Surveying

3.4.1 Basic Information about Higher Education in Sweden

Higher education in Geodesy and Surveying in Sweden is divided into undergraduate studies and postgraduate training and research.

Undergraduate Studies

At the undergraduate level students can choose between GENERAL STUDY PROGRAM and SEPARATE COURSES.

The duration and extent of these programmes and courses is expressed in a system of points. One term of full-time studies corresponds to 20 points, which means that one week of full-time studies with lectures, assignments (practical work, exercises) and independent study usually gives 1 point.

In some cases it is possible to study separate courses either on a full-time or part-time basis. Full-time courses are usually run during the day, part-time courses in the evening. The part-time courses are chiefly designed for people who wish to study and work at the same time. A 20 points course studied part-time normally takes two terms to complete.

The Academic Year

The academic year consists of two terms (40 weeks), the autumn term and the spring (20 weeks) term. The autumn term usually runs from the end of August

to mid January, the spring term from mid January to the beginning of June.

Entrance Requirements

General Entrance Requirements

To satisfy the general entrance requirements the student must

1) have concluded and passed a complete upper secondary school course,
2) be 25 years old and have worked for at least 4 years,
3) have a knowledge of English comparable to the standard of the Swedish two year "gymnasieskola".

Special Entrance Requirements

In addition to the general entrance requirements all study programmes and most separate courses have special entrance requirements. These requirements comprise background knowledge at upper secondary school level in subjects which are of particular importance for the course of study.

Programmes and Courses

Restricted Admission

All programmes and courses have a limited number of study places. For general study programmes the applicants are selected on the basis of their qualifications. Both the applicants' school results and their experience of working life are taken into consideration. For separate courses the methods of selection vary.

General study programmes offer degree granting education. Study programmes include a number of courses of varying length and scope. A course usually consists of between 5 and 20 points. Most study programmes consist of between 120 and 160 points, which means that they correspond to between 3 and 4 years of full-time study.

Separate courses

One of the aims of separate courses is to meet the need for further education and training. They are also intended to provide an opportunity to adopt courses of study to the needs of the individual. Separate courses vary in length from 5 to 60 points.

Postgraduate Training and Research

Postgraduate studies in Sweden usually lead to a doctorate, foreign students can also take a Master's degree.

Doctorate

The regulations state that a doctorate shall take about 4 years of full-time study after the completion of a first degree. This assumes that you have a good background knowledge, participate actively in the course work, and study full-time. In practise a doctorate usually takes more than 4 years. The studies will include research to be presented in a dissertation. The dissertation generally takes more than half the total time. All doctoral students receive individual supervision.

Master's degree

Studies for a Master's degree are available for foreign students in general and in some study programmes even to Swedish students. It comprises 60 points and consists of course work and an independent dissertation (term paper or equivalent). The courses are at postgraduate or advanced undergraduate level, and the dissertation usually corresponds to 20 points.

3.4.2 Master of Science in Surveying (Civilingenjör)

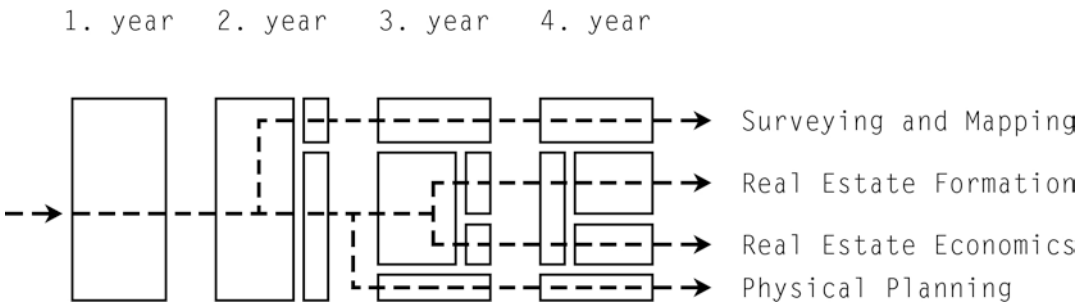
Surveying is a general study programme (160 points) at the Royal Institute of Technology in Stockholm.

Entrance Requirements

In addition to the general entrance requirements mentioned before, the student must have background knowledge in Mathematics, Physics and Chemistry from the 3 year "gymnasieskola".

Structure of the Surveying Study Programme

According to the recent programme from 1982 with a strong concentration on a few number of specializations, the student can after two years of compulsory courses select one of four specializations.



A great number of courses varying between 1 - 14 points are offered in the four above mentioned specializations by the Department of Geodesy, Department of Photogrammetry, Department of Land Improvement and Drainage, Department of Real Estate and Real Estate Planning.

Each student (or a small group of students) makes an individual diploma work (degree project 12 points) during the last part of the fourth year.

3.4.3 Bachelor of Science in Physics with Specialization in Geodesy

Geodesy is a part of the Physics Study Programme 120 points (3 years of study) at the University of Uppsala.

The Physics Study Programme consists of a basic block of 3 terms (60 points) which contains courses in mathematics, physics, and theoretical physics. After the basis block, the student can select one of seven possible orientations, astronomy, electronics, experimental and theoretical physics, geophysics, meteorology, or technical biology.

Within the block of geophysics, the student can choose courses in geodesy. This course consists of geometric geodesy, 5 points, astronomic geodesy, 5 points, satellite geodesy, 5 points, satellite dynamics, 5 points, computer techniques and data processing, 5 points. A part of the final term of the education is devoted to work on a degree project (5 points), which is an important part of the study course.

In extension with this study programme the student can choose further separate courses in advanced geodesy, consisting of between 5 and 40 points in the field of satellite geodesy, physical geodesy, adjustment, application of space techniques to geodynamics.

Distance Education in Geodesy

Surveying engineers / technicians and other students living outside Uppsala have the possibility to enroll in a distance course in geodesy (20 points), a form of correspondence education for further vocational training with some mandatary meetings during weekends at Uppsala University. The main aim of this course is to meet the highly increased demand of well qualified surveying engineers / technicians and to give them an idea of the full spectrum of geodesy. An extension distance course (20 points) conveying theoretical knowledge in geodesy, computer techniques and data processing is planned.

4. Postgraduate Training and Research

4.1 Postgraduate Studies and Research in Geodesy and Surveying at the Royal Institute of Technology in Stockholm

Education in Geodesy and Surveying at the postgraduate level is given by the Department of Geodesy along its specific research and postgraduate study programme.

The study and research programme at the Department of Geodesy in Stockholm is oriented towards geometrical geodesy and physical geodesy, satellite geodesy, control and engineering surveying, land and topographic surveying, geodetic instrument technique and control, statistical treatment and geodetic observations, geodetic measuring procedure (planning - realization - economy), contact with scientific fields which have a relation with geodesy (ANDRÉN, UHÄ).

Awarded degrees: techn. licentiate in geodesy, doctorate in geodesy (teknologie doktor). The title "docent" is awarded based on documented extensive research activity.

4.2 Postgraduate Studies and Research in Geodesy at Uppsala University

The Institute of Geophysics consists of three departments: Solid earth geophysics, geodesy, and seismology. Each department has its specific research programme and postgraduate study programme (DYRELIUS).

The study and research programme at the Department of Geodesy in Uppsala is oriented towards geometric and physical geodesy, space geodesy, establishment of geodetic control networks on land - recognizing the time variant aspects of

these networks, measurement and representation of geodynamic phenomena (polar motion, earth tides, crustal motion), lunar and planetary geodesy (ANDERSON, TENGSTRÖM).

Awarded degrees: Master of science in geodesy (only for foreign students), fil. licentiate in geodesy, doctorate in geodesy. The title "docent" is awarded based on documented extensive research activity.

5. Further Educational Opportunities

i) Courses in mine surveying are held at "gymnasieskola" level at Bergsskolan in Filipstad.

ii) A 20 points course in stereophotogrammetry is given at Lund University.

iii) Courses for qualification as a Map Technician are also offered in some towns by the labor market authorities.

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S W I T Z E R L A N D

1. General

In Switzerland surveying and agricultural engineering is among others characterized especially by the fact that on the one hand federal and cantonal authorities function with few exceptions as supervisory authorities, while on the other hand the implementation of assignments is issued to surveying and engineering enterprises on a state-controlled or self-employed basis.

The tasks of surveying are accomplished by contributions of geodesy, by the national survey including first to third order triangulation, levelling and official map series, by official surveying treating the fourth order triangulation, mensuration of parcels (property register surveys) and the so-called general plan, and finally by all types of engineering surveys.

On the federal level it is the Federal Topographic Service (Bundesamt für Landestopographie) - subordinated to the Federal Ministry of Defense (Eidgenössisches Militärdepartment) - which is in charge of the national survey and the official map series. The Federal Survey Board (Eidgenössische Vermessungsdirektion) answers to the Federal Ministry of Justice and the Police (Eidgenössisches Justiz- und Polizeidepartment). It is the supreme technical authority with respect to official surveying. This obligation is in cooperation with cantonal survey authorities.

The private engineering and surveying enterprises fulfill - according to preference and qualification - tasks related to the official surveys, planning and land organization, agricultural engineering, infrastructure or engineering survey. Planning is conducted at the local, regional and federal levels, while agricultural engineering and land organization encompass all types of structure and land improvement including reapportionment of fragmented parcels in the open field, in forests and building areas. Tasks of infrastructure include so-called housing planning and consolidation in building areas as well as construction projects for provision of public utilities and sewage- and refuse-disposal services at the regional and communal level.

The 13 cantonal and federal authorities employ 8 % of the approximately 2.800 strong Swiss survey personnel, the 19 communal authorities 6 % and the 257 private offices 80 %.

2. Organization of the Educational System

The Swiss geodetic educational system comprises three stages. The vocational training constitutes the lowest level which may be followed by training at cantonal Higher Technical or Engineering Schools (Höhere Technische Lehranstalt, Ingenieurschule) and finally by a course of study at Federal Technical Universities (Eidgenössische Technische Hochschule). In order to be eligible for employment in the official areas of surveying, official admission requirements must be met, i.e. by means of a Federal Professional Licence (Eidgenössischer Fachausweis) or the Federal Surveying Engineer's Licence (Eidgenössisches Ingenieur-Geometer-Patent).

3. Educational Levels and Qualifications

3.1 School Education

The duration of the basic level of Swiss school education (primary school) is 4 to 6 years, depending on the canton concerned. Subsequent school education is 3 to 5 years secondary school (Oberschule, Sekundarschule, Realschule, Bezirksschule, Progymnasium).

In the educational path, a school leading to a final school-leaving certificate (Maturitätsausweis), which is the approximate equivalent of the British General Certificate of Education Advanced Level, is attended directly upon completion of the primary school (Gymnasium, Diplommittelschule, Berufsschule, Berufsmittelschule). Thus, a federal recognized final school-leaving certificate is acquired upon the successful completion of 13 years of school education.

3.2 Vocational Training

The vocational training leads to qualification as a survey draftsman (Vermessungszeichner) and is governed by a federal law. The admission qualification for such training is in general the conclusion of 8 to 9 years primary and secondary school (approximate equivalent of the British General Certificate of Education Ordinary Level). The vocational training lasts for four years. The curriculum is orientated exclusively towards the simple theoretical and practical aspects of official surveying. Two to four months' field work are included every year. The remaining period is divided into office work and a nine-week intercantonal block course at one of the municipal vocational schools in Lausanne or Zurich. Only those enterprises are admitted as training enterprises which conduct regular work pertaining to the official surveying.

Upon successfully sitting the final examination, the trainee is awarded a federal certificate of eligibility to practice as a survey draftsman (Eidgenössischer Fähigkeitsausweis als Verzeichnungszeichner).

Approximately 25 % of the survey personnel in Switzerland have qualified as a survey draftsman.

3.3 Surveying Engineer

The surveying engineer is trained at cantonal Engineering Schools (formerly: Higher Technical School) primarily as a surveying specialist. He deals with technical tasks of surveying at the plane surveying level and, after some practice, also with organizational aspects. He has mastered the measuring and evaluation methods and is able to apply them both correctly and economically. As a result of the knowledge gained during the vocational training and the broadly based professional training at the Engineering School, he is well qualified to deal with land register surveying and many other aspects of agricultural and surveying engineering such as the rationalization of land holdings, land improvement, photogrammetry, building survey, etc. The right to practice official surveys as a free trade in Switzerland is, however, reserved to the Federal Licenced Surveying Engineers (Eidgenössisch patentierter Ingenieur-Geometer).

The successful conclusion of the training course for survey draftsmen and the successful sitting of an entrance examination constitute the admission qualification for the course of study. Candidates holding the final school-leaving certificate may be accepted if they can provide proof of adequate practical training over a minimum of one year.

German and French Switzerland each have an education centre for surveying engineers and they are, respectively, the following engineering schools: Beider Basel Engineering School in Muttenz and the École Technique Supérieure de l'État de Vaud in Yverdon.

The duration of the course of study is 6 semesters. There are intermediate diploma and diploma examinations. Successful candidates are awarded the diploma and enjoy the right to use the title "Surveying Engineer".

This qualification constitutes also the authorization for the holder to be employed as chief assistant to the Federal Licenced Surveying Engineer.

Approximately 6 % of the Swiss survey personnel have qualified as a Surveying Engineer.

3.4 University Graduate Engineer
(Diplomierter Kulturingenieur and Diplomierter Vermessungsingenieur ETH)

An agricultural and surveying engineer who has qualified at one of the two Federal Technical Universities is entitled to work in all areas of private and official surveying, concentrating on two main fields:

The agricultural engineer is busy primarily in the fields of planning, land organization, agricultural engineering, infrastructure, in communal and official surveying.

The surveying engineer works in geodetic and national survey, official surveying, engineering survey, communal surveying and with instrumentation enterprises.

A recognized final school-leaving examination (type A to E) or the entrance examination for a Federal Technical University constitute the requirements for admission to a course of study at federal technical universities which are located in Lausanne and Zurich. Students with a good qualification attained at an engineering school may continue their studies at a Federal Technical Unitvarsity upon successfully sitting a transition examination.

The course of study lasts 8 semesters and includes various practical field courses held during vacations.

The academic training of Swiss graduate engineers will now be considered using the curriculum of the Federal Technical University of Zurich as an example.

The students enter the Department for Agricultural Engineering and Surveying. Upon conclusions of the fourth semester they select either the field of study of agricultural engineering or of surveying.

The knowledge acquired up to this stage is examined in two intermediate diploma examinations. The first intermediate diploma, which may be sat at the earliest upon conclusions of the 2nd semester, examines the subjects: analysis, mechanics, jurisprudence, descriptive geometry, geology and petrography.

The second intermediate diploma examination, which may be taken at the earliest upon conclusion of the 4th semester, covers the subjects: surveying, hydrology and hydraulics, economics and business economics and alternatively two of the optional subjects which are ecology, statistics and probability in addition to numerical mathematics and linear algebra.

The second half of the course of study involves reinforcement in the following fields:

Areas of reinforcement for agricultural engineers:

- agricultural engineering including rationalization of land holdings, hydraulic engineering in agricultural areas, land improvement in mountainous areas, hydraulic engineering in built-up areas
- surveying including geodetic survey, official survey, photogrammetry, geodesy, error theory and adjustment calculation
- areas of civil engineering, jurisprudence and economics which are of importance for the agricultural engineer (including those employed at the communal level and working in developing countries)
- local, regional and federal planning.

Areas of reinforcement for surveying engineers:

- reinforcement in geodesy, error theory and adjustment calculation, surveying, photogrammetry, geophysics, cartography
- intensive reduction in agricultural engineering, civil engineering, planning.

The curriculum at the Federal Technical University of Lausanne is very similar.

During the course of the studies various practical exercises and field courses in surveying, agricultural engineering, geophysics, building and agriculture must be completed.

The final diploma examination comprises several examinations in the various specialized subjects and two theses. It may be taken at the earliest upon conclusion of the 8th semester, although individual examinations may be sat during earlier semesters. Specific reinforcement subjects such as soil mechanics and foundation engineering, agricultural hydraulic engineering, water protection and environmental ecology, stream engineering in addition to soil conservation and torrent damming are also examined.

In both areas of reinforcement two theses must be prepared:

on agricultural engineering and surveying or on surveying plus either geodesy, geophysics or cartography.

The professional title awarded is Graduate Agricultural Engineer (Federal Technical University) and Graduate Surveying Engineer (Federal Technical University) respectively (Diplomierter Kulturingenieur ETH, Diplomierter Vermessungsingenieur ETH). Both titles are combined in the university diploma of the Federal Technical University of Lausanne.

Approximately 17 % of the Swiss survey personnel have qualified as an university graduate engineer.

4. Other Professional Training and Further Educational Opportunities

4.1 Survey Draftsman

The assignment of specific tasks pertaining to the official geodetic register to qualified specialized personnel is laid down. In this connection the "survey draftsmen with a professional licence" have a special role to play because they are entitled to fulfill official tasks in the area of surveying self-reliantly.

Survey draftsmen who, upon completion of their training, have worked four years for a licenced surveying engineer in land register survey and have passed an additional two-year practical work in one or several of the following five specialized areas: lot survey, lot survey revision, general plan, trigonometric-tachymetric work, photogrammetry, are eligible to sit examinations for advanced professional licence.

Approximately one third of all survey draftsmen have acquired the professional licence.

4.2 University Graduate Engineer

Only holders of the Federal Surveying Engineer's Licence may be entrusted with official geodetic registers and their revision.

The licence examination comprises both a theoretical and a practical examination.

The theoretical examination is held primarily by university professors. The subjects covered are: advanced calculus, geometry, physics, error theory and adjustment calculation, surveying, photogrammetry, land register survey, redistribution of parcels of land, jurisprudence including reality, land register and survey right and an introduction to geodesy.

The practical examination in the following specialized areas:

horizontal control, traversing, photogrammetry and data processing, field mapping and compilation of a map, lot survey, lot survey revision, topographical work, is held during the course of the field work, technical work in the office and oral examinations.

Admission qualification for the theoretical section of the examination is the final school-leaving examination. An autodidact may thus be admitted, too. The diploma examination taken at a Federal Technical University is recognized as being equivalent to the theoretical examination.

The passing of the theoretical examination and subsequent practical experience of at least one year constitute the requirements for admission to the practical section of the examination.

The Federal Surveying Engineer's Licence (Eidgenössisches Ingenieur-Geometer-Patent) is awarded by the Federal Ministry of Justice and the Police. Approximately 85 % of all graduate engineers acquire this surveying engineer's licence.

Further education for academics provides the opportunity to gain a doctorate with the title Doctor of Technical Sciences (Doktor der technischen Wissenschaften).

4.3 Further Training

Refresher courses, further training courses and seminars are offered at all levels of further education in surveying.

5. Other Educational Opportunities

In addition to the educational courses described above, two other courses are offered in Switzerland leading to qualification as a geodetic specialist: for photogrammetrists and for cartographers.

The former acquires his professional title in the following manner:

as a survey draftsman with four years practical experience he enters upon two further years in an office for photogrammetry in order to acquire a federal professional licence for photogrammetry.

It is also possible to receive training in this professional field by attending the Swiss School for Photogrammetric Operators (Schweizerische Schule für Photo-

grammetrie-Operateure) in St. Gallen. It is open to candidates from all countries. Professional training for cartographers is held at the Federal Topographic Service in Bern or at private cartographic establishments. Trainees from the whole of Switzerland receive their theoretical training in separate cartography classes at the College of Commercial Art of the City of Bern (Kunstgewerbeschule der Stadt Bern). The duration of the training is four years.

Upon successfully sitting the examination, the candidate is awarded the Federal Certificate of Cartographer (Eidgenössisches Fähigkeitszeugnis als Kartograph).

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T U R K E Y

1. General

After the establishment of the Turkish Republic official surveying, in particular the production of the geodetic fundamentals and maps of different scales, was organized more strictly than had hitherto been the case.

The work is assigned to various authorities, the most important of which is the Turkish Geodetic Survey Service (Executive Board for Maps). As a part of the General Staff it belongs to the area of the Ministry of Defence. This military authority is responsible for the national triangulation of the various orders and the production of topographic maps in various scales, in particular the topographic base is 1:25.000. By order of ministries and other official authorities also maps for special purposes can be provided.

Technical implementation within the Geodetic Survey Service falls to the following groups:

- Geodetic Group which is subdivided into the following departments:

  a) astronomical, gravimetrical and geophysical work
  b) leveling
  c) horizontal control

- Photogrammetrical Group with the following departments:

  a) photogrammetry
  b) topography (for local supplementation of photogrammetrical sheets)

- Cartographical Group with the following departments:

  a) drawing department
  b) reproduction department
  c) preparation of derived maps
  d) archives.

In addition, there are a further two groups for organization and operation as well as a working group responsible for the training of survey specialists.

The Executive Board for the Land Register and the Cadastre, which is responsible for cadastral work, is the second largest surveying authority. It is the

task of this office to produce in cooperation with the Executive Board for Maps large-scale cadastral maps and to maintain them. Photogrammetry is the survey method which is by and large used.

The third organization is the Ministry for Housing and Development. On its behalf the "Municipal Bank" produces the cartographic source material for urban planning. In this way many towns are represented for the first time on a large scale. The survey work itself is assigned to private companies.

The Road Construction and Hydraulic Engineering Board as well as the Ministry for Local Affairs also conduct extensive survey work. Source material pertaining to forestry is furnished by the Executive Board for Forestry.

The production of compilation source was, however, newly governed by a new law issued in 1961. Accordingly, all authorities were required to use base maps to the scale of 1:5.000 as source material, provided that maps of a larger scale are not absolutely vital. As mentioned, the Executive Board for Maps and the Executive Cadastral Board are jointly responsible for the production of these base maps which must meet the needs of all authorities. Production of map series on an even larger scale is left to each authority as the need arises.

As a result of this law all survey work has become subject to new rules of coordination. In pursuance thereof, all authorities which are interested in maps of the scale 1:5.000 for a certain area meet and lay down an annual plan.

2. Organization of the Educational System

Survey specialists are in great demand in Turkey. For a long time, however, this need was neglected with the result that many authorities strove to carry out their survey work using relatively simple methods and only a small number of qualified personnel. A further consequence was the setting up of vocational schools by these authorities which had as their objective the training of just enough personnel to cover their own needs.

Most of the technical personnel is trained by the Cadastral and Land Register Board itself in its own vocational schools. The vocational school belonging to the Geodetic Survey Service also seeks to meet its own requirements. Also non-commissioned officers receive here their vocational training.

The facilities for geodetic education at universities and technical colleges have widely been improved since 1949. It was 1949 before a department for

mapping and cadastre was established at the Technical University of Yildiz (Istanbul). Presently there are five universities where in Departments of Geodesy and Photogrammetry (since the new university law of November 06, 1982 their names are standardized) geodesists and surveyors of different qualification are educated. Moreover there are further universities, approximately twelve or so, where elementary geodesy (topography) and photogrammetry is taught.

In Turkey geodetic education is offered on four different levels as

- technicians at vocational schools
- graduates of higher vocational schools
- engineers } at universities
- graduate engineers

3. Educational Levels and Qualifications

3.1 School Education

School education commences at the five-year primary school. The pupil then attends either a higher technical school or a general secondary school. Upon completion of the former the pupil sits the technical final school-leaving examination while at the general secondary school the final school-leaving certificate is taken (both qualifications are the approximate equivalent of the British General Certificate of Education Advanced Level). The education at both schools lasts six years and covers the 6th to 11th classes.

3.2 Training Leading to Qualification as Technician

Technicians are trained by the Cadastral and Land Register Board itself. At the vocational school of the cadastral organization pupils who have completed the 3rd class at the general secondary school acquire in 3 years the technical and legal knowledge required for the implementation of cadastral work. They acquire first of all the cadastral certificate and after passing an examination they qualify as a technician. They are subsequently employed as technical officials.

3.3 Training Leading to Qualification at Higher Vocational Schools

The graduates of higher vocational schools for mapping and cadastral survey form the second level, which was been founded in seven cities since 1981. At these

schools graduates of the general secondary schools and of the vocational schools are trained for further two years. After the final examination graduates with good marks have the opportunity to continue their studies at the university after some additional examinations.

3.4 Education at Universities

Since the new university law studies in geodesy are offered in the Departments of Geodesy and Photogrammetry of following universities:

Technical University Istanbul (founded 1970), Yildiz University Istanbul (founded 1949), Karadeniz University in Trabzon (founded 1969), Selçuk University in Konya (founded 1974) and Technical University for Surveying and Mapping (founded 1969) which is affiliated to the Ministry of Defense. At the two universities in Istanbul and at the university in Trabzon the degree of an engineer can be awarded after eight semesters, and after further three semesters the degree of a graduate engineer can be obtained. Graduates of engineering studies at the Military University and at the university in Konya are to continue their studies at other universities in order to obtain the degree of a graduate engineer. In order to increase the capacity, at the Yildiz University one has the opportunity to join evening lectures which lead after ten semesters to the degree of an engineer's. Approximately 400 students start with their studies at one of the five universities per year.

Studies in engineering take eight semesters. During the first four semesters the contents of the lectures is the same for all engineering students of different special subjects. However, the special field (f.i. geodesy) is offered from 8 up to 18 hours of lectures in each semester, where subjects orientated fields can be chosen. Examinations have to be passed during each semester. After the four semesters of basic studies a previous examination has to be passed in order to prove the qualification for further studies. Special studies start in the fifth semester. The mode of examinations is the same as in the basic studies. The maximum time for studies is limited to 12 semesters. The successful final examination awards the degree of an engineer in geodesy and photogrammetry, officially recognized. In further three years, students who have passed the examination with a good of very good result have the opportunity to gain the degree of a graduate engineer (Dipl.-Ing. or M.Sc.) after the presentation of a thesis and a successful examination.

4. Other Professional Training and Further Educational Opportunities

A doctorate may be gained upon conclusion of further study.

Furthermore, the Cadastral and Land Register Board offer their employees further training courses and additional training measures.

Further technical training courses for officers and NCOs are held at the Vocational School of the Geodetic Survey Authority.

5. Other Educational Opportunities

At approximately one dozen other universities at various faculties, as f.i. civil engineering, architecture, geology and mining, agronomy, agricultural engineering, forestry etc., a two semester's education is offered in topography and elementary photogrammetry.

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THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

A.L. Allan, London

1. General

In the United Kingdom of Great Britain and Northern Ireland land surveying is carried out by government agencies and by private firms.

Responsibility for geodetic control, level networks and mapping down to the scale of 1250 in urban areas in England, Wales and Scotland (Great Britain) falls within the jurisdiction of the Ordnance Survey of Great Britain. There is a separate organization, the O.S. Northern Ireland, for that province. The O.S.G.B. has now taken the former Directorate of Overseas Surveys (DOS) under its control. Other official agencies range from the Property Services Agency, the counties of England and Wales, the regions of Scotland, various metropolitan counties, such as the Greater London Council, statutory undertakings, such as the Central Electricity Generating Board, and nationalized industries, such as British Rail and the National Coal Board. Of considerable importance is the Hydrographic Department of the Royal Navy and various ports authorities.

Private surveying is generally organized in small firms of about 10 persons, working in engineering and development projects, although there are a few very large companies with complete geodetic, photogrammetric and development competence, which operate on a world wide basis. Recent government policy has been to subcontract work of all kinds to private firms.

The only legislation affecting the right to practice surveying in the UK concern mining surveyors, and the Privy Council's grant of a royal charter to the Royal Institution of Chartered Surveyors, which has two divisions governing the land, hydrographic and minerals activities of its members.

The land tenure system in the UK is administrated by the Land Registry which uses the O.S. plans as index diagrams. Boundary disputes are resolved by *ad hoc* decisions of the courts of law. This "general boundary" system, which has worked well in the past, mainly because properties have not been frag-

mented (thanks to the practice of primogeniture), has not required the services of a cadastral surveyor. Cadastral surveying is taught in educational courses merely for the benefit of surveyors working overseas, and especially in former colonies where cadastral systems were introduced.

Research and development is carried out by the large government and private agencies, often sponsored at an university or polytechnic and by the National Physical Laboratory, and the National Engineering Laboratory.

Representation of the UK to international organizations such as the F.I.G. and I.A.G. is organized either via the Royal Society (a scientific body) or the Royal Institution of Chartered Surveyors (a professional body), in conjunction with the appropriate private learned society, such as the Photogrammetric Society. Recently, the small group of higher geodesists, the Association of British Geodesists, has been incorporated within the Royal Astronomical Society.

2. General Structure of Education

2.1 Schools

Education is compulsory in the UK between the ages of five and sixteen; the assessment of standards is by the ministry of education; and although most schools are run by the state, there is a strong private section in secondary education. State examinations are administered through a number of examining boards some associated with universities, in England and Wales; but in Scotland and N. Ireland by the respective education departments. Scottish education differs from the rest of the UK in some important aspects.

2.2 Survey Education

The following remarks pertain only to those branches of surveying covered by the I.A.G. study, described under the various titles - "geodetic, topographic, engineering, cadastral, hydrographic, mining, and land surveying". In the UK the title "geodesy" applies only to "higher geodesy".

Although it may be studied as an optional interest subject at secondary school, formal technical education is provided by the following institutions:

(1) technical colleges
(2) polytechnics
(3) universities.

There is some permeability, in theory, amongst these institutions. Little takes place, however, except vertically from technical college to polytechnic.

The RICS still holds private examinations for a decreasing number of candidates, especially for overseas candidates who may sit in their own country, at an approved centre, such as the British embassy.

The Royal Naval Hydrographic School and the School of Military Survey mount courses accessible to approved civilians, and are recognized by the RICS for membership alongside the holders of university degrees.

3. Educational Levels and Qualifications

3.1 School Education

School education commences at a three class primary school (for children aged five to eight years) followed by a four class junior school. This is followed either by state education to the age of 16 at a comprehensive school, or at a private school. At this stage, pupils may sit examinations of the General Certificate of Education (GCE) Ordinary level, taking typically ten subjects in the top classes, or the more applied Certificate of Secondary Education (CSE) examinations. Many pupils study for a further two years to sit the GCE Advanced level examinations in three or four subjects. Grades of pass are awarded from E to A in ascending order of quality. A typical university will demand at least three grade 'C' passes for entrance to surveying courses, two of which must be in mathematics and physics or their equivalent.

School leavers apply to universities through a clearing system of the Universities Central Council for Admissions (UCCA) and are usually subjected to interview by the departments concerned, which restrict entry to the places available. Entry to polytechnics is via a similar, but independent, process.

In Scotland, pupils are required to pass in four or five subjects at the Scottish Education Department Higher Schools Certificate examinations one year earlier than in England. University courses in consequence are typically of four years duration which contrasts with the three year studies in England and Wales; thus the average age of graduation in both systems is the same.

It is a feature of all UK degrees to award passes at five different grades in ascending order of merit; pass, third class, lower second class, upper second class, and first class. Only the last two classes are generally acceptable for continued studies for Masters and Doctorate degrees.

Another unique feature is the universal operation for most final examinations at educational institutes, including technical colleges, of an external examiner system, which has the important function of equating national standards and reducing personal bias from assessment procedures.

3.2 Technician Studies (TEC or SCOTEC)

The education of technicians at technical colleges, and polytechnics is organized by the Technical Educational Council (TEC or SCOTEC in Scotland) which has co-ordinated and validated a wide variety of modular courses at 33 colleges throughout the country. Two levels of technicians are identified after two or four years of full-time study or three or six years of part-time study, after passing approved GCE (SCE) examinations at 'O' level. Higher diplomas and certificates are awarded at 17 colleges in the UK (ALLAN, 1981). Subjects are typically selected from:

physical science, mathematics, environmental studies,
public administration, cartography, hydrography,
land surveying, construction technology, photogrammetry,
mine surveying, mineral valuation, engineering surveying,
general and communication studies.

Because of the modular structure of such courses, employers can require students to take a wider selection of topics, e.g. planning, building construction, electronics, within a generally controlled format and to suit local needs.

3.3 Polytechnic and University Joint Degree Studies (BSc)

(a) Although surveying features in most degree courses in civil engineering, mining, nautical studies, and in some geography degrees, eight establishments provide advanced optional specializations for three years as follows:

Portsmouth Polytechnic (civil engineering and geography)
University of Cambridge (engineering)

The City University (civil engineering)
University College of Wales, Aberystwyth (geography)
University College of Swansea (geography)
University of London (civil engineering and geography)
University of Nottingham (civil engineering)
Oxford Polytechnic (construction)

(b) Specialist first degree courses in surveying are offered at the following establishments:

University of Glasgow (topographical science) (four years)
University of Newcastle (surveying science) (three years)
North East London Polytechnic (surveying and mapping sciences) (three years)
University College of Swansea (topographical science) (three years)
Portsmouth Polytechnic (topographical science) (three years)

The reason for the longer course at Glasgow has already been explained in 3.1; the Scottish universities provide the teaching during their first year of studies in foundation sciences which are usually covered in the upper 6th form at English/Welsh schools. Degree courses in mining have been omitted.

The curricula of all these courses follow similar lines with some bias, as their titles suggest; all feature third year student specialist projects, and at the North East London Polytechnic, third year elective specializations are studied.

The core curriculum includes typically (percentages):

hydrography (8); geodesy (13); mathematics and science (16); instrumentation (16); mining and engineering surveying (11); mapping (16); law (11); development and planning (9).

A feature of all is the importance placed on the practical field work, at residential centres, which reinforces the theoretical studies.

3.4 Graduate Courses

Graduate courses leading to the awards of master's degree of graduate diplomas are at the following establishments:

University of London (three courses: surveying, photogrammetry and numerical methods in photogrammetry and surveying)
University College of Swansea (cartography)
University of Glasgow (three courses: surveying, cartography and photogrammetry)
University of Oxford (geodesy).

Specialist courses leading to diplomas only are provided at the following institutions:

School of Military Survey (surveying)
Naval Hydrographic School (hydrographic surveying)
Plymouth Polytechnic (hydrographic surveying).

The first two grant exemption from the RICS examinations.

4. Research

In addition to taught courses, the various educational establishments engage in research work; students read for masters degree in two years or doctorates in three years minimum. Specializations depend on the particular academic staff concerned and studies usually last longer than the minimum period prescribed.

5. Further Education and Extension Studies

There is an increasing awareness of the need for refresher and extension courses, which are offered by various universities, polytechnics and technical colleges. Such topics as land information systems, industrial engineering, and computer methods are popular. Many attract overseas students in considerable numbers.

A new feature of the RICS is the insistence upon Continuing Professional Development (CPD) for new members, who are obliged to attend approved events such as seminars, and carry out further reading, to remain in membership. It remains to be seen how this system can be enforced effectively.

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U S S R

V.D. Bolshakov, Moscow

Annotation:

Unfortunately the authors could not obtain an actual report from USSR. Therefore the paper which had been presented at the FIG-Congress in Sofia 1983 has been taken alternatively.

Higher geodetic school in the USSR as a part of people's education system takes its origin from Lenin's decree on March 15, 1919 on creation of geodetic service in the country.

According to the existing in the USSR classification of sciences, section "Geodesy" includes three main parts: Geodesy; aerial surveying, photogrammetry, phototopography; cartography. This paper deals with the most essential scientific and methodological problems in training engineering and research personnel in the USSR according to the above mentioned fields of geodesy.

Vocational training of engineering personnel in the mentioned above fields is carried out in the following specialities: astro-geodesy with specialization in marine geodesy, applied geodesy, satellite geodesy, aerial photogeodesy, cartography. Cartography in its turn has two specializations -projecting and compilation of maps, and map publication (after the 4th year of studies at the Institute).

All higher educational institutions training engineers in geodesy except Moscow and Kiev state universities, carry out training according to the common curricula and syllabuses, graduates from Moscow and Kiev state universities get the qualification of a cartographer-geographer. Curricula and syllabuses are worked out taking corresponding speciality profiles into account and are scientific and methodical base for vocational training of engineers in the field of geodesy.

Consider briefly the profiles of engineering specialities in the field of geodesy.

1. Profile of Training an Engineer in Astro-Geodetic Speciality

Main precise astro-geodetic works along with gravimetric and satellite observations are performed in the USSR with the aim of determining the figure and dimen-

sions of the Earth as a whole, detail studies of its parts, investigation of gravitational field of the Earth and movement of Earth's crust.

Designing of highly precise fundamental astro-geodetic nets for this purpose is also necessary for solving various engineering problems in economy, in particular for mapping and investigation of natural resources of the whole country, including land, coastal zone and the whole ocean.

Therefore an engineer astro-geodesist should know:

1. Theory and methods of geodetic, astronomical, gravimetric, satellite observations and measurements; theory and methods for mathematical computations of these observations and measurements' results.

2. Scientific base of the scheme and programme for designing fundamental astro-geodetic and gravimetric nets and a net of satellite tracking stations.

3. Design, methods of testing and operation of basic types of devices and instruments, used for astronomical, geodetic, gravimetric, photo- and radiogeodetic, topographic, photogrammetric measurements, satellite observations and for autonomic orientation.

4. Mathematical theory of higher geodesy, theory of the figure and external gravitational field of the Earth, theory of artificial Earth satellite movement in the Earth gravitational field.

5. Foundation of theory and practical results of combined use of the data obtained by astro-geodetic, gravimetric and satellite observations with the aim of investigating modern state and changes in time of the form and gravitational field of the Earth as a whole and in its separate parts, geodetic exploration of other planets, studies of internal Earth structure and its atmosphere taking into account achievements of geophysics, geology and space exploration.

6. Theory and practice of computer employment and automatic devices in the course of carrying out a set of field and office work, performed when designing fundamental astro-geodetic nets on land, in shelf zone and the world ocean.

7. Theory, methods and technological processes of state topographic, aerial photogrammetric, marine cartographic and geodetic surveys; foundations of marine geologo-geophysical work, foundations of mathematic cartography, compilation, editing and publication of topographic and special maps.

8. Theory and practice of photometric and radiometric methods for distance measurements; foundations of electronic and radioengineering.

9. Economics, organization and planning of field and office processes of a set of astro-geodetic and gravimetric, topographic and aerophotogrammetric works as well as satellite observations, the system of enterprise management.

An engineer-astro-geodesist should be able to:

1. Carry out geodetic investigation and reconnaissance of points of all-orders of accuracy geodetic nets.

2. Perform precise measurements of angles and zenith distances; perform precise and highly precise levelling; measurements of gravity, photometric and radiometric distance measurements, astronomic determination of latitudes, longitudes and azimuths; determine location of a ship and her velocity in coastal zone, and the world ocean by satellite data, radiogeodetic and other information.

3. Organize and carry out mathematical treatment of measurement results, mentioned above.

4. Organize and direct field and office works for establishment of fundamental geodetic and gravimetric nets for geodetic control of topographic, aerial photogrammetric and geophysical surveys.

5. Organize and direct geodetic works on land, coastal shelves, open ocean and in polar regions to perform special surveys, solve separate scientific and production problems.

6. Design technical projects, fill in technical and accounting documentation, provide security of personnel and technical means when performing all mentioned above works.

Since 1974 MIIGAiK has been training astro-geodesists with specialization in marine geodesy according to plan.

Training of highly qualified engineers in astro-geodetic speciality is based on close combination of theoretical studies with teaching and teaching-and-production practical training and prolonged production practice.

2. Profile of Training an Engineer in Speciality of Applied Geodesy

Performing surveys for designing modern engineering constructions as well as carrying out engineering works and watching the behaviour of these constructions in operation are impossible without the use of special geodetic measurement methods. An engineer-geodesist of this profile organizes geodetic works necessary in the three stages, and takes part in carrying out the most important of them.

In accordance with the described aim an engineer-geodesist should know:

1. Theory, methods and practice of geodetic, astronomical and gravimetric observations and measurements; methods of mathematical treatment of these observations and measurement results.

2. Constructions, methods of exploration and operation of basic types of astronomical, geodetic, topographic, gravimetric and photogrammetric devices and instruments.

3. Theory, methods and processes for performing state topographic, aerial phototopographic surveys; foundations of mathematical cartography, projection, compilation, editing and publication of topographic and special maps.

4. Foundations of computation methods, used in designing engineering constructions, as well as foundations of technology and organization of engineering works, methods for compilation and carrying out the working master plot plan of an object being under construction.

5. Theory, methods, staff and organization of engineering and geodetic works, carried out in survey designing, construction and operation.

6. Foundations of modern theory and practice of radioelectronics and light range finding engineering methods of automation use and electrooptical means for measurements in engineering and geodetic works. Foundations of computers for treatment and analysis of measurement and observation results. Programming methods.

7. Economics, scientific methods of planning and organization of field and office engineering-and-geodetic, astro-geodetic, gravimetric, topographic and phototopographic works.

An engineer-geodesist should be able to:

1. Develop technical projects, carry out calculations, make up an estimation for performing any geodetic works, as well as carry out field and office geodetic works, which require high qualification of an engineer, on all stages of engineering construction enumerated under section "should know".

2. Organize field and office geodetic works and direct their performance.

3. Make up technical projects, organize and carry out watching by means of geodetic methods deformations of engineering constructions in the periods of construction and operation.

4. Organize and supervise an over-all plan of a construction under building, read easily technical and building drawings.

5. Keep technical and financial accounting documentation for geodetic works being performed.

6. Guarantee safety of personnel and technical means when performing geodetic works.

3. Profile for Training an Engineer in Aerial Photogeodesy

Modern topographical maps are made based on geodetic measurements performed by means of aerial photosurveying and photogrammetry. Aerial photogrammetric methods provide engineering surveys for construction.

Besides mapping the Earth, the world ocean and other planets of solar system remote sensing makes it possible to explore natural resources and environmental control.

Accordingly an engineer-aerophotogeodesist should know:

1. Schemes and programme for designing the state astro-geodetic net.
2. Theory and methods of geodetic measurements and approximate astronomic definitions, arrangement of geodetic devices and ability to use them in his work.
3. Theory of aerial photography, aerial photosurveying, photogrammetry, aerial photo identification and methods of their use for map compiling.
4. Construction and operation of aerial photosurveying and photolaboratory equipment and photogrammetric devices.
5. Theory and methods of mathematical treatment of geodetic and photogrammetric measurement results.
6. Practical procedures of programming and operation of computers for carrying out geodetic, photogrammetric and economical computations.
7. Theory and devices for radio-geodetic and electrooptic methods for range measurements.
8. Foundations of geomorphology, cartography and methods for gathering information about a terrain from topographic maps.
9. Methods for creation of maps of different scales.
10. Economics, organization and planning of geodetic, aerial phototopographic works and foundations of scientific production control.

An engineer-aerophotogeodesist should be able to:

1. Perform designing of fundamental geodetic nets and computation of observation results.
2. Make horizontal and vertical control and identification of aerial photography.
3. Design three dimensional and horizontal photogrammetric nets by all the methods.
4. Carry out processing of aerial photography making topographic mapping by universal and differential methods.

5. Make computations and perform photography along strips and work at a photo-laboratory.

6. Carry out ground stereophotogrammetric survey and processing of photographs for solving different scientific and engineering-and-production tasks.

7. Make up technical projects and make calculations for performing aerial phototopographic and geodetic works.

4. Profile of an Engineer-Cartographer

Engineers-cartographers are trained to be able to produce topographic mapping by field and office methods, to compile and publish general geographic maps and atlases and to edit them, to compile special maps and atlases (geological, geomorphological, hypsometric, soil, geobotanic, climatic, economic, etc.).

Training of an engineer-cartographer is carried out according to a common curriculum with subdivision in the IV and V years into two specialities: engineer-cartographer compiler and engineer-cartographer publisher. Engineers in both specializations are trained as versatile specialists.

In the former the problems of special map design, development of their new types, their mathematical background and mathematical use as well as the use of new technical aids in the course of map compiling and map publishing processes prevail; in the latter – the problems of map publishing technology, analysis of materials used in printing art, development and perfection of methods and means for reproduction of maps in printing.

An engineer-cartographer should know:

1. Methods of state topographic surveys and methods of field and office editing of original topographic maps.

2. Methods of projecting, editing, delineating, preparation for publishing and publishing of geographic maps of all types.

3. Organization of map compiling and map publishing and foundation of planning, technical normalization and economics of cartographic production.

An engineer-cartographer should be able to:

1. Project general geographic maps and atlases.

2. Direct cartographic works in all their forms and in their combinations.

3. Make editing on all stages of general geographic amps and atlases production (creation).

4. Choose and compute cartographic projections for maps being produced.

5. Compile general geographic and special maps.

6. Develop and produce original copies and patterns of map delineation.

7. Develop technology of map preparation for publication and publication of maps and atlases.

8. Analyze and estimate topo-geodetic, cartographic, geographic, statistic and reference materials for creation of general geographic and special maps.

Training of engineers in geodesy is completed with defending diploma work before the State Examination Board.

Every graduate gets a unique diploma of an engineer, those who got only excellent marks in all the subjects during the whole period of studies or excellent (not less than 75 %) and good marks (not exceeding 25 %) and were prominent students in scientific societies and in social work get diploma with honours. Diploma with honours provides the possibility, following the decision of Academic Council of the Institute, to enter the post-graduate studentship immediately after the graduation from the Institute.

Resulting from the above main principles of profiles for training engineers in the field of geodesy, taking into account curricula, the duration of training at the higher educational institution can be subdivided into several cycles: I cycle includes general scientific and social-political subjects; II cycle - general technical subjects; III cycle – general-vocational (professional) subjects; IV cycle – special subjects. A peculiarity in distribution of subjects into terms is that special subjects are taught from the first year. I creates some difficulties for the students, but provides their full-fledged training and taking into account teaching practices which start from the first year,

future specialist gets the possibility of using theoretical knowledge for solving practical tasks, are trained to organize geodetic works in a right way and acquire skills which are necessary for performing geodetic measurements. That's why during the first three years the four cycles are being trained simultaneously. The general technical cycle is the largest in the course of training the first- and second-year students and is the foundation for training the subjects of the special cycle; in the third year it becomes less than the specialized one, and in the fourth year it is already possible to train only special subjects. Social-political subjects are taught during all nine terms, that provides high ideological level of fresh specialists.

The total duration of training in geodetic profile specialities lasts for 5 years.

Remarkable achievements of soviet cosmonautics resulting from artificial earth satellites launching and launching of other space vehicles resulted in creation of a new branch of geodesy, i.e. satellite geodesy. In this connection and on the base of developing researches in this branch in 1968 for the first time in the country MIIGAiK started training specialists in a new speciality, i.e. satellite geodesy. Specialist in it solves main problems of geodesy both with routine methods and using observations of AES (artificial earth satellites) and other space vehicles. They are trained for providing geodetic control (support) of space surveys of the Earth, the Moon and other planets for their mapping and detailed exploration.

In accordance with the decisions of the XXV Congress of the CPSU "... to go on in exploration and developing outer space, to increase investigations for using space facilities in natural resource remote sensing, in metrology, oceanology, navigation, communication and other needs for economy" in 1976 the Institute started training specialists in natural resource remote sensing.

When training engineers in the fields of geodesy in the USSR great attention is paid to connection between theoretical and practical training and the use of rich experience accumulated both in our country and abroad. With this aim since 1976 MIIGAiK has been changing groups of students of 12-30 students with PPR, HPR, PRB, CzSSR, SFRU for teaching and production practices.

Such contacts yield good results in the field of both teaching and educational and scientific activities of the USSR Higher Geodetic School.

The training of geodetic science and pedagogical personnel for the USSR Higher School and Scientific Research Institutes is carried out by means of the Post-Graduate studentship of the Moscow Institute for Engineers of Geodesy, Aerial Surveying and Cartography.

At present average number of post graduates in MIIGAiK amounts to about 100 annually.

The training of scientific personnel for both socialist and developing countries has been going on since 1959 and 53 candidates of technical science have been trained.

It is worth mentioning that the Post-Graduate studentship yields good results.

Regular work on training the candidates of science is carried out not only with the post-graduates but with the competitors for science degree by all Special Chairs of higher educational institutions of the USSR.

Great attention is paid to training of geodetic science personnel for Higher School and Scientific Research Institutes of Siberia and the Far East.

Great attention is paid to training the doctors of science, the specialists of the highest qualification.

There are 18 Academic Councils awarding academic degrees in the USSR. Four of them are councils awarding doctor's degrees and fourteen are those awarding master's degrees (a degree of a candidate of science).

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Reports on Asia South America

FINAL REPORT OF THE REGIONAL WORKING GROUP A S I A

M.G. Arur, India

For presentation at the sessions of IAG Commission IX during the XVIII. General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Hamburg, 15.-27. August 1983, Federal Republic of Germany.

1. Introduction

It was decided in Canberra during the IUGG Assembly in December 1979, that regional working groups should be introduced for the elaboration of educational models and to achieve a cooperation with other international organizations dealing with geodetic problems.

The following scientists constituted the working group for Asia:

M.G. Arur (India) Chairman
I. Nakagawa (Japan) Member
R.M. Gupta (India) Member

The period under report was spent mainly in collection of basic data and presenting and exchanging ideas during the symposium held in Graz in September, 1982.

2. Symposium in Graz in September, 1982

The following papers pertaining to authors from the region of the working group were presented in the symposium.

(i) Serbetci, M.: Recent Activities on the Development of Higher Education in Turkey.
(ii) Yasar, I.K.: General Aspects for Education in Geodesy.
(iii) Oshima, T.: Surveying Teaching in Japan, Past and Present.
(iv) Gupta, R.M., Arur, M.G.: Some Thoughts on the Patterns of Geodesy Education for Developing and Less Developed Countries.
(v) Gupta, R.M., Arur, M.G., Datta, M.M.: Geodesy Education in India.

The above papers were well received and followed by fruitful discussion.

3. Collection of Basic Data

A questionnaire was decided by the Working Group which was sent to as many as 18 countries in Asia and Africa for supplying the necessary information regarding the status of education in Geodesy in their country.

Countries who were addressed are:

1. Malaysia	10. Afghanistan
2. Iran	11. Indonesia
3. Nigeria	12. Israel
4. Turkey	13. Pakistan
5. Saudi Arabia	14. Sri Lanka
6. Thailand	15. Bangkok
7. Nigeria	16. Bhutan
8. Lagos (Nigeria)	17. Iraq
9. China	18. Nepal

We asked the details (i) regarding the name of the organization where Geodesy is practised (ii), where the Geodesy education is conducted (iii), details of the various education programmes and (iv) man-power requirements for next 5 years. We also requested them to suggest models of education in their respective countries. A compilation of the replies received is given in the annexure.

From the information so far received, it is evident that there is no first degree programme in geodesy in most of the Asian countries but the same is taught as an auxiliary subject in a course equivalent to degree level. It is also noticed that in many less developed countries like Bhutan, Nepal etc. the facilities for training in geodesy are not available. Hence these countries depend on other countries for training, Geodesy as a discipline or as (Geodetic Science) specialist course is undertaken in post graduate levels. These levels include post graduate diplomas with emphasis in Geodesy, a Master Degree Programme in Geodesy and a Doctoral Degree programme in that discipline. From the needs for the next 5 years programme, it is seen that requirements of scientists are a few in numbers whereas professionals are required to be 2 to 3 times more than scientists.

First degree course in land surveying programme structures appeared to differ from one institution to another, but the curriculum is similar and the contents are in broad terms devoted to:

i) Geodetic Survey Instruments including Control Survey of first and second order and computations

ii) Geodetic Astronomy including the mathematical theory of determination of position and azimuth of first and second order

iii) Photogrammetry Surveying

iv) Theory of Errors

v) Satellite Geodesy, practical aspects of processing of observations.

However, more complete data needs to be collected and efforts are to be continued.

4. Conclusion, Recommendation and Acknowledgements

The course contents of the curricula for the post of technologists and professionals appeared to be similar all over the Asian countries. They are designed for the execution of survey projects and appeared to meet the needs of the countries. However, the up-dating of programmes from time to time require to introduce new instrumentations and techniques, as Geodesy no longer pertains to provision of control for subsequent mapping. It is emerging as a full-fledged science, useful in space and sea exploration in Geophysics. At the same time it cannot be practiced without prior knowledge of land surveying. Thus training is of vital importance for the future well-being of mankind in general and Geodesy in particular in Asian countries. To achieve this it is suggested that a regional centre for advanced training in Geodesy and other allied disciplines should be set-up in one of the countries of the continent. This centre will enter to master's degree and doctoral degree programmes. Initially the faculty should be pooled not only from the Asian region but also from other advanced countries with financial assistance from United Nations.

The task of the Commission is important and needs to be continued as all the envisaged objectives have not yet materialized.

The Chairman thankfully acknowledges the support of all the members of the Working Group and the colleagues from other Asian and African countries who have helped the Working Group by their cooperation.

ANNEXURE

Country	Name of the Contact	Institution	Course Programme	Terminal Qualification Duration of Course	Student Nos.	Requirement for the next 5 years
Afghanistan	Dr. Sh. Abdulla Geological Survey (Cqoul Asat) Kabul, Afghanistan	a) Department of Geodesy, Kabul Polytechnical Institute b) Geodesy & Cartography aid office	Related to Geodesy	Ph./MD 4 to 5 years	30-40	not indicated
Bhutan	Mr. Saura Rabgye Chief of Survey, Survey of Bhutan	–	–	–	–	–
China	Mr. Li Qinghai	a) Wuhan College of Geodesy, Photogrammetry and Cartography, City of Wuhan, China b) Institution of Geodesy and Geophysics Academia Sinica, Wuhan, China c) Tongji University Shanghai	Many courses of Geodesy, Astronomy, Gravity, etc. Self study of usual context of Geodesy Basic course	4 years of degree + 1 year of graduate study – 4 years of undergraduate level	30 2 –	25 scientists 150 professionals – 450 technologists
Indonesia	Prof. Dr.-Ing. Sjamalr Mira Jurusam Bandung, Indonesia	a) Institut Teknologi Bandung b) Universitas Gajah Mara c) Akademi Teknik Nasional	Jurusan Geodesy Begian Geodesy Jurusan Geodesy	High School 8 x 18 weeks High School 8 x 18 weeks High School 8 x 18 weeks	60 50 40	100 scientists 500 professionals 2500 technologists
Israel	D. Mandelin Secretary of Prof. Pekarie, Rahavet - Israel 78100	The Weissmann Institute of Science	–	–	–	no data received as Prof. Pekarie was out of country
Malaysia	Seah Kok Seang Director of Mapping Malaysia	University of Technology	Satellite Geodesy mathematical and spherical and practical Astronomy applied to Geodesy	B.Sc. and Surveying 5 years	10	2 scientists 5 professionals 15 technologists
Nepal	Mr. S.S. Mananchar Geodetic Survey Branch Katmandu/Nepal	Survey Training Center	Geodesy, Topography Cadastral Surveying and Topography & Geodesy Survey Cadastral Survey	B.Sc. with mathematics, 64 weeks Senior Surveyor I.Sc. with mathematics, 40 weeks Junior Surveyor I.Sc. with mathematics, 40 weeks course	20 60	4 scientists 20 professionals 250 technologists
Thailand	Lt. Gen. Swasdi Pachimkul, Royal Thai Survey Dept., Bangkok 18285 Thailand	Survey School	Surveying and Mapping	undergraduate level course of 33 weeks	10	10 scientists 35 professionals 15 technologists

REPORT OF WORKING GROUP SOUTH AMERICA

A.A. Cerrato, Buenos Aires

Foreword

To prepare this report a list was compiled of South American study centres that teach Geodesy and related subjects, at universitary level, or presumably might do it.

In the wish of directing consultations to the most representative ones, it was adopted as selection criteria, their foundation date and a relatively high number of students and professors.

(The "Universidad Nacional Mayor de San Marcos" of Lima - Perú, was established in 1551; the "Universidad Nacional de Córdoba" - R. Argentina, established at the start of the XVII century, has about 43.500 students and 5.000 professors distributed in several careers).

In June 1981, thanks to the support of the National Committee of the IUGG, explanatory notes were sent to Deans and Directors of those universities that could have schools for Surveying, Geographical Sciences Engineers etc., and so might have to face the teaching of Geodesy and related sciences. As many as 47 notes were so distributed: Bolivia (1), Brazil (8), Colombia (4), Chile (4), Ecuador (3), El Salvador (1), Guyana (1), Honduras (1), Nicaragua (1), Panamá (1), Paraguay (1), Perú (3), Puerto Rico (1), Uruguay (1), Venezuela (5) and Argentina (11).

Some Central American Countries were included in the inquiry on account of their being Spanish-speaking.

Details were asked about those careers, admission requirements, teaching levels, plans for the future and the names of other institutions whose tasks are similar and might also give that information.

We also sent copies of Commission IX purposes and registration forms to the Graz Symposium.

Up to August 1982, 20 answers were received from: Brazil (8), Colombia (1), Puerto Rico (2), Uruguay (1) and R. Argentina (7).

The particular characteristics of the teaching of Geodesy in Argentina are certainly known by the writer, on account of his activities at the University of Buenos Aires and that National Committee.

With all this information and that which is included in the joined Annex, he will attempt answering the general questions proposed at Commission IX.

Geodesy and Education

Among those sciences that are devoted to the study of the Earth, Geodesy is engaged in its geometric-mathematical description, with the greatest possible accuracy.

The enormous development of technology in the last decades has notably improved the measuring instruments considered as traditional and created other ones, absolutely new, that force a deep revision in the methodology developed along centuries.

Electronic computation has reached high levels of power and economy, that were unimaginable a short time ago, and that allow the application of statistics methods of analysis and filtering of data for the most efficient calculation of results.

Automation keeps going on, inexorably, in all the steps of the geodetic process, from the measurement stage to the achievement of the final document.

The artificial satellite, in a few years has helped solve many problems that worried geodesists, so accelerating the race towards the unattainable horizons of knowledge.

Geodetic measurements are now reaching accuracies in the range of variations of geometrical and physical parameters of the Earth.

Time, once a variable considered as an observation in Astronomical Geodesy and also, but with greater care, in Satellite Geodesy, now enters as a fourth dimension at geodetic points, in the latest field of Geodynamics, that now shows a strong development, rushed by the impulse of all Earth's sciences.

Electronic distance meters, the interferometric ones, static and falling body gravity meters, horizontal pendulums, signal receivers for Doppler effect satellites, inertial positioning, VLBI, and other devices are wonderful systems but so expensive that may well be out of reach for many professionals

and even for some universities.

The situation gets worse because of the growing production of instruments, always more sophisticated but that very soon becomes obsolete.

The whole teaching of Geodesy and related sciences: Topography, Photogrammetry, Cartography, etc., in all their extent; theory and practice, would now embrace an enormous field of knowledge, that must deserve a careful meditation, to establish their reasonable extent and that most convenient methodology.

It has to be realistic, taking on account that an academic career has as an aim a professional diploma that enables the future activity of the graduate, in his country or region, but conditioned to his insertion in a series of guidelines, established not only by his personal ambition, but, also, by the sociological and economical possibilities of the environment.

Some Comments about Education in Geodesy

In modern civilization, the teaching of the ever growing field of knowledge, reaches the characteristics of a fundamental and much demanding activity.

It is a process of transference of intellectual values that, for several reasons, can't only depend on the goodwill and initiative of each particular teacher, whatever his eagerness for offering all of his experience, nor of the pupil's, that is overwhelmed by the problems of an overcrowded learning process.

The problem is very important and is undergoing a deep crisis from which Geodesy can't escape.

It turns out that every time it is more difficult to teach all the desirable facts, and a process of selection must be undertaken, starting to cut off some branches of the luxurious tree of knowledge, that seems to grow up indefinitely. Of course, the cutting starts at those branches that are getting dry. It is a necessary process, but painful, specially when remembering the very good fruits they have yielded during so many years.

From the student's point of view, the restrictions arise, near totally, from the allowable time, the number of years in which he is incased in his academic career, that restricts the total knowledge he can acquire in benefit of an adequate process of assimilation of concepts.

The environment also acts by means of local usages and necessities, academic tradition, territorial extent, population density, economic possibilities, etc.

In developing countries or those that are away from the great centers of research and instruments production, the cost of new procedures may be unaffordable.

Doubts arise about the convenience of preparing professionals qualified in the utilization of sophisticated techniques that will be outside their immediate possibilities.

The real needs, present and future, must be carefully weighted, to put teaching in its adequate dimension and decide its best course.

The plan for a technical career usually follows this general scheme:

Basic subjects:	Mathematics - Geometry
	Physics - Chemistry
Professional subjects:	General
	Special
Complementary subjects:	Legal
	Administrative
	Financial
	Professional practice
	Cultural

The proportion ascribed to each group will depend on the kind of professional to be trained and from his relation with the environment.

These subjects can be distributed in different ways in several education stages, leaving perhaps part of them for their later teaching in complementary courses, post-graduate, etc.

Certainly this solution is most convenient, because the content of studies will be relieved in the stage of assimilation of technical subjects, the most specified ones for each profession.

A good basic formation that may give the mathematic fundamental principle to solve any further development, is the best choice at this era of great evolution. But not a minor problem is to limit that basic formation to what is just reasonable.

Part of teaching of these subjects, the most elementary, should be shifted to the secondary school levels. As the physical mathematical sciences are of

growing application in every branch of science, the knowledge of this basic part will surely benefit professionals of the most different specialities.

When preparing the plans for geodetic careers, it must be decided the depth to assign to each subject in relation to the labor possibilities set by environment and primary interests of the country.

Geodetic works are performed in so many characteristic stages: previous planning, reckoning and materialization of points in the field, measurements, calculations and up to the production of the final document.

It is a long way, that embraces a wide spectrum of activities, where many people may find place according to their specialization, personal capability and, sometimes, their own will.

In only a few occasions it may happen that, from an early age, people have a definite idea about their destiny.

So, it should be convenient to put some flexibility into the contents of the plans of study, letting different possibilities opened for a later updating and specialization, to be afforded when needed.

This can be the case, for example, with those subjects devoted to commercial and financial management, that perhaps are necessary after some years of being in the professional practice.

Educational Levels

As regards the different educational levels and their distribution in the labour structure of the profession, it must be taken into account the very notorious influence of the last electronic system on this science of careful measurements and complicated calculations.

In regular works, all the operations are becoming more and more automated and the departure is widening between the technician that pushes buttons on instruments and the professional that has the knowledge to carry on the most complete methodology.

As many field measurements cease to be as in old times a very specialized task, the requirements for the training of technicians are diminishing; at the same time the number of professionals of the highest level needed to direct and advise them also diminishes.

In developed countries specialization seems to be the most noticeable feature. But, widely informed professionals must also be present, with a deep knowledge of Geodesy, Geophysics and other Earth's sciences to keep improving the geodetic activity and looking to the future.

The rate of development of a country and, specially, of its geodetic activities, will indicate the best needed distribution for its technicians and professionals, at different levels.

The more underdeveloped the country, the simpler will be this distribution.

Present Situation in Argentina

In the Argentine Republic, there are technicians and professionals trained to undertake topographic - geodetical tasks, at different levels and degrees of responsibility.

The first step is reserved to the geographic-mathematic technicians (Técnicos Geógrafo-Mathemáticos) trained by the "Consejo Nacional de Enseñanza Técnica", in collaboration with the "Instituto Geográfico Militar" (Military Geographic Institute), graduating age about 18, at a secondary school level, with the purpose of acting as auxiliary personnel for the professional topographer or geodesist.

At the university level, there is the Land Surveyor (Agrimensor). Because of the historic antecedents of this title, the vastness of the country, the characteristics of land property and the evolution of techniques, he has a very varied and well reputed action.

The Surveyor has all the knowledge necessary for measuring the land and is a specialist in the tasks that aim at obtaining the chart. He also has the necessary juridical information to study deeds as an unavoidable step in the land measurement, to materialize it conveniently, on site and documents.

As a general rule, a Surveyor takes 4 years of university, to get his degree.

Some Argentine universities have now extended this career up to 5 years, giving the degree of Surveying Engineer (Ingeniero Agrimensor).

The reason for this change is not only to increase studies for more knowledge, but also to get an academic Engineering degree. That because of administrative reasons insures a higher hierarchy in the structure of professions, in our country and abroad.

Professional unions and universities are used to organize supplementary courses for graduates, for information and up-dating knowledge on instruments, cadastre, appraisement, law, etc.

As a higher degree we have that of Geodetic-Geophysical Engineer ("Ingeniero Geodesta - Geofísico"). In the University of Tucumán this career is a basic one (5 years of studies) and in the University of Buenos Aires it is a Post-Graduate career, for Surveyors and Civil Engineers, needing studies for 2 years, plus field works and a final thesis.

Giving to this professional a whole vision of necessities and possibilities of the country, the studies of Geodesy and related sciences are carried up to their higher levels.

A New Curriculum for Surveying

The Council of National Universities Rectors has convened a special commission of professors and representatives of the "Federación Argentina de Agrimensores" (Argentine Surveyors Confederation) to analyze the study plans and contents for the career "Land Surveying", and to project a curriculum that may satisfy the minimal contents.

The commission agreed on this plan

Basic subjects	Hours
Introduction to Land Surveying	60
Algebra	150
Mathematical Analysis	300
Geometries	150
Trigonometry	60
Physics	300
Probability and Statistics	75
Adjustment Calculus	90
Geomorphology	60
Edaphology	60
Laws (for Land Surveying)	240
Economy and Finances	75
Rural Economy	105
Building Economy	90

Professional Subjects	Hours
Topography	300
Topographic Drawing	100
Photogrammetry	150
Photointerpretation	90
Geodesy	345
Special Measurements	120
Cartography	150
Boundaries and Surveying	150
Land Regulation	120
Cadastre	150
Systems of Land Information	150
Organization of Surveying Works	60
Appraisement and Valuations	150
Final professional work	150

A Proposal for South America

This region has its very own characteristics: The great extension of some countries (Brazil: 8.512.000 km^2, Argentina: 2.776.000 km^2) and a rather low density of population that is distributed irregularly, the greater part near the coasts.

The pyramid of personnel devoted to geodetic and similar tasks would have the Technicians at its base, graduated at a secondary level (high school, specialized courses of some 4 years).

They should be able to accomplish field measurements with topographic, geodetic and electronic instruments, as well as routine calculations with electronic computers of different capacities.

They would act as technician auxiliaries.

The following stage would be assigned to "Land Surveyors" ("Agrimensors"), Surveying Engineers ("Ingenieros Agrimensores") and Cartographic Engineers ("Ingenieros Cartógrafos") who will be able also to plan and direct the geodetic and topographic works.

The land surveyors do attest the land property, cooperate to develop and maintain the cadastre, etc.

The diploma is obtained after 4 or 5 years of an university career, that must include such subjects as land property, cadastre, routes and railroads, juridical, ecological and sociological subjects and all other that are necessary to a good accomplishment of the social objectives of this profession.

In a higher level would be situated the Geodetic and Geodetic-Geophysical Engineers ("Ingenieros Geodestas - Ingenieros Geodestas-Geofísicos"), with 5 or more years of university career and other requirements.

He must have good general information about the Earth sciences to insure a good knowledge of the planet as a whole.

A strong mathematical and physical training must be the basis of this profession as well as a good knowledge about data analysis and computation.

All these professions refer to activities to be carried out on firm land.

In countries that may have rivers, lakes or sea coasts a professional structure must be prepared to work in those places.

The first objective could be attained at a secondary (high school) level. It would be that of Hydrographic-Oceanographic Technician ("Técnico Hidrógrafo-Oceanógrafo"), appointed to auxiliary tasks in this type of work, and to routine calculations.

With an appropriate academic organization perhaps these studies and degrees may be put together with the above mentioned Technical Geographer.

The highest level would be that of Hydrographer-Oceanographer, Master Hydrographer and Oceanographer and Hydrographic Engineer ("Hidrógrafo, Oceanógrafo, Master Hidrógrafo y Oceanógrafo, Ingeniero Hidrógrafo"), each one with 5 or more years of an university career.

Teaching and Research

A good, very well planned education, with competent professors and responsible students will produce able professionals in whom strong needs of study and perfectioning will certainly wake up.

Investigation will spring up as a natural human fact, induced by curiosity and desire of improving.

This will be the right moment to face the possibility of affording a higher level, the Doctorate in these specialities, when real excellence may justify this high distinction.

ANNEX

Some Information about the Education in Geodesy in South America

ARGENTINE REPUBLIC

In Argentina, universities are official or private. In the first ones, teaching has been gratuitous up to two years ago but now there is a small payment that is bound to help the students.

Normal admission age is about 17-18, after high school (secondary school) having to pass a special examination that selects the best qualified ones.

Engineering careers must be 6 years long and confer the diploma of Engineer, the highest academic technical degree.

Up to now no Doctorship has been established in engineering.

In the "Facultad de Ingeniería - Universidad de Buenos Aires" and during many years, the career of Civil Engineering embodied the teaching of Topography and Geodesy. And, having passed all the examinations of the 3rd year, Communication Lines and Geodesy it was possible to get the diploma of Land Surveyor (Agrimensor).

This career is now studied in 4 years, as an independent one, and some technical and complementary subjects have been added: Physical Geography, Photogrammetry, Rural Information and Colonization, Agricultural Hydraulics and Drainage, Cadastre, Cartography, Cartographic Design, Legal Surveying, a second course of Topography and one of Geodesy (Physical and Satellite).

The profession is oriented towards the carrying out of the tasks of Geodesy and Topography, to obtain the chart, to make real surveys, cadastre, etc.

The greatest number of Argentine universities follows this scheme with variations on behalf of local necessities, but some of them have extended the courses up to 5 years and grant the degree of Surveying Engineer.

In the Facultad de Ingeniería of Buenos Aires there is the Institute de Geodesia whose first director was Emerit Prof. Engr. Eduardo Baglietto. It was

established to encourage the investigations he had started in 1934, in the field of Geometric, Astronomical, Gravimetrical and Physical Geodesy.

In that institute there is a Graduate School that may be entered by Surveyors and Civil Engineers from all the country.

Its scope is to form engineers that join the mentality of the engineer builder of goods and the specialists of the Earth.

Studies extend for two years, with many specialized subjects as: Physical Geodesy, Photogrammetry, Astronomical Geodesy, Statistics and Adjustment, Special Mathematics, Applied Electronics, General Seismology, Geomagnetism, Geophysical Gravimetry, Cartography, Surveying Seismology, Geoelectric Surveying, Agricultural Hydraulics, Drainage, Oceanography, Hydrography, Applied Geology and Economy.

Students must also attend a Geodetical and a Geophysical Field Campaign and work on a thesis suggested by their professors.

Having passed all their examinations and requisites, they receive the diploma of Ingeniero Geodesta-Geofísico (Geodetic-Geophysical Engineer).

There is another specialization, that of Hydrographic Engineering, that adds elements of Harbors and Channels and Elements of Navigation.

This school was established in 1959 and has prepared about 100 professionals. Some of them have made important careers abroad.

The "Universidad Nacional de Tucumán" prepares Surveyors and Geodetic-Geophysical Engineers, both in regular grade courses.

Prof. Engr. R.N. Sánchez (now teaching Geodesy at the University of Laval - Québec - Canada) some years ago organized in Tucumán courses of advanced level in Analytical Photogrammetry (Prof. Konecny - F.R.G.) and Geodynamics (Prof. P. Melchior, Brussels, Belgium).

He also put up a registering station for Earth-tides with horizontal Verbaandert-Melchior-pendulums.

In the "Universidad Nacional de La Plata" courses of Geodesy are given to the students of Surveying.

The "Universidad Nacional del Nordeste - Facultad de Ciencias Exactas y Naturales y Agrimensura" and the "Universidad Nacional del Sur" also have courses in Surveying.

The "Universidad Católica Argentina" is private and has courses of Topography and Geodesy for students of Civil Engineering. Computation is applied to digital models of the land.

The Argentine Army has an "Escuela Superior Técnica" to prepare Officers-Military Engineers - with different specialities.

The Geographic Service prepares them for future directive places in the "Instituto Geográfico Militar" (Military Geographical Institute) which is in charge of the chart of the country.

The "Instituto Tecnológico Buenos Aires" depends on Argentine Navy and prepares specialists in Earth's sciences. Now it is preparing Licenciates in Meteorological Sciences, in Hydrography and in Oceanography, with the necessary geodetic-topographic background.

Education in the Secondary Level

After the elementary school (ages 6-12) follows High School.
At this level, the "Consejo Nacional de Educación Técnica", an official civilian institution, maintains the "Escuela Nacional de Educación Técnica María Sanchez de Thompson" that prepares Técnicos Geógrafo-Mathemáticos (Geographic-Mathematic Technicians) in 6 years, the last 3 in the Instituto Geográfico Militar by a special agreement. They are able to perform auxiliary tasks.

The "Servicio de Hidrografía Naval" (Navy's Hydrographic Service) has a school for cartographic designers.

BRAZIL

From the information we have received it comes out that this nation shows characteristics similar to those of Argentina.

According with the information of the Director of the "Instituto de Planejamiento e Estudios Ambientais - Universidade Estadual Paulista Julio de Mesquita Filho" in Brazil there aren't specific basis courses for geodesists, aerophotogrammetrists, etc., only for Cartographic Engineers. Specialities

are obtained in post-graduate specialization courses.

There aren't technical courses at secondary level but it is planned to introduce them.

The first institution to program systematic teaching in geographical sciences at an university level, to obtain topographic, thematic and special charts, was the "Escola Técnica do Exército", now "Instituto Militar de Engenharia" (1941), that is preparing engineers for cartographic works.

The "Universidade do Estado de Guanabara" in 1965 started to prepare Cartographic Engineers with a most complete field.

Now there are such courses at the "Universidade do Estado de Río de Janeiro", in that above mentioned "Instituto Militar de Engenharia", at the "Universidade Federal do Paraná", the "Universidade Federal de Pernambuco" and the "Universidade Estadual Paulista".

The "Universidade Federal do Paraná" has had post-graduate courses since 1971 and will start Doctorate in the next two years.

The "Instituto Militar de Engenharia" programmed to start in 1980 a Master in Cartographic Engineering.

The profile for the Cartographic Engineer would include: geodetic nets, astronomy, gravimetry, processing, charts, appraisements, technical assistance, teaching, judicial actions and astrophysical studies (missiles, satellites).

In the "Universidade do Estado de Río de Janeiro" - Instituto de Geociencias - Departamento de Cartografía - the course of Cartographic Engineering takes 4.800 hours, 40 % for the basic (27 professors) and 60 % for the professional cycle (17 professors from the Cartographic Department and 10 from other universities).

The same career at the "Instituto Militar de Engenharia" takes 1.620 hours for the first two years, 2.220 hours for the other three plus 375 hours for the final project.

In the "Universidade Estadual Paulista Julio de Mesquita Filho" - Instituto de Planejamiento e Estudios Ambientais, it takes little more than 4.700 hours, 33 % devoted to basic subjects, 16 % to the general professional subjects, 30 % to specific ones, 3 % to complementary (gymnastics, Brazilian problems) and the remaining 18 % to the supervisioned works and final projects.

Its studies adopt a "credit" system of greater academic flexibility.

At the "Instituto Astronómico e Geofísico de la Universidade de São Paulo" courses are given about Elements of Geodesy, Introduction to Gravimetry and Physical Geodesy, this last one is in charge of Prof. Camil Gemael well-known because of his activities at the University of Paraná.

The courses of Cartographic Engineering at the "Universidade Federal de Pernambuco", Departamento de Engenharia Cartográfica, give predominance to Cartography and include Remote Sensing and Photointerpretation.

The "Escola Nacional de Ciencias Estatisticas" maintains a Technical Course "Geodesy and Cartography" that includes Photogrammetry, Topography, Geodesy (also Gravimetry) and Cartography.

COLOMBIA

At the "Universidad del Valle - Cali" - División Ingeniería, the careers of Civil Engineering and Topography are studied. In the latter Topography, Photogrammetry, Geodesy and Astronomical Positioning are included.

The high cost of instruments creates problems in teaching and professional practice.

PUERTO RICO

At the "Universidad de Puerto Rico" - Recinto Universitario de Mayaguez - Escuela de Ingeniería - Departamento de Ingeniería Civil, there is a Baccalaureate in Surveying and Topography and an Associated Degree in Surveying and Road Building, that qualifies students as auxiliars of Surveyors and Civil Engineers.

At the "Universidad Politécnica de Puerto Rico" courses of Geodesy are given.

URUGUAY

At the "Universidad de la República" - Facultad de Ingeniería, there is a 5 years career of Surveying Engineer, to plan geographic tasks, cadastre and the national chart. This is a responsibility of the "Instituto Geográfico Militar Uruguayo".

VENEZUELA

At the "Universidad del Zulia - Facultad de Ingeniería" and School of Geodesy, Surveying and Geodetic Engineering are studied in 10 semester careers.

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