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THE EDUCATION IN GEODESY AND SURVEYING IN DENMARK

by

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Abstract

In Denmark geodesists and cadastral surveyors traditionally have been trained separately.
The education of the former is based on a thorough knowledge of mathematics and consequently leads to a high theoretical level.
The training of the cadastral surveyors has to include cadastral knowledge and town planning as well. They obtain a broad knowledge in surveying, but a moderate knowledge in geodesy. Both geodesists and surveyors will be trained in at least one field of specialization so that they reach a level enabling them to pursue a research career. Thus they have different knowledge and background.
We consider it important that the research teams are broadly compounded. We are doubtful whether one "ideal" education for geodesy and surveying does exist.

Introduction

In the following we will make a distinction between geodesists and surveyors based on their types of qualification and type of training. This distinction is somewhat artificial, because in practice there will exist persons who have qualifications and training somewhat in the middle of what we are going to describe.

In short, a surveyor will know a great deal about geometrical geodesy, including cartography and photogrammetry, only very little about physical geodesy, but will be trained in various economical and legal fields, including environmental planning.

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The geodesist will know about geometrical and physical geodesy and also a great deal about mathematics, statistics, physics, geophysics, astronomy, and computer science.

Besides these two groups we have a number of civil engineers who have specialized in surveying and/or photogrammetry. We will not discuss their type of education here.

Both the geodesist and the surveyor will be trained in at least one field of specialization so that they reach a level enabling them to pursue a research career.

While there is a relatively great demand for surveyors in Denmark (20-30 per year), the demand for geodesists is very limited (1-2 per year).

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 at the Central Institute of Mathematics of the Faculty of Natural Sciences. This Central Institute 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, edm, 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 advantage 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").

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Some of the courses are combined 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 ½-1 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 standpoint, 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, who have specialized in geodesy over the years (totally about 40 since 1928), have been employed some years at the DGI, and about 50% have stayed there permanently.

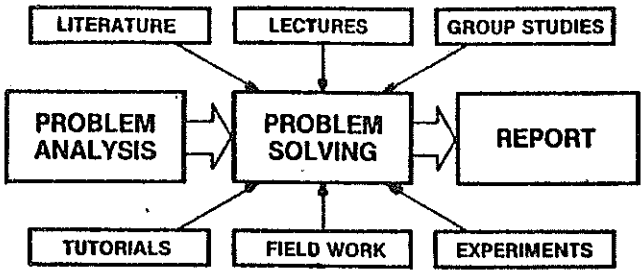
The Training as a Chartered Surveyor

Since 1974 the training as a chartered surveyor (landinspektør) has taken place at the University of Aalborg. As, with regard to training principles as well as the organization of the departments, this University is rather untraditional, we shall first give a short description of the pedagogical principles followed [3]:

Project-Organized Studies

In teaching at all levels the University of Aalborg departs from the traditional lecture form and organization in subjects. Instead, the pedagogical concept is problem-centred and project-organized studies.

This form of study provides a professional training under working conditions similar to those in occupation and thereby has a greater degree of relevance for the student.



The starting point of a project is normally a problem of practical or theoretical nature. Under supervision the students, who usually work in groups, will then formulate and analyse the problem and find ways to solve it. The project work is supported by courses of lectures, reading, discussions in study groups, tutorials, laboratory work, and other practical experiments.

At the end of each term the results of the work are presented in a report which is evaluated by internal or external examiners.

Main Groups and Project Groups

During their studies the students are organized in main groups which include up to 80 students, 6-10 teachers, and a secretary. The students are divided into smaller groups of up to 7 which constitute the real working units, the project groups. As the students progress in their studies, the main groups and the project groups become smaller because of the growing specialization. Often the last project is conducted individually or in groups of two or three students.

The main group is meant to function as a professional and economic/administrative unit, and the members of a main group are therefore located close together.

A common theme of study serves to co-ordinate the work of the different project groups. There is a wide freedom of choice as to the topics dealt with by the project groups, but they must all fall within the area defined by the common theme and must be approved by the teachers of the main group.

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Basic Year

All students start their studies by following one of four one-year basic programmes of study:

- Arts and Aesthetics
- Language and Education
- Social Science
- Technology and Science

During the basic year a group or an individual student works with three or four projects which will give both a comprehensive view of the area of knowledge covered by the selected basic programme of study and a knowledge of the most important theories and methods within that area.

It is furthermore the general purpose of the basic year that the students develop the ability to formulate problems independently and to work towards their solution. Also the understanding of interdisciplinary work and the ability to co-operate and communicate, both within and outside the academic community, are being developed during the first year of study.

The student receives from his teachers and fellow students a current impression of the way in which his work is developing and the progress he is making. At the end of the basic year the report from the last project work is submitted for marking by an external examiner.

Intermediate and Graduate Level

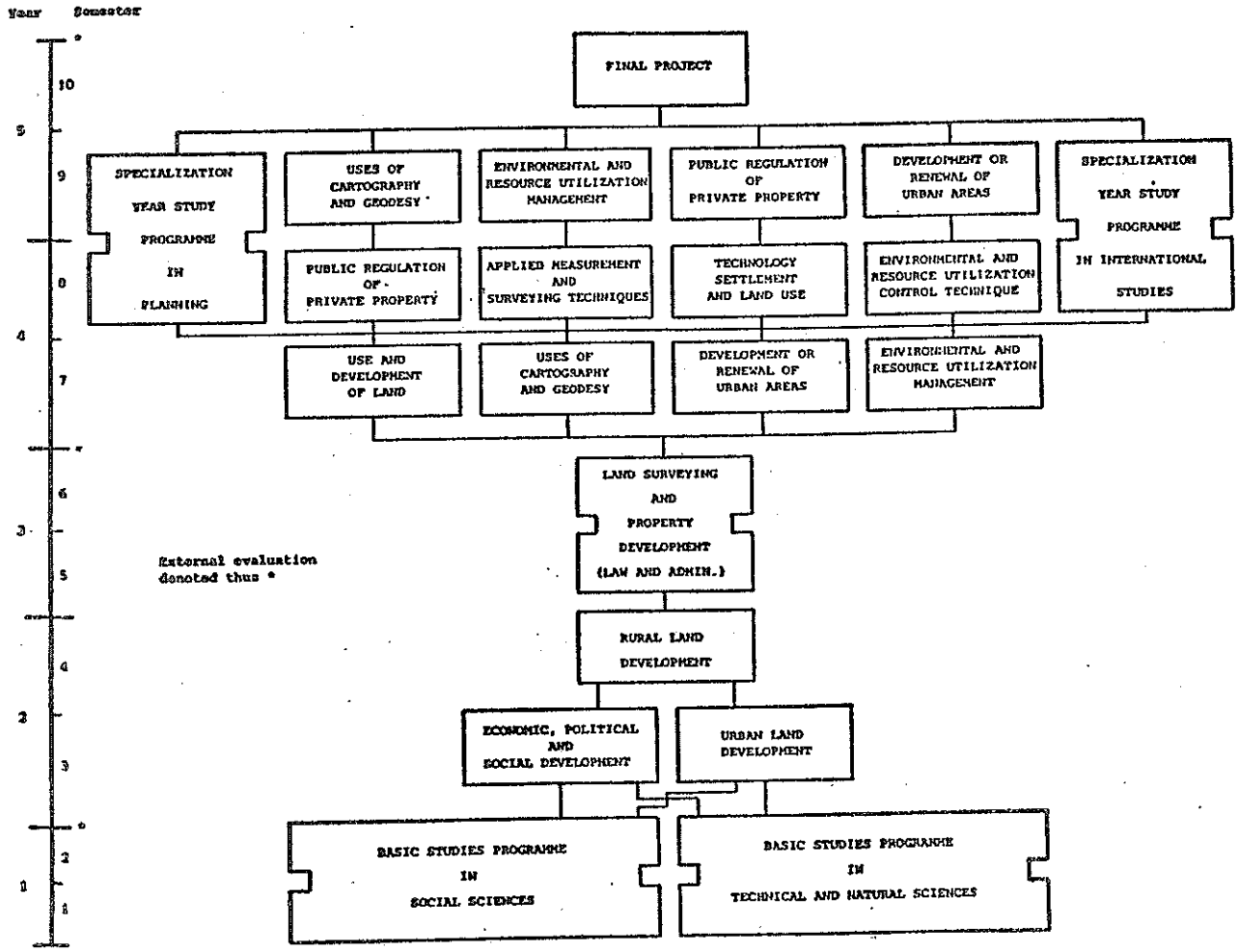
When the student has passed the one-year basic programme of study he is ready to continue in the superstructure, where the studies will be characterized by a gradual specialization. In principle the student is free to choose and combine his studies according to his own interest and ambition. However, in order to obtain certain professional qualifications the student may follow in full or in part a recommended sequence of studies.

There are study programmes of 3 to $3\frac{1}{2}$ years duration to intermediate level and 5 to $5\frac{1}{2}$ years to graduate level, both including the basic year. The decision to include the graduate level is normally made after two or three years of study.

As in the basic year the work is based upon projects supported by courses and exercises relevant to the problem which the particular project attempts to solve. In order to obtain the necessary professional qualifications courses and exercises of a more general nature are also offered. The project work as well as the general courses are both evaluated currently and at the end of each term, normally by faculty of the University and marked according to the pass-fail system.

Examinations with external examiners are held at the end of each unit of study, i.e. after the basic year and at the end of studies. The latter examinations are marked on a scale from 0 to 13, 13 being the highest possible. At least 6 is required to pass.

The specific course of study for the degree as a Chartered Surveyor is shown in the figure.



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The figure shows a subdivision into three phases, i.e. basic studies programme, 3rd-6th semesters with professional contents to achieve authorization as a Chartered Surveyor, and a specific professional specialization within the last four semesters.

The specific training programme in surveying up to the intermediate level (3rd-6th semesters) contains 1260 working hours. The contents are [1]:

1. Surveying
   a) Surveying instruments, their design and adjustment.
   b) Surveying and setting out. Existing networks, network densification; theory of errors, adjustment and computation. Detail survey and setting out.
   c) Levelling. Existing point nets, levelling.
   d) Computation of areas, graphical and numerical methods.

2. Photogrammetry
   a) The theoretical foundation. Photogrammetric map production and coordinate determination.
   b) The practising surveyor's rôle in photogrammetric mapping.

3. Computer science
   Besides the edp, which belongs to the above-mentioned topics, also the use of edp for cadastral purposes and archives.

4. Cartography, drawing, and reproduction
   Map projections, map appreciation, map production in various scales by manual or automatic methods. The production, use, and maintenance of cadastral maps. Drawing and reproduction techniques.

5. Exercises in surveying, photogrammetry, and cartography.

During the next 2 years up to graduate level the student may select the themes indicated in the figure. The themes related to surveying are the two following: Applications of cartography and geodesy. Applied measurement and surveying techniques.

It shall be stressed that there does exist a great deal of flexibility in the actual choice of project within the themes. Therefore, the students, who aim at a specialization, can do so to a high degree within the whole curriculum.

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The interested reader can in [2] find a much more detailed description of the system used in Aalborg. Also some pros and cons about the educational system are included.

Conclusion

Hopefully, the information given above unveils the differences between the training of geodesists and chartered surveyors. The vast majority of the surveyors gets employment in private practice and during the last decade also in public. Those few students, who specialize in surveying, mostly get employments e.g. in the DGI or in jobs related to off-shore duty. At these places of work it is common that both geodesists and surveyors join the same teams. Experience seems to show that they supplement each other in a very efficient way. So to the question: Does there exist an ideal surveyor or geodesist? we will answer in the negative. Society needs both types of university degrees.

References

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