CHANGES IN SWEDISH HIGHER EDUCATION IN PHOTOGRAMMETRY AND REMOTE SENSING

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Commission VI

ABSTRACT

The surveying and mapping profession in Sweden is changing from production and up-dating of map series to establishment and maintenance of digital databases which are parts of geographical and land information systems. In addition to urban information, environmental monitoring has become more important. The development towards fully digital photogrammetric systems require more education in image analysis. This has influenced the contents of courses taught to students in surveying and mapping, as well as the general trend to emphasize basic disciplines such as mathematics, statistics, numerical analysis, physics and computer science. The role of engineering in society is included to make the students more conscious about needs and goals of the profession.

INTRODUCTION

Higher education in disciplines of surveying and mapping is in Sweden concentrated to the Royal Institute of Technology, KTH, and its School of surveying in Stockholm. It has eight full professors, three of which are within surveying and mapping, namely Geodesy, Photogrammetry, and Environmental and natural resources information systems. Technical universities in Lund and Gothenburg teach the basics of surveying and mapping to civil engineering students. Faculties of natural sciences, agriculture and forestry at other universities teach remote sensing, photo interpretation and parts of photogrammetry with emphasis on applications. There is a chair for remote sensing at the department of physical geography of the Stockholm University, and another one for forestry remote sensing in Umeå at the Agricultural University. This paper will deal with the changes and trends of the education programmes at the Royal Institute of Technology and its School of surveying.

HISTORICAL BACKGROUND

The School of surveying at KTH was established 1932 with two professor chairs, Geodesy and Reallotment technology (became 1951 Real estate planning). The chair of Photogrammetry was established 1945, the chair of Irrigation and drainage 1952, the chair of Real estate economy 1964, and the chair of Environmental and natural resources information systems 1986.

The curriculum comprised four years of compulsory courses until the late 1960s, when the last two years were changed into optional courses. Students were advised to combine courses with emphasis either on surveying and mapping, real estate planning, natural resources management, or real estate economy. In the late 1970s the curriculum was again organized in compulsory courses, but after two years, the students could select one of three branches, surveying and mapping, land law and planning, and real estate economy. The development in the 1980s lead to an earlier differentiation between the branches, because the amount of common courses for the mapping and economy branches decreased. The common curriculum is 1,75 years for all surveying students, then the mapping students are separated, while the planning and economy students have still more courses in common. Today the school accepts 105 new students per year and the curriculum is 4,5 years. Approximately 20 students select mapping, 35 planning, and 35 economy.

EDUCATION IN ENGINEERING AT KTH

The Royal Institute of Technology has eleven Schools which organize educations leading to a degree, Master of Science in its field of Engineering. The schools are: Engineering physics, Computing Engineering, Electrical Engineering, Mechanical Engineering, Industrial Economy, Vehicle Engineering, Chemical Engineering, Materials Science, Civil Engineering, Surveying Engineering, and Architecture. Each school has its separate curriculum. The students apply for and are accepted to a school and they belong to that school all the time until graduation. It is very exceptional that students change school and curriculum during their studies.

Each school has 3 -7 specializations, branches at the end of the curriculum. For most schools the students select specialization after three years. The School of Surveying has a very deep differentiation; the students in mapping have make their choice already after 1,75 years. At the end of the studies the students do a diploma work and write a diploma project report. The general outline of the studies at KTH is shown in Fig. 1.

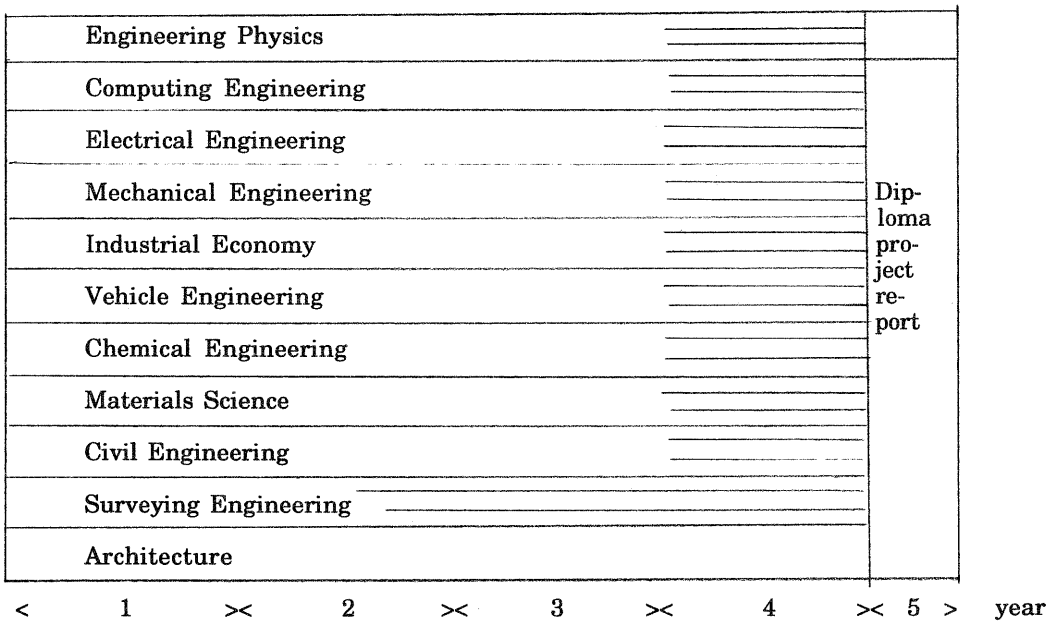

Fig. 1. General Outline of the present Master of Science in Engineering Curriculae at KTH. The horizontal lines divide the students into groups following the same curriculae.

In the first and second year emphasis is put on mathematics, mathematical statistics, numerical analysis, computing, informatics, physics, mechanics, but basic courses in engineering and applications are also given, so as to introduce the students into the subjects of their future selectives (branches). It is typical that each school has designed their own contents of courses in mathematics, calculus, etc. The teaching is given by the departments of mathematics, physics, numerical analysis, mechanics. The boards of the schools decide the compositions of the curriculae, budgets, and general policy. The schools "buy" teaching from the departments, which "deliver" the services according to the specifications.

The system of "buying" and "selling" teaching has lead to a situation where e.g. the departments of mathematics and physics teach several different courses with almost the same contents to different schools. It is realized that teaching the fundamentals of sciences and mathematics could be done more cost-effective and with a better quality if students from several schools followed the same courses.

There has also been a clear tendency that the boards of the schools have favoured their own departments, i.e. they prefer to include more courses from applied disciplines in the curriculum, rather than buying courses from departments of other schools. The members of the board represent many different categories: teachers, undergraduate students, PhD students, employees, and external representatives of the profession. No one group can have a majority of votes. In this system, and particularily in Sweden, everybody wants to make everybody happy. Department heads propose new courses, the board says yes, equal distribution of money, etc. leads to a large number of small courses in applied subjects. Students get a splintered and divided impression of the knowledge communicated to them. There is, however, big variation between the schools in this respect. The School of surveying has been able to avoid splinting the curriculum into too many and too small courses.

NEW POLICY FOR CURRICULAE AT KTH

We live in a changing society. The development is faster now than before. New needs and problems will present themselves more frequently in the future than today. Industry and government representatives talk about life-long continued learning. Universities should teach for competence rather than profession. To meet the future needs and requirements on engineers, KTH has decided a new general structure of curriculae.

The new policy says that emphasis will be on fundamentals, more mathematics, physics and computer science. More about the role of engineering in society, i.e. environmental issues, economy, languages (Swedish is a small language), resources, management. Less of applications, and less of training of professional skills. A few large courses, rather than many small ones.

The new policy will make it possible for the students to change from one school to another, and to select optional courses up to certain number of credit points and include them in their curriculum. The diploma project report will be of higher quality and comparable to a MSc thesis.

The first 1 - 1,5 years of study will be a base program in mathematics and science. There will be only two or three such programs. The next 1-1,5 years will be a base program in a school of engineering. There will be 11 - 12 such programs. The last part of the curriculum is a competence program, which

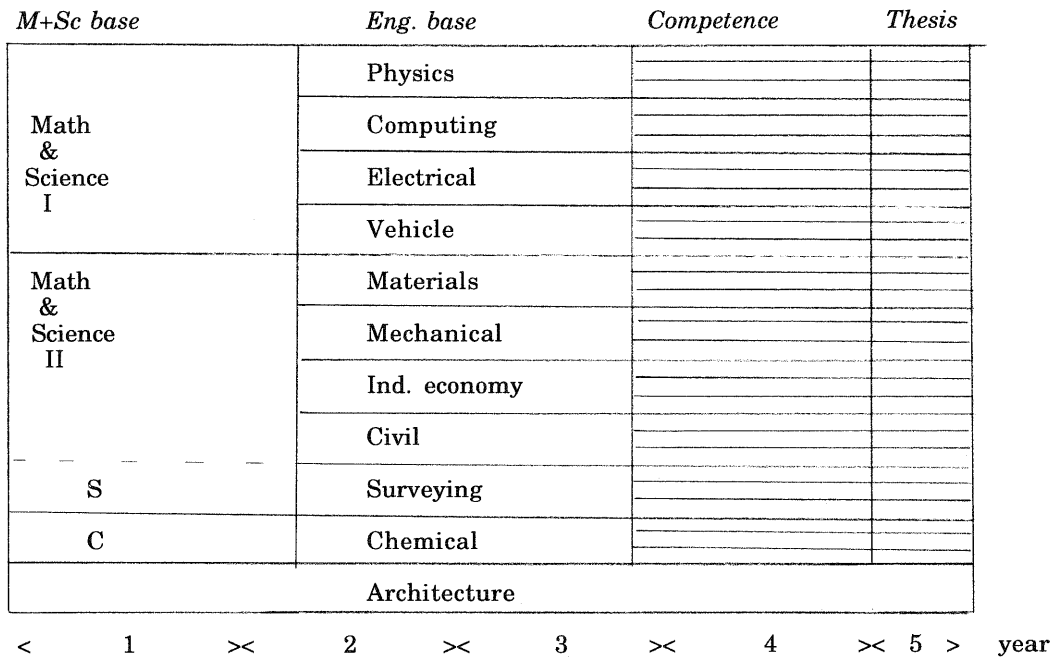

Fig. 2. New structure of curriculae at KTH.

corresponds to today's branches. There will be some 50 such competence programs. They will include a M Sc thesis. With this layout the student makes two choices during the studies: the engineering base, and the competence program. The general outline is illustrated in Fig. 2. The schools of KTH are now planning according to this scheme, which will begin to be applied for the academic year 93/94.

TODAY'S CURRICULUM IN SURVEYING ENGINEERING

The general structure of the curriculum is shown in Fig. 3. Students in surveying engineering has their own classes from the very beginning of the studies. The courses are designed for the surveying students only. Those who select the real estate economy specialization do not study any geodesy, photogrammetry, or cartography at all. Those who select the planning specialization have a first course in these disciplines together with students who select mapping as specialization. The course is called Basic surveying and mapping.

The Swedish high school (gymnasium) has a number of branches. The School of surveying at KTH recruites students from four types of gymnasiums: natural science, engineering, economics, and social science. Students from the two latter types have studied less mathematics, physics and chemistry. They are not usually taking mapping as their specialization, if and when they come to KTH's School of surveying. As the background knowledge in mathematics and sciences thus varies very much among the surveying students, not all can follow the same courses in such subjects. This has lead to a situation where the mapping students study basic mathematics and sciences also after the first 1,75 years which are common to all students at the School of surveying. This explains the math courses in the third year of the curriculum below.

The curriculae of the specializations for real estate planning and for real estate economics have several courses in common also in the third and fourth years. Similarily, students in mapping and in planning can follow the same courses in Applied geology and hydrology , and in Natural resources information systems.

Presently the curriculum for surveying students who specialize on mapping comprises the following courses:

First year:
Mathematics I
Ecology and geology
Basic computing
Basic civil engineering
Law
Land use planning
Economics

Second year:
Land use planning
Numerical analysis
Statistics I
(At this stage mapping and economy students separate from each other)
Basic surveying and mapping
Geology, hydrology and limnology
(At this stage the mapping and planning students separate from each other)
Mathematics II
Programming and data base management
Photography

Third year:
Mathematics III
Statistics II

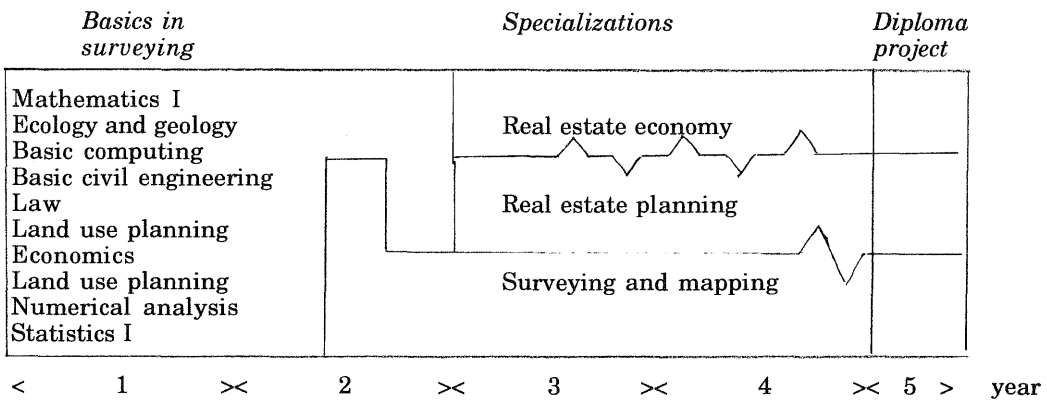

Fig. 3. General outline of the current curriculum at the School of surveying

Physics
Adjustment of observations
Cartography
Geodetic surveying
Computer-assisted mapping
Photogrammetric mapping

Fourth year:
Geodetic surveying
Advanced geodesy
Integrated surveying and mapping
Photogrammetric mapping
Photogrammetric triangulation and error theory
Remote sensing and digital image processing
Two options, either:
Engineering surveys
Geodetic positioning and
Non-topographic Photogrammetry
or:
Natural resources information systems and
Applied geology and hydrology

Fifth year: Diploma project.

PROPOSED NEW CURRICULUM IN SURVEYING ENGINEERING

The development of photogrammetry and remote sensing towards fully digital methods for acquisition of imagery, analysis, and presentation, and the merging with GIS and spatial data, has made it necessary to review the curriculum of surveying and mapping and the syllabi of courses taught by the department of photogrammetry. This process began more than a year ago, and during this process the new general policy for all curriculae at KTH was decided.

In the first stage of development of a new program the three branches mapping, planning and economy of surveying engineering presented what can be described as optimum for each branch independently of the others. That resulted in a general structure shown in Fig. 4. Already after 1,25 years of study, the students would have to decide to study mapping, or not. The students not taking mapping would study together for 2 full years before they would be separated.

After some adjustment of the curriculae in the directions given by the general policy of KTH, the surveying engineering base was increased to one full academic year. See Fig. 5. From next year only students from the natural science and the engineering gymnasiums would be eligible for studies at the School of surveying. With this general structure it is hoped that the mathematics and science base would be the same as for students aiming at civil engineering, mechanical engineering, materials science, and industrial economy. This base would be one academic year. Then the students would have their first choice, namely that of the engineering base, and those chosing surveying engineering would study that base program during the second academic year. Then they would split into one of the three specializations economy, planning and mapping. In the fourth year students from planning and mapping are offered to select environmental engineering, an option offered also to students in civil engineering.

PROPOSED CURRICULUM FOR SPECIAL COMPETENCE IN MAPPING

The following curriculum is an outline. As compared to the current program, this one has a larger common base in surveying engineering. Information techology, database management, remote sensing, fundamentals in mapping, GIS/LIS are subjects taught to all students before

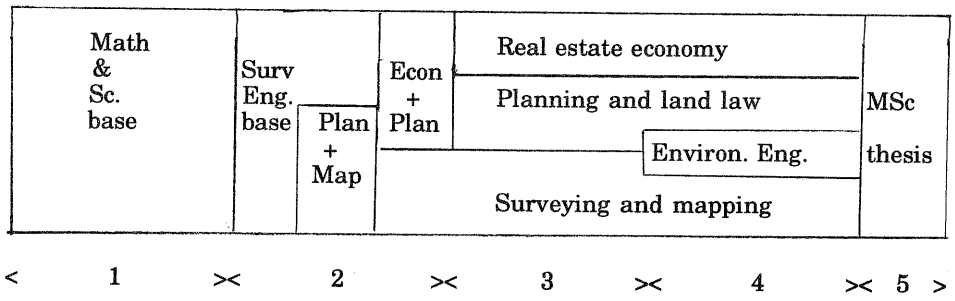

Fig. 4. First approach to general structure of a curriculum of surveying engineering

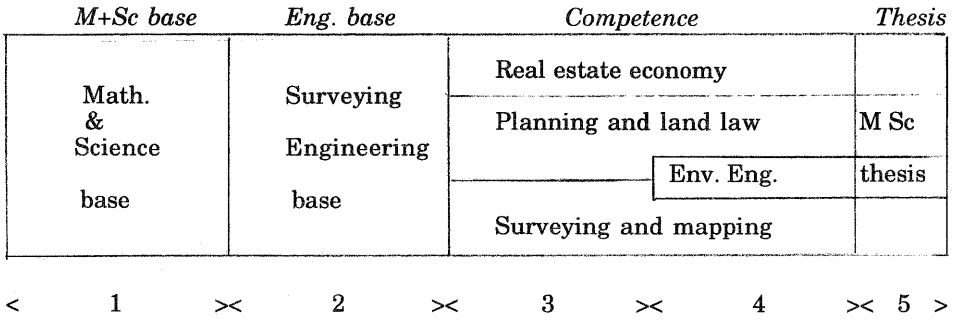

Fig. 5. Second approach to general structure of a surveying curriculum.

they specialize. The number and length of advanced courses at the end of the studies have been reduced. The numbers in the following table are suggested credit points. A full academic year is 40 points. The complete engineering curriculum is 180 points, and leads to a MSc degree in engineering.

Mathematics and Science base. 40 credit points (first year).

Mathematics and mathematical statistics	15
Programming and numerical analysis	10
Informatics, CAD/GIS	5
Research methods and philosophy	5
Environment and natural resources	5

Surveying engineering base. 40 of 50 credit points (second year).

Foundation and road engineering	5
Applied geology and hydrology	5
Real estate planning	5
Civil and public law	5
Economy	5
Building and environmental law	5
LIS/GIS	5*
Remote sensing	5*
Introduction to surveying and mapping	10*

* Compulsary for further studies in mapping.

Competence in surveying and mapping. 100 credit points (third, fourth and thesis years)

Physics and photography	5
Mathematics II and statistics II	5
Theory of errors and adjustment I	5
Digital image analysis	5
Geodesy	10
Photogrammetry	10
Cartography	5
Higher Geodesy	5
Geodetic positioning	5
Photogrammetric block triangulation	5
Digital photogrammetry	5
GIS II	5

Selected optional courses, in total 10 credit points, e.g.

Industrial geodesy	5
Physical geodesy	5
Theory of errors II	5
Non-topographical photogrammetry	5
Theory of photogrammetric errors	5
Physics II	5
Optics	5
or something else	
M Sc thesis	20

CONCLUSION

The rapid development of science and engineering, and the changing needs and problems of society, makes it necessary to define new goals for education in engineering sciences. Emphasis has been shifted in the direction of more basic subjects and less applications and professional skills. The trend for surveying engineering curriculum is more information technology related to land use, land law, land economics, environmental engineering, remote sensing, digital photogrammetry, digital cartography, GPS and GIS/LIS technology.

At the time of writing this report, the School of Surveying at the Royal Institute of Technology, KTH, Stockholm, is in the process of designing new curriculae and syllabi. The intention is to start the new program beginning from the academic year 1993/94.