

On the Introduction of Staged Bachelor and Master Courses of Study for Surveyors in Germany

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Key words: Changes in Curricula; Quality Control in Education.

ABSTRACT

Intensive efforts to create a common European environment for higher education are being undertaken in Europe. These led to the 1999 Bologna Declaration which aimed at increasing the international competitiveness of European higher education and at ensuring better compatibility and comparability of the higher education systems by the introduction of undergraduate and postgraduate levels in all countries. These levels are the degrees of Bachelor and Master. Neither of these degrees has existed until now in Germany.

In the courses of Geomatics, Surveying and Geodesy German students currently complete their studies with the degree of Diplomingenieur after a period of study of nine semesters at a technical or general University or with the more practically oriented degree of 'Diplomingenieur (FH)' after eight semesters at a University of Applied Sciences. These degrees are approximately equivalent with a Masters (Diplomingenieur) or Bachelor degree at honours level (Diplomingenieur (FH)).

Universities are individually responsible for deciding when to put the change into effect. It is likely that the existing and new degree courses in Geomatics will exist side by side for some time, since a majority of practitioners still rejects the degrees of Bachelor and Master in Germany.

In order to ensure that the high standards of education at German universities are maintained in the new courses in all faculties including Geomatics, experts from both teaching and practice are setting minimum educational standards. These standards have formed the base for the accreditation of German Bachelor and Masters degrees by independent accreditation agencies since 2000. Criteria for the evaluation of our degree courses are presented and briefly explained.

In the conclusion it is suggested that Commission 2 of the FIG should make recommendations to ensure the maintenance of quality control in education.

ZUSAMMENFASSUNG

In Europa gibt es intensive Bemühungen zur Schaffung eines einheitlichen europäischen Hochschulraumes. Das führte 1999 zur Bologna-Erklärung, die das Ziel verfolgt, die Bildungsabschlüsse anzugleichen und eine bessere Kompatibilität und Vergleichbarkeit der

Hochschulsysteme durch Einführung strukturierter, zweistufiger Studienabschlüsse Bachelor und Master zu schaffen.

In Studiengängen der Geoinformatik und des Vermessungswesens schließen bisher deutsche Studenten ihr Studium als Diplomingenieur nach einem neunsemestrigen Studium an Universitäten bzw. als Diplomingenieur (FH) nach einem achtsemestrigen Studium an Fachhochschulen ab. Diese Abschlüsse lassen sich mit denen eines Masters (Universitäten) bzw. eines Bachelor honours (Fachhochschulen) vergleichen. Der Zeitpunkt der Umstellung deutscher Studienabschlüsse auf Bachelor und Master liegt in der Eigenverantwortung der einzelnen Hochschulen. In den Studiengängen der Geomatik werden über einen längeren Zeitraum beide Abschlüsse nebeneinander existieren, da die Berufspraxis mehrheitlich gegenwärtig Bachelor und Master noch ablehnt.

Um das hohe Ausbildungsniveau an deutschen Hochschulen auch in den neuen Studiengängen zu garantieren, wurden in allen Berufszweigen durch Experten aus Lehre und Berufspraxis verbindliche Mindestkriterien zur Qualitätssicherung der Ausbildung erarbeitet, so auch auf dem Gebiet der Geomatik. Diese Kriterien bilden seit 2000 die Basis für die Akkreditierung von deutschen Bachelor- und Master-Studiengängen durch unabhängige Akkreditierungsagenturen. Kriterien für unsere Studiengänge werden vorgestellt und kurz erläutert.

Abschließend wird angeregt, daß die Kommission 2 der FIG Empfehlungen zur Qualitätssicherung der Ausbildung zusammenstellt.

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1. INTRODUCTION

In Europe intensive efforts have been made since the middle of the nineteen nineties towards the design of a uniform European university environment in the context of the creation of a common European economical and cultural environment. To this end the Ministers of Education of 29 European states signed a common declaration in Bologna in June 1999 with the aim of making the European Union the most competitive and dynamic knowledge-based economy in the world. The Bologna declaration contained compulsory undertakings regarding the creation of a common European environment in the tertiary education sector [Confederation of EU Rectors' Conferences, 1999] and covers the following main points:

- Introduction of a system of easily comprehensible and comparable degrees.
- Introduction of staged degrees in all countries, with a first qualifying degree at the earliest after 3 years.
- ECTS compatible course point systems.
- Removal of remaining mobility barriers for students and university teachers. creation of a European system of quality assurance with comparable methods and criteria.
- Promotion of the European dimension in curriculum design and education.

The introduction of structured, two-stage completion of a course of study, generally referred to as Bachelor and Master, requires a radical change in higher education policy in the Federal Republic of Germany because up until now these courses have not been available in Germany. This process started as early as October 1997 with the decision of the *Kultusministerkonferenz*, the decision-making body of the science and education ministers of the states and of the federal government, to introduce staged degrees of Bachelor or *Bakkalareus* and Master or *Magister* with the aim of making the German higher education system more attractive internationally [Kultusministerkonferenz Deutschlands, 1997].

2. TECHNICAL AND ENGINEERING DEGREES IN GERMANY

2.1 The Current System of German University Degrees in Surveying and Geodesy

Two different but single stage courses of technical and engineering sciences study exist in the Federal Republic of Germany, leading to the title of *Diplomingenieur* (engineer with a university degree). Graduates at one of altogether 8 technical or general universities must complete a nine semester theory oriented course in Geodesy and Surveying. This education is based on a thorough scientific grounding in mathematics, physics, computer science and further courses and is almost comparable with a master's degree. These graduates fulfil the prerequisites for, and have the right to study towards the degree of Doctor of Engineering.

Apart from this it is possible to attain the degree of *Diplomingenieur (FH)* (engineer with a university degree) at one of altogether 15 universities of applied sciences in Germany after completing an eight semester course of study. These courses are primarily practice and application oriented with a practical content of over 35% and produce a typical surveying engineer who has proved himself very well in the German survey industry, but is however, largely unknown outside the German-speaking world. This degree is comparable with that of a bachelor (honours) as can be obtained in some English-speaking countries.

The graduates of all German study courses finish their studies with a dissertation, which is extensive comparable with a Master thesis.

By contrast to many other countries the degree qualifications in Germany are regulated by a legislative framework for each particular degree course and type of university, which is decided upon jointly by the federal and state authorities. Supervising compliance with this legislative framework is the responsibility of about the appropriate ministry at state level. The legislative framework contains a catalogue of examination subjects, and thus determines to a large degree the subject spectrum of the course, details of the syllabi of the individual subjects, evaluation criteria for the examinations and further relevant details. On the one hand the quality of the education at individual universities is safeguarded and comparable degree courses guaranteed. On the other hand little leeway remains for university autonomy and for specific profiles at individual universities, and the process of introducing syllabus changes needed as a result of new professional or technical developments is usually complicated, bureaucratic and long-winded [Hoisl et al, 1998].

Following the granting of fundamentally more autonomy than before to many universities by the respective state governments within the last few years, they have been endeavoring to develop special profiles of their own, even in spite of scarce financial resources. In addition, the rapid pace of scientific and technical development necessitates continuous revision of course curricula and syllabi as well as the introduction of new, previously unknown courses of study, for example Mechatronics or Geoinformatics or Geomatics. The disadvantages of the German university system listed above make themselves particularly noticeable here. The lack of knowledge at international level about German degrees moreover puts the competitiveness of German universities at a disadvantage in the international arena. Finally, the existence of completely different degrees is unfavorable for a common European labour market. These reasons finally led to the decision at political level to introduce new, staged degrees. The inclusion of teaching staff as stakeholders in this reform was, however, initially low, with the result that considerable resistance to this modification of the degrees system exists in many universities and courses of study to this day.

Particularly strong reservations against staged courses of study exist in the building industry and to some extent also in surveying. Particularly in the state surveying sector, in many private surveying firms, but also at several general universities and universities of applied sciences doubts are held about the advantages of staged degrees and the existing trusted German *Diplomingenieur* system is preferred for surveying. Furthermore the introduction of bachelor and master degrees can disturb the existing hierarchy in the state sector.

2.2 The New System of Staged German University Degrees

In the late nineties the first German universities began to introduce staged courses of bachelor and master, as found commonly internationally, in technical and scientific fields of study. In the first phase postgraduate courses leading to a master's degree dominated. Both the German *Diplom* and bachelor degrees acquired elsewhere in the world are accepted as admission criteria for these courses. Since the courses call for the completion of an initial degree and often require professional experience of at least one year in addition, the universities can charge study fees for such master's courses provided that this does not conflict with the legislation of the respective state. The traditional *Diplom* courses, bachelor's degrees and master's degrees immediately following a bachelor's degree remain free of charge.

Furthermore, two clearly differentiated profiles for staged courses of studies building on the system of the present degree qualification were developed in Germany. These are on the one hand the more strongly theory oriented courses of study leading to the degree of Bachelor of Science or Master of Science. The education must be scientifically based and fundamentally and method oriented.

Besides this there is a profile for more application oriented degrees of equal status. These must be both scientifically based and application oriented. Courses of this nature must be highly practice relevant, among other things demonstrated by a practical semester of study or adequate traineeships in the curriculum. The degrees are called Bachelor of Engineering or Master of Engineering for courses of studies in the engineering sciences and Bachelor/Master of Computer Science for computer science courses. Individual universities or universities of applied sciences may usually decide independently whether they establish courses of studies of the first or second profile, and this can vary from course to course.

The framework for the introduction of staged courses of studies in Germany merely lays down:

- Bachelor curricula are at least three and at most four years long.
- Master's courses are to take at least one and at the most two years.
- In the case of consecutive courses bachelor/master the total course length may not exceed five years.
- The quality assurance of the new degrees involves short-term accreditation and regular
- Evaluations issued by independent accreditation agencies.

The *Kultusministerkonferenz* has established an accreditation council, which accredits the individual accreditation agencies to secure the quality assurance of the accreditation agencies. Independent of the quality assurance the authorization of all degree courses is the responsibility of the appropriate ministries of the individual states in accordance with the federal structure of the Federal Republic of Germany. The approval procedure is no longer as complicated and extensive as it was in respect of the *Diplom* courses. Cooperative bachelor and master's courses in association with European universities and other foreign universities are to be particularly fostered. *Diplom* courses may continue to be offered parallel to bachelor's

and master's courses. This decision lies in the common responsibility of the respective state ministries and the universities.

Overall, it may currently be predicted that *Diplom* courses and bachelor's and master's courses will exist parallel in many courses of study for a considerable time. In addition, the new system of German degrees will lead to an increased competition between the individual universities both nationally and internationally.

2.3 Staged German University Degrees in Surveying, Geoinformatics and Cartography

The first German master's course was established as early as 1999 at the Stuttgart University of Applied Sciences as a postgraduate master's course in Photogrammetry and Geoinformatics. The course lasts eighteen months (including six months devoted to a master's thesis) and is held in English. It is now running for the third time and is primarily favoured students from developing countries. Up to now no study fees are charged for. About 25 % of the 30 students get a scholarship, coming from the German Academic Exchange Service (DAAD). On completion of the course of study is the degree of Master of Science is attained.

At the University of Applied Sciences in Mainz a part-time master's course in Geomatics started starts in the summer semester of 2002. It received accreditation in 2001 for a period of four years from the accreditation agency ZEvA ("*Zentrale Evaluations- und Akkreditierungsagentur Hannover*", Central Evaluation and Accreditation Agency Hanover). This master's course runs part-time in German for four semesters. Fees are charged and the degree of Master of Engineering is attained. The admission requirements are a *Diplom* or bachelor degree in one of the following areas: Surveying, Cartography, Geo-sciences, Mathematics or Computer Science.

A six semester bachelor's course in Cartography and Geomatics commenced at the beginning of 2001 at the University of Applied Sciences in Karlsruhe. This course includes a practical semester and shall to be complemented by a consecutive master's course. An international course of studies has existed at the same university since the winter semester 2001/02 with the degree Master of Science in Geomatics. This four semester course of studies also contains study phases in Australia and is held in English.

Furthermore, a four semester master's course in International Project Management has been established at the University of Applied Sciences in Berlin in cooperation with the University of Newcastle. It is a full time postgraduate course for which fees are charged, and was accredited in Great Britain. In addition, a German-speaking master's course in Town Planning exists at the Stuttgart University of Applied Sciences. Both of these courses have also a *Diplom* or bachelor's degree in surveying as part of the acceptance criteria.

3. ON THE QUALITY ASSURANCE OF BACHELOR'S AND MASTER'S COURSES IN SURVEYING, GEODESY AND GEOINFORMATICS AT GERMAN UNIVERSITIES

The accreditation by independent accreditation agencies is the most important instrument of the quality assurance of all bachelor's and master's courses in Germany as already mentioned in section 2.2. As far as courses in Surveying, Geodesy, Geoinformatics and Cartography are concerned; only two agencies are currently prepared to undertake accreditations: These are the "**Accreditation Agency for Study Programs in Engineering and Informatics**" (ASII) and the "**Central Evaluation and Accreditation Agency of Hanover**" (ZEvA). These two agencies cooperate on the accreditation of courses in civil engineering and surveying, use the same experts as auditors in their audit teams to some extent and use essentially the same list of requirements for bachelor's and master's courses. These minimum requirements for the accreditation of bachelor's and master's courses in the engineering sciences and in computer science were set up for every course of studies by commissions of experts of the ASII on which the following bodies were equally represented: technical or general universities, universities of applied sciences and commercial associations or technical & scientific organizations and professional associations. Similarly, the audit teams are composed of 4 or 5 experts, with a representative from each of: the general or technical universities, the universities of applied sciences, industry, a second representative of the university type concerned and, optionally, a student representative. It is desirable to participate an representative of a foreign university, if international bachelor's and master's courses will be accredited. None of the experts may be employed by the university concerned or have a close relationship to the course of studies to be accredited.

Bachelor and master courses of both profiles (see section 2.2) are accredited by comparison with defined minimum requirements. These requirements are based on the recommendations of the *Kultusministerkonferenz* as developed by the Accreditation Council, as well as recommendations of the German Scientific Council. Furthermore the minimum requirements were defined in cooperation with national and international scientific organisations, professional and technical bodies and practitioners. The aim is to make diversity possible in the university sector in Germany and to ensure the quality, transparency and comparability of the education offered and the processes and resource allocation necessary to achieve this. In principle, the accreditation process is independent of the individual field of study, the university and the state. The accreditation is granted in accordance with internationally accepted standards and for a limited period of time. At the end of this period a re-accreditation is required, which includes an evaluation and examines the aims of the course and its translation into practice. To this end the success of the graduates in the labour market is analysed [Accreditation Agency for Study Programs in Engineering and Informatics (ASII), 2001].

Each bachelor's or master's course to be accredited is evaluated according to the following criteria:

- Educational objectives
- Admission criteria
- Curricular requirements
- Extent of study

as well as

- Institutional and organizational environment.

The current ASII criterion catalogue for courses in Surveying and Geoinformatics comprises the following requirements.

3.1 Educational Objectives of the Individual Modules

All modules of the structured course must be described qualitatively and quantitatively with regards to their contents, the methods of teaching and learning and the lowest acceptable standard of learning achievement. The descriptions have to be summarized in a booklet, which has to be made available to the students for the choice of their modules. Evidence of the furtherance of the acquisition of **key qualifications** by the students in the education process must be particularly described. These key qualifications include self-discipline, qualification in foreign languages, competence in communication, general abilities, social competence, critical self-evaluation and consideration of social aspects of the engineering activity [Accreditation Agency for Study Programs in Engineering and Informatics (ASII), 2001]

3.2 Curricular Requirements

In this respect the universities must describe the contents and duration (as a rule one semester) of the modules of the course together with the credit points allocated in accordance with the European Credit Transfer System (ECTS). One semester is considered to involve a student in 900 hours of working time for which 30 credit points are allocated. Thus for a typical module 4 hours a week of contact time for 15 weeks involves a total of 60 hours, to which are added 60 hours of individual study, giving altogether 120 hours or 4 credit points. If a higher quota of individual study is assumed then more credit points will be allocated.

A thesis (bachelor's or master's thesis), for which credit points are also allocated according to the time involved (e.g. 12 weeks correspond to 15 credit points) is also part of the curriculum of the bachelor's or master's course. The quality of the learning achievement is, however, described by a marking system independent of credit points [Accreditation Agency for Study Programs in Engineering and Informatics (ASII), 2001], [ASII, Fachausschuss Bauingenieur-/Vermessungswesen, 2001].

3.3 Extent of Study

The total extent of a bachelor's and follow-up master's course of studies may not exceed 10 semesters. The total of 300 credit points could, according to [ASII, Fachausschuss Bauingenieur-/Vermessungswesen, 2001] conceivably be made up as follows:

Version A

- Bachelor's degree with at least 6 semesters and 180 credit points, followed by
- Master's degree with 3 - 4 semesters and 90 - 120 credit points.

Version B:

- Qualified bachelor (honours) degree or *Diplomingenieur (FH)* with 8 semesters and 240 credit points, followed by
- Master's degree with 2 semesters plus a master's thesis and at least 60 credit points.

The minimum requirements for a Bachelor of Engineering and a Master of Engineering could, for example contain: [ASII, Fachausschuss Bauingenieur-/Vermessungswesen, 2001]

3.3.1 Bachelor of Engineering

Total content: approx. 180 Credits (version A) approx. 240 Credits (version B)

No.	Subject area	Quota
1	Basics of mathematics and science	ca. 15 %
2	Basic surveying	ca. 20 %
3	Advanced surveying	ca. 40 %
4	General subjects	ca. 10 %
5	Practical phase and thesis	ca. 15 %
	Total	100%

Typical contents:

- 1 Basics of mathematics and science: higher mathematics, geometry, adjustment theory
- 2 Basic surveying: plane surveying, software development, GPS, Photogrammetry, Geoinformatics
- 3 Advanced surveying: engineering surveying, cadastre, remote sensing, database systems, geoinformation systems, internet technologies
- 4 General subjects: foreign languages, law, land planning, valuation, professional practice.

At present the technology and hence the emphasis in Surveying, Geodesy and Geoinformatics is changing considerably, deviations from the contents given, as examples are therefore possible.

3.3.2 Master of Engineering

Total content: approx. 120 Credits (version A) approx. 60 Credits (version B)

The master's program must guarantee one of the following alternatives:

- Advanced specialisation in selected engineering subjects with communication of special methodic knowledge
- Education in specialisations beyond classic surveying subjects with a view to interdisciplinary and networked applications.

For courses of studies leading to a Bachelor of Science or Master of Science analogous requirements exist [ASII, Fachausschuss Bauingenieur-/Vermessungswesen, 2001].

No.	Subject area	Quota
1	Basics of mathematics and science	*)
2	Basics of specialisation	ca. 15 %
3	Advanced specialisation	ca. 30 %
4	General subjects	ca. 10 %
5	Practical phase and thesis	
5a	Practical project	ca. 20 %
5b	Master's thesis	ca. 25 %
	Total	100 %

*) depending on admission criteria

3.4 Institutional and Organizational Environment

Adequate provision of staffing and equipment as well as the competence of the teaching staff of an institution are also of fundamental importance to ensure that quality standards are met. Therefore the minimum requirements of the ASII for the accreditation of bachelor's and master's courses include a list of requirements concerning adequate conditions of service, the permanent provision of adequate spatial, general and instrumental facilities (lecture rooms, laboratories, computing technology, specific laboratory equipment, library) as well as the numbers and qualifications of teaching and support staff [Accreditation Agency for Study

Programs in Engineering and Informatics (ASII), 2001]. The ASII committee for civil engineering and surveying gives a number of indications for evaluating the competence and scientific activities of teachers of degree courses in building and surveying engineering, which amounts to a list of requirements for the competence estimation of the teaching staff in particular [ASII, Fachausschuss Bauingenieur-/Vermessungswesen, 2001].

4. RECOMMENDATIONS FOR THE INTERNATIONAL QUALITY ASSURANCE OF BACHELOR AND MASTER DEGREE COURSES IN SURVEYING, GEODESY AND GEOMATICS

Bachelor and master degree courses vary considerably between different countries, and to some extent even between the universities in some states. It is therefore timely, with regard to the increasing internationalisation of the national labour markets and to the gradual merging to a global labour market, to develop internationally comparable quality assurance activities in university education. To this end it is necessary to provide for standardisation of the degree courses (bachelor and master), for comparable detailed transcripts of results, for comparable Diploma supplements and for internationally accepted uniform minimum education criteria for the individual degree courses as well as monitoring of these standards. Commission 2 of the FIG ("Professional Education") could and should make an essential contribution to this effort within the next few years for courses in Surveying, Geodesy and Geoinformatics.

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BIOGRAPHICAL NOTES

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