Initiative for International Master's Program in Photogrammetry at the Helsinki University of Technology

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Key words: pedagogy, curriculum, Bologna agreement, photogrammetry, master's program

SUMMARY

Beginning in fall 2005, the surveying curriculum at the Helsinki University of Technology (TKK) was arranged according to the new European academic two-phase structure, so called Bologna agreement. The aim of the agreement is to construct a "European Higher Education Area" with a system of comparable degrees and to increase student mobility, particularly after the undergraduate level. International Master's programs and cooperation among European universities strongly belongs to the strategy of the Bologna.

The Institute of Photogrammetry and Remote Sensing takes initiative to establish international Master program in photogrammetry. Two types of models are initiated: 1) international Master's program offered by the TKK and 2) collaborative international Master's program among assembled universities in Europe. Since academic chairs of photogrammetry tends to disappear, besides the Bologna agreement, initiative also arises from need of the educational continuity in photogrammetry.

In this paper, the current photogrammetric curriculum at the TKK and its possibilities for international Master's program are described. Bologna Process in Europe and at the TKK is briefly examined, and compatibility of the Bachelor's degrees in Europe is discussed. Also issues of cooperation, student intake, funding, language issues, flexibilty and aims of the purposed program are reviewed.

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1. INTRODUCTION

At the latest in 2010, academic curriculums in Europe will be arranged according to the new European academic two-phase structure, so called Bologna agreement. The agreement aims to construct a "European Higher Education Area" with a system of comparable degrees and to increase student mobility in Europe, particularly after the undergradute level.

Beginning in fall 2005, photogrammetric studies at the Helsinki University of Technology (TKK) was arranged according to new curricula. The actual need for creating the new curriculum originated from the Bologna agreement, however, another important reason was to assure the educational continuity in photogrammetry in Finland. This concern arises from the recent development in Europe: academic interest in photogrammetry has declined and the chairs of photogrammetry tend to disappear.

On the other hand, the use of digital photogrammetry and other imaging technologies – such as laser scanners, SAR interferometry, and hyper spectral scanners – is currently growing. As a consequence, the need of academic research and employment in companies is increasing. Particularly, in the research field it is essential to have competent staff to be internationally competitive. However, it has been recently noticeable that typical photogrammetric research problems are slipping in the other fields – like in computer vision and information technologies. The reason for this progress is obvious: the science of photogrammetry has a lot of interesting and even essential problems to solve, but the research capacity is slighter compared to the other fields. Consequently, the chairs of photogrammetry have disappeared in many countries, while other fields have taken the responsibility of photogrammetric research and education. This progress has been the most evident in the Nordic Countries.

From the educational point of view, it is important to have strong chairs of photogrammetry. Furthermore, if the education generates competent researchers, the quality of research will increase – which enables better teaching. This academic circle fuels itself, if the education and capable students are ensured. International Master's programs are potential for strengthening the academic circle. On the other hand, they also allow students from those countries that no longer have their own chairs in photogrammetry to study this field of profession.

As mentioned, European countries will create an internationally competitive area of higher education by 2010. In order to fulfill this strategy, intesive cooperation among participating European countiries is needed. The uniformed credit and study system gives excellent opportunity to internationally educate a new generation of surveyor professionals, who are

able to apply existing methods and also to develope new concepts. The aims of this paper are to describe the current structure of photogrammetric studies at the TKK and to make an initiative to arrange international Master's program in the field of photogrammetry. The main focus of the proposed international Master's program is in data acquisition and accuracy concerns covering both terrestrial and aerial acquisition methods.

2. CURRENT CURRICULUM IN PHOTOGRAMMETRY AT THE TKK

In Finland, the education of photogrammetry has been an essential part of the surveying curriculum, and traditionally, it has been organized only on the academic level. Since fall term 2005, the surveying curriculum at the TKK was arranged according to the Bologna agreement. The main change was the division of the former Master's studies to two consecutive phases: three years Bachelor studies and two years Master studies. Thereafter, doctor's degree should be completed in three years.

Within surveying, the Bachelor's curriculum has two degree program options: real estate economics and geomatics. Geomatics further divides into two parallel options: geoinformatics, and geodesy and photogrammetry. During the Master's program, photogrammetry will specialize in both photogrammetry and remote sensing. Within the new academic curricula, the education is organized in modules, which build up vertical learning chains in a progressive manner. See also Vitikainen (2005).

The current curriculum of the TKK uses ECTS credits (European Credit Transfer and Accumulation System), which is regarded as a prerequisite for potential interchange of the degrees within Europe. One full year of studies will count for 60 ECTS credits, and the degree of Master of Science after five years studies will count for 300 ECTS credits. At the TKK, the first third, i.e. 100 ECTS credits will be granted for fundamental studies on engineering and technical sciences, as well as on a respective discipline, like surveying (Table 1). The second third will concentrate on studies of the degree program – like on geomatics – which constitutes the major and the minor. In geomatics, there are three major options: 1) geodesy and navigation, 2) photogrammetry and remote sensing, and 3) geoinformatics. From the remaining third, 50 ECTS credits will be used for the academic education – including Bachelor's and Master's theses – and 50 ECTS credits for freely chosen courses.

Table 1. The general structure of the new curriculum at the TKK. The modules (P, O, A1, etc.) are explained in Figure 1. The entire degree counts for 300 ECTS credits. One study year corresponds to 60 ECTS credits or to 1600 hours of work. The curriculum is divided into the Bachelor's program of 180 ECTS credits and into the Master's program of 120 ECTS credits.

Master of Science in Technology	**300**	Bachelor's studies **180**	Master's studies **120**
Technical sciences, engineering sciences, common basics of surveying.	**100**	**P** 80 **O** 20	
Geomatics profession. Major options (modules A1-A3): • Geodesy and Navigation • Photogrammetry and Remote Sensing • Geoinformatics	**100**	**A1** 20 **A2** 20 **B1** 20	**A3** 20 **B2** 20
Master's Thesis, Bachelor's Thesis. Competence in performing research and scientific tasks. Social impact, technical implementation, economy and finances, …	**100**	**V** 10 **K** 10	**C** 20 **W** 20 **M** 10 **D** 30

The studies for the Bachelor's degree count for 180 ECTS credits and for the Master's degree for 120 ECTS credits (Figure 1). The Bachelor's program concentrates on building the fundamental of technical sciences, including mathematics, physics, information technology, and engineering.

The Bachelor's degree will not validate for a professional graduation – basically it is considered as a milepost, which the students should pass before entering the studies of the Master's program. The students will learn the necessary basics for the field of science. However, the Bachelor's program should also prepare a student for professional and engineering related preparedness in a way that he/she is able to be trained at work. Correspondingly, those who have graduated from a technical institute should complete respective basic studies in technical sciences before entering to the Master's program.

The studies of Master's degree provide necessary skills and abilities to manage technical-scientific tasks. Within surveying, the specialization subjects will remain as in past: facility management, real-estate economics and assessment, land consolidation, economical law, geodesy, positioning and navigation, photogrammetry, remote sensing, geoinformatics, and cartography. These subjects cover widely tasks of our profession as modern surveyors.

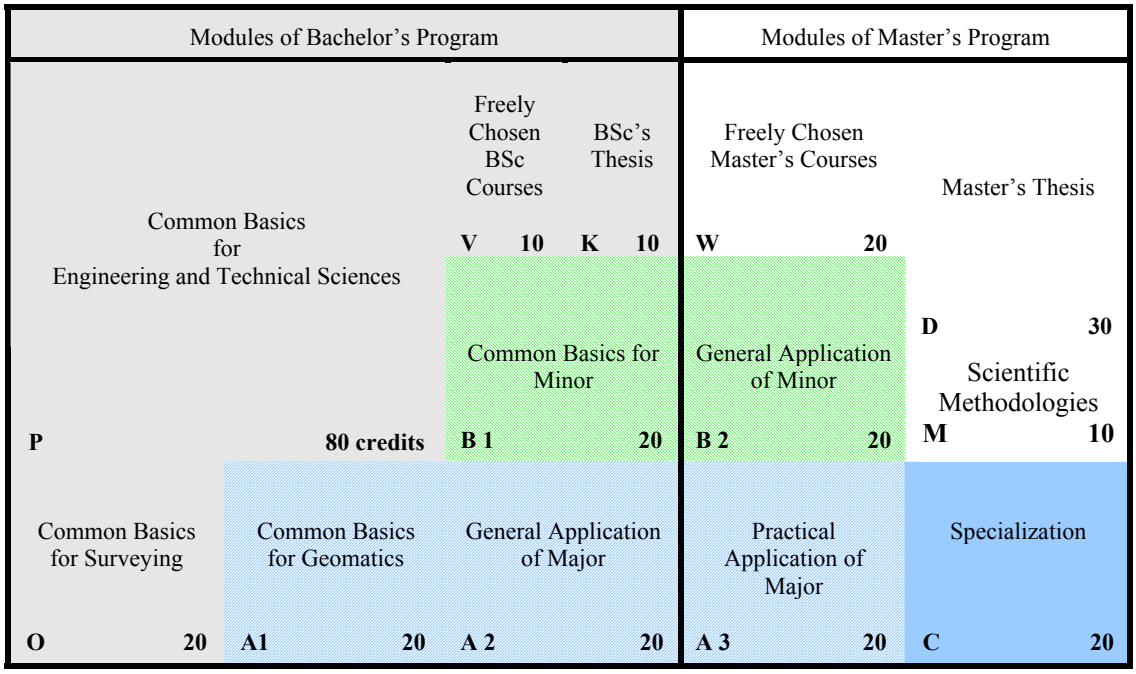

Figure 1. The new degree program in geomatics is divided in modules (P, O, A1 etc.). While major modules are named A1-A3, minor modules are B1-B2. In order to study photogrammetry in Master's level, the common route would be to choose A1 to be common basics for geomatics and A2 for geodesy and photogrammetry. Thereafter, in the Master's program, the module A3 is taken on photogrammetry and remote sensing. The minor B2 would then be e.g. on geodesy, geoinformatics, information technology, or media technology. The specialization module C will prepare for research and development of new applications and for postgraduate studies. In the C-level, separate modules of photogrammetry and remote sensing are provided.

2.1 Modules for Students in Photogrammetry

The program structure is modular. For each module, we may describe the content according to the professional and pedagogical objectives. The following descriptions relate to those geomatics students, who will specialize in photogrammetry.

The module P is common for most students at the TKK and contains the fundamental of engineering and technical sciences, as well as languages and law, economics and environmental subjects.

The module O is common for both degree programs – geomatics and real estate economics – of surveying and should give a general understanding on various tasks of surveying. Most of the students of the degree program in real estate economics do not continue geomatics studies from this point. Therefore, it also contains everything that all land surveyors should know in minimum about geomatics.

The first major module A1 is common for all students in geomatics. It contains those parts of geodesy, positioning, navigation, photogrammetry, remote sensing, cartography, and geoinformation techniques, which every student in geomatics should know. Additionally, this module gives an insight into mapping processes.

The first minor module B1 is a parallel to A1 and it can be chosen from many departments of the TKK or even from other universities. B1 in geoinformatics – the primary option for students in photogrammetry – is aimed for those, who want to become "land surveyors" in a broad sense. In any case, it can be seen that the professional competence of the surveyor at the Bachelor level depends notably on chosen B1.

The second major module A2 contains general applications of geodesy and photogrammetry. It constitutes the major subject for the Master's program. Together with the thesis K it completes the Bachelor's degree. At this point, a student will have a good insight into essential tasks of surveying. One might not have detailed knowledge on surveying expertises, but every student should be competent in finding out necessary information to carry out practical tasks. The module V is used for freely chosen courses.

The third major module A3 is the practical application of photogrammetry or remote sensing. Together with the thesis D this completes the Master's degree. It gives the student the competence to accomplish professional tasks in engineering and project management or in application development and research. The second minor module B2 for geomatics students might be e.g. the ones on practical application on geoinformatics or geodesy, or on cartography, media technology, information technology, or computer science. The module C provides the student the option for deeper specialization in his profession, as well as appropriate basis for the doctoral studies. Conversely, module C might also relate to science, engineering, as well as to business issues.

2.2 The New Curriculum Compared to the Old Program

When the new curriculum is compared to the old one, it is obvious that the weight of technical-scientific base, i.e. the module P with 80 ECTS credits, will largely remain as it has been, whereas the expertise and specialization in every major subject, like photogrammetry or remote sensing, becomes narrower than before. After the students have completed the module P, the new program structure will diverge fast and will produce various individual combinations of studies. This is due to the hierarchical tree structure of the program. In practice, every student must yearly choose a new root to proceed. For example, the chain in photogrammetry will consist of the following modules: O in surveying, A1 in geomatics, A2 in geodesy and photogrammetry, A3 in photogrammetry and remote sensing, and C in photogrammetry (Figure 3).

The new Master's program is approximately 20 study weeks broader than the previous degree program of diploma engineers. This is reasonable, since during the last fifteen years, the content and coverage of the courses within the entire science of technology has increased remarkably. However, the available funding for practical education on engineering has

simultaneously declined. For example, within photogrammetry and remote sensing the scientific area covering all relevant theory, new technology and applications has become manifold, but the amount of practical exercises has only decreased. Obviously, there is still a continuing need for developing the education at the TKK in a more efficient way.

2.3 Core Analysis of the Course Contests

While preparing the new degree programs at the TKK, the contents of all new modules and respective courses were analysed. The course contents were divided according to different types of didactic objectives. Firstly, *core content* was described as knowledge that a student must gather and learn in order to proceed. Secondly, *supplementary knowledge* was considered as useful and was included in the content, but only as a secondary. Relevant material will be given, but not necessarily processed during the course. Thirdly, *special knowledge* was regarded as relevant, but in which only some of the students might have an interest. Therefore, this will not be included into the course material, but the references are given. The content analysis of individual courses is still in process and will be adjusted according to the professional and pedagogical objectives which were set for the modules.

COURSES IN PHOTOGRAMMETRY						
	Modules of Bachelor's Program			Modules of Master's Program		
	O	A 1	A 2	A 3	C	
I Period				Practical application of photogrammetry	Close-range photogrammetry	Analytical photogrammetry II
II Period			General photogrammetry		Laser scanning	Digital photogrammetry II
III Period	Introduction to photography, photogrammetry and remote sensing	Basics in photogrammetry	Digital image processing	Analytical photogrammetry I	Computer vision	
IV Period				Digital photogrammetry I		Digital photogrammetry III

Figure 3. Courses of photogrammetry in the new curriculum and their relationships with modules. Courses are given during five years. The academic year is divided into four periods.
(Haggrén et al. 2005.)

3. BOLOGNA AGREEMENT AND COMPATIBILITY OF MASTER'S PROGRAMS IN EUROPE

3.1 Bologna Agreement

Bologna agreement is a joint declaration by the European Ministers of Education convened in Bologna on 19th June 1999. This intergovernmental initiative aims to create a European Higher Education Area (EHEA) by 2010 and promote the European system of higher education worldwide. It now has 45 signatory countries – EU member states and ascension candidates. The agreement declares that following aims shall be reached: 1) readable and comparable degrees, 2) system of two main cycles: undergraduate and graduate, 3) increased student mobility, 4) establishment of a system of credits, and 5) European cooperation in quality assurance. (European Ministers of Education 1999.)

3.2 Bologna Process at the TKK

One of the goals, when renewing the photogrammetric curriculum at the TKK, was to aid the Bologna Process. System of two main cycles was built: three years' undergraduate studies and two years' Master studies. Respectively, graduate studies aiming to doctor's degree should be completed in three years – which can also be seen as a third cycle. At the same time, credit system at the TKK was changed to be applicable in the European Credit Transfer System (ECTS) (TKK 2005a). Furthermore, the modular structure of the studies was designed to increase student mobility – in other words, students are able to include separate modules into a personal curriculum from other universities or exchange studies. Next step of the process will be the launch of quality assurance system of teaching in 2006.

3.3 Compatibility of Degrees Regarding Photogrammetry in Europe

According to the Bologna Process, the Bachelor's programs at different universities should prepare for comparable competences and provide necessary prerequisites for corresponding Master's courses. For example, a Bachelor's degree in geomatics from the TKK should enable completing Master's degree at the KTH (Royal Institute of Technology in Stockholm) or vice versa. Equivalently, comparison of the degrees should be possible after the Master's level as well.

However, when applying comparable Bachelor's degrees, various barriers remain, especially in the detailed level. For example at the KTH, the education on photogrammetry has been limited to one basic course since 2003. This course is given on the third study year and covers theory, models and applications. At the TKK, before entering to Master's program, students have passed 4 courses, total of 14 credits, in photogrammetry. In other words, competences can be hard to compare and they can significantly differ in detailed level. Therefore, comparison of the degrees in general level might not be enough, but extra photogrammetric studies might be required before entering to a program of other university. On the other hand, in general level, Bachelor's degrees in geomatics might be comparable, while the characters

of each university is more evident in the Master's level – and that diversity can be utilized by a student.

While system of degree can be specified comparable according to aims presented in the Bologna agreement, country-specific, cultural and historical viewpoints cannot be evaluated straightforward. Traditions and needs of each country are hard to combine, but in contrast, diversity can be seen as an advantage. On one hand, student could combine individual studies from a variety of universities and on the other hand, overlapping or specialization studies could be concentrated in certain schools.

The surveying majors at the TKK are partly very local and national, but in general international. In the reorganization of studies of photogrammetry at the TKK, the process was started by gathering the topics of the discipline. After that, this substance was divided firstly in modules and then in the courses. Naturally, this division does not only follow the general themes of photogrammetry, but also the research emphasis of the Institute of Photogrammetry and Remote Sensing at the TKK.

To define compatibility of the Bachelor's degree in photogrammerty in Europe, more analysis and cooperation is definitely needed. Following issues should be discussed when defining each study program:

- Study subjects, course descriptions and credits in international credit system, prerequirements of courses
- Aim and focus of the each program
- Student intake: amount, quality and prerequirements of Master's courses
- Flexibility and restrictions of the program

4. INITIATIVES

In this chapter, two initiative models of international Master's program in photogrammetry are presented: 1) international Master's program offered by the TKK and 2) collaborative international Master's program among assembled universities in Europe.

4.1 Model I: International Master's Program Offered by the TKK

International Master's program in photogrammetry offered by the TKK is planned to be equal to the new program presented in the Chapter 2. This is reasonable since Bachelor's of geomatics should be able to fluently continue to the Master's studies at their home universities. Correspondingly, the new program was planned to cover the field of photogrammetry in the way that it is also internationally competent.

The general plan of the model I is presented in the Figure 4 and descriptions of the photogrammetric courses in Table 2. Key issues of the model are student admission, compatibility of Bachelor's degrees and prerequirements of courses in photogrammetry. The general quality of the student's Bachelor's degree and language skills will be evaluated before admission. At the TKK, general principles of foreign student's admission are defined,

but each department can specify admittance principles independently. Since compatibilities of the Bachelor's degrees are not yet clearly defined, not only the general quality of the Bachelor's degree is evaluated, but also some prerequirements of courses in photogrammetry are needed. Student can either have equivalent knowledge in photogrammetry compared to students from the TKK or students can take required classes a.k.a. "bridge studies" at the TKK before entering to the Master's Program. Preferably, the "bridge studies" should be started half a year before actual Master's program starts in the fall term. Particularly, the minimum number of qualified international student must enter to the program each year – since teaching in English requires extra effort, program might not be arranged every year.

Two-stage admittance process might be considered as well. In that case, the final degree status is granted to the students after the first year, if they have completed the requirements of the programme: e.g. 40 credit units of the programme courses with a minimum average grade 3 out of maximum 5. This would be appropriate when no formal entrance examination exists; the two-stage admittance might simplify and speed-up the student selection on the one hand and fairness and equal requirements on the other. It also enables the option of not awarding the student status to clearly non-performing students.

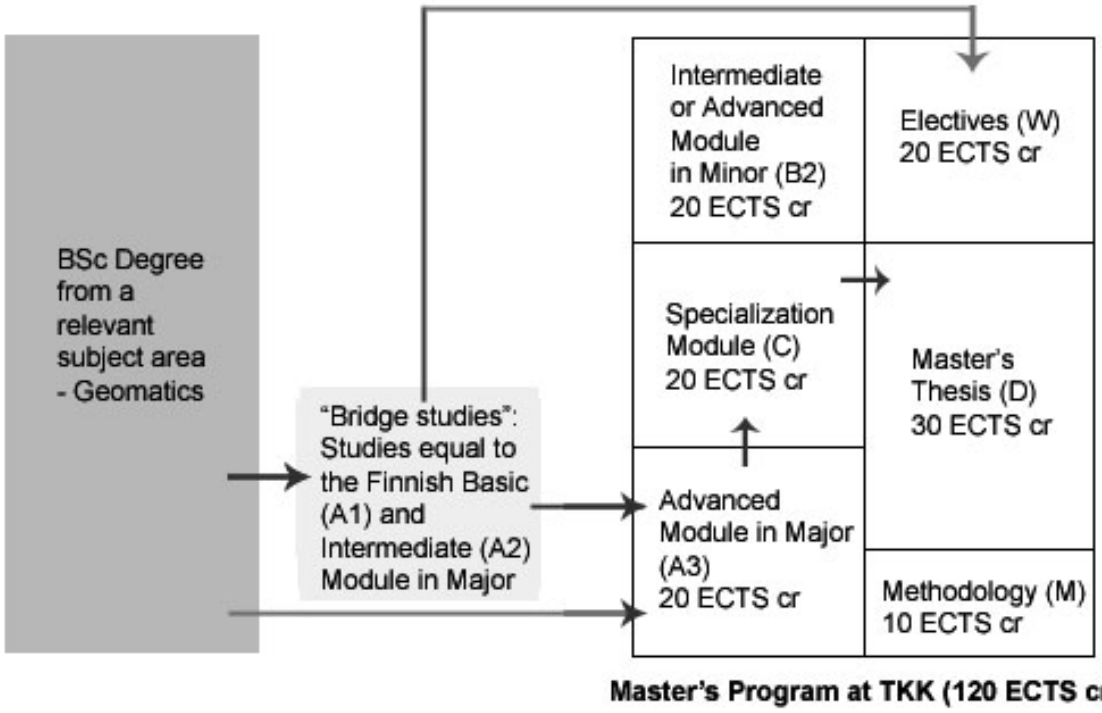

Figure 4. Model I: International Master's program in photogrammetry offered by the TKK. Relevant Bachelor's Degree (BSc) with equal studies in photogrammetry should be passed before entering to the Master's program at the TKK. In the Master's studies, modules A3 and C consist completely of photogrammetry. Minor module (B2) and Electives (W) are supporting the major subject. "Bridge studies" can be included into the Electives.

By the Finnish law, tuition fees are not collected when studying towards a Finnish university degree. This applies to Finnish citizens as well as to non-citizens after they have been granted the degree or visiting student status by the TKK. Living costs in Finland are slightly higher

than European average. Students should budget about 700...750€ per month, to cover the normal living costs and accommodation in a student residence. As members of the student union, all students are permitted to daytime low cost health care and to a variety of social activities. A private health insurance, for the cases of hospital treatment, is required from every foreign student. (TKK 2006a.)

Table 2. Descriptions of photogrammetric courses held at the TKK.

”BRIDGE STUDIES”
Maa-57.1010 Fundamentals of Photography, Photogrammetry and Remote Sensing (4cr, period III)
Contents: Satellite imaging, aerial and close-range photography. Image formation theory (analoque and digital). Production of digital images. Image geometry (central projection, orthophoto, scanners). Stereo photography and mensuration (photobase, accuracy aspects, anaglyph etc.) Principles and properties of sensor construction. Visual interpretation of images. Photo orienteering.
Maa-57.1030 Fundamentals of Photogrammetry (3cr, period III)
Contents: Image orientations. Transformations concerning central projection. Fotogrammetric measuring equipments (analog, analytical and digital). Acquisition and selection of suitable image data sets. Coordinate systems and -transformations. Mapping process in general level.
Maa-57.2050 General Photogrammetry (3cr, period II)
Contents: Alternative manners of image measurements. General, analytical model of photogrammetry: observations in image coordinate system, transformations to 3D coordinate system, image orientations and geo-referencing. Analytical stereo measuring. Measurements by one image.
Maa-57.2060 Digital Image Processing (4cr, period III)
Contents: Image transforms, sampling, enhancement, restoration, compression and geometric transformations.
MODULE A3
Maa-57.3100 Photogrammetry in Practice (6cr, period I)
Contents: Mapping process and applications. Acquisition of 3D geographic data. Aerial photographic methods, geo-referencing. Stereo plotters. 3D digital terrain models, animations. Close-range photogrammetry.
Maa-57.3110 Remote Sensing in Practice (6cr, period II)
Contents: Interpretation of satellite image. Supervised and unsupervised classification, common statistical classifiers. Steps of the interpretation. Empirical modeling. Accuracy of the interpretation. Applications.
Maa-57.3120 Analytical Photogrammetry I (4cr, period III)
Contents: LS-estimation, physical camera models, theory of two or three images, methods for orientation, reconstruction and calibration, feature-based photogrammetry.
Maa-57.3130 Digital Photogrammetry I (4cr, period IV)
Contents: Segmentation, feature extraction, area- and feature-based image matching, geometric and radiometric object reconstruction.
MODULE C
Maa-57.3170 Close Range Photogrammetry (3cr, period I)
Contents: Basics of ray optics, mathematical models of close range photogrammetry, image acquisition and measuring devices, camera calibration, network design, photogrammetric measuring systems, special techniques (moiré, raster photogrammetry, tomography), measurement of deformations, e.g. applications in medicine, industry, archaeology and architecture.
Maa-57.3140 Analytical Photogrammetry II (4cr, period I)
Contents: Projective geometry, projective camera models, epipolar geometry, projective reconstruction.
Maa-57.3180 Laser Scanning (2cr, period II)
Contents: Principles and equipement of laser scanning. Geographic data acquired by laser scanners. Accuracy and geo-referencing of laser scanner data and data fusion with other data sets. 3D modeling. Applications.
Maa-57.3150 Digital Photogrammetry II (4cr, period II)
Contents: Multiresolution analysis, shape from shading, optical flow, object tracking, shape matching, automation of photogrammetric problems, calibration of digital systems.

T-61.5070 Computer Vision (5cr, periods III-IV)
Contents: Image formation and some basic methods in image processing. Motion detection and estimation. Image segmentation, its basic principles and methodologies. Extraction of shape and other features, feature selection. Extraction and comparison of structural representations.
Maa-57.3160 Digital Photogrammetry III (2cr, period IV)
Contents: Object recognition and scene analysis using pattern recognition and artificial intelligence methods.

4.2 Model II: Collaborative International Master's Program among Assembled Universities in Europe

Model I, presented in the previous chapter, is designed to cover the field of photogrammetry in a way that it will produce graduates with broad knowledge of the discipline. However, this type of model does not exploit the fact that overlapping courses and specialization studies could be concentrated on certain schools in Europe. On one hand, system could be more effective in the level of common basic studies and on the other hand, each university could concentrate on their special knowledge on teaching and at the same time, specialization studies could superiorly be available for students.

When establishing collaborative program, following issues should be considered and determined:

- **Cooperation:** App. 5 universities with tight cooperation and one coordinator university are needed. Cooperation might include exchange studies and/or exchange of teaching staff and material. According to Haux and Schmidt (2002), exchange of teaching staff has been regarded beneficial, but student exchange has not been that common – but valuable – in two-year programs.
- **Flexibility and restrictions:** Since multicultural nature of the program, questions of flexibility of the available courses and certain limitations should be considered. Should program have fixed catalog of subjects to be taken or can student follow individual program tailored to his or her needs? Are strict time limits and a minimum grade point average for the graduation introduced? According to Thian (1996), broad-based, international Master's program can only be effective when student can – to some extent – choose his/her specialization according to his/her interest and needs of his home country. By the flexibility and multidisciplinary, study program can fulfil the demands of industry when growth and development of technology is fast. As a disadvantage, this kind of program requires more teaching staff.
- **Student intake:** In the admittance procedure, quality and the amount of the student intake must be evaluated. Can the relevant Bachelor's degree be achieved from any country or even from any field? How to compare Bachelor's degrees and skills of photogrammetry? Should entrance exams, language tests and "bridge studies" (see Chapter 4.1) to be introduced? It seems that suitable intake amount of the students is app. 10-15 (Haux and Schmidt 2002; TKK2005b; TKK2006b). Limitations exist because of suitable class size, teaching staff resources and available thesis work positions. Above all, since teaching in English requires extra resources, at least the minimum number of qualified students must enter to the program it to be arranged every year.

- **Aims:** Since the program has an international nature, graduates will most probably be open-minded about direction of their career. Thereby, program may produce graduates for heterogeneous markets: in research, consulting business and component manufacturer. Program should provide broad knowledge of the field, and the in-depth knowledge of students would mainly be gained through the work for the Master's thesis, and from specialization and minor studies. Specialization studies advances that program is adjusted into changing needs of industry and research, but thereby degree may also contain e.g. studies of languages, computer science, project and team management, and even practical training between academic study years. Cooperation is also needed when topics of Master's thesis and project works are searched from industry. Thian (1996) recommends that students can choose their subjects of the Master's thesis also in area-oriented way, in other words students can do research in their home countries and this way rich the international nature of the program.
- **Focus:** We purpose that the main focus of the proposed international Master's program is in data acquisition and accuracy concerns covering both terrestrial and aerial acquisition
- **Detailed organization of the program:** Various detailed issues should be determined such as distance based learning, language issues, responsibilities of the coordinator, length of the program, time for the Master's thesis, and potential/compulsory practical training.
- **Funding:** Erasmus program can be seen as a funding option for students and teachers for the short term inside of Europe. Professors and other university teaching staff can have funding for 1 week to 6 months teaching period at universities those hold an Erasmus status. Correspondingly, students can have funding from the Erasmus fro 3-12 months. Secondly, Erasmus Mundus program can be seen as an option when studies are offered to students from the third world countries. (European Commission 2006.) In any case, agreement about tuition fees must be done, when various universities take part in the program. Additionally, potential sponsors must be searched.

The Institute of Photogrammetry and Remote Sensing offers part/complete modules A3 and/or C (Table 2.). Additionally, languages, management studies, computer science etc. can be offered by the TKK.

5. CONCLUSION

We have suggested two initiatives for international Master's program in photogrammetry in Europe and discussed about obstacles regarding establishment. Model II – collaborative international Master's program among assembled universities in Europe – can be seen more beneficial and effective way to construct Master's studies of photogrammetry in Europe. We hope cooperation among European universities and interest by students of photogrammetry. Additionally, industry and research institutes are welcomed to discuss about needs of the field and qualities of graduated photogrammetrists.

Even if international Master's program has to face many organizational and cultural barriers, they have been successful in attaining their objectives (Lehoux et al. 2005; Thian 1996; Haux and Schmidt 2002; TKK 2006b). Tight cooperation, proficient coordinator, qualified students

and teaching resources are needed. Since academic interest on photogrammetry tends to decline, international Master's program can be seen as an opportunity in the middle of changing needs of the discipline.

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BIOGRAPHICAL NOTES

Ms. Hanne Junnilainen is a student of photogrammetry at the TKK and at the moment, she is finalizing her Master's thesis about 3D modeling in archaeology. She has been working as a research assistant in the Institute of Photogrammetry and Remote Sensing since 2000. Currently she works as a Teaching Assistant.

Dr. Henrik Haggrén has been Professor in Photogrammetry and Head of the Institute of Photogrammetry and Remote Sensing at the TKK since 1994. He is former Chairman of Commission 6 on Engineering Surveys of FIG (1992-1994), the FIG Working Group WG 2.2 on Virtual academy and distance learning and ISPRS Working Group WG III/1 on Sensor Pose Estimation. He has more than 100 publications in the field of photogrammetry and remote sensing.

Mr. Petri Rönnholm received his Licenciate Degree in Technology in Surveying from the TKK, Department of Surveying in 2005 and Master of Science degree in 1997. He has been working at the TKK/Institute of Photogrammetry and Remote Sensing since 1995 and he has over 30 publications on photogrammetry and remote sensing. He is an editor of the Photogrammmetric Journal of Finland (2005-).

Mrs. Katri Koistinen has graduated as M.Sc. in Surveying Science from the TKK in 1995. The same year she has joined the Institute of Photogrammetry and Remote Sensing as a research scientist and a post-graduate student. Since August 2000 she has been the Teaching Assistant in Photogrammetry and Remote Sensing. She has been actively taken part to the available pedagogical education for the university teachers.

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