

EDUCATION OF PHOTOGRAMMETRY IN FINLAND

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ABSTRACT:

In Finland, the education of photogrammetry has been an essential part of the surveying curriculum. Traditionally it has been organized only on the academic level. In this paper we describe the current curriculum as far as it regards education of photogrammetry and remote sensing at Helsinki University of Technology, TKK. We will also present some experiences in applying modern learning theory based on progressive inquiry in order to provide parts of our education to primary and secondary schools. Beginning in Fall 2005, the surveying curriculum at TKK will be arranged according to the new European academic two-phase structure, or the so-called Bologna agreement. The main change will be the division of the former Master's studies to two consecutive phases, which will be three years' Bachelor's studies and two years' Master's studies. Within surveying, the Bachelor's curriculum will have two programme options, one for real estate economics, and one for geomatics. Geomatics will further divide into two parallel options, one for geoinformatics, and one for geodesy and photogrammetry. During the Master's programme, photogrammetry will specialize in both photogrammetry and remote sensing. Within the new academic curricula, the education has been organized in modules, which build vertical learning chains in progressive manner. As far as it concerns photogrammetry, we have made first experiments in progressive learning also with pre-academic generations, i.e. within primary and secondary schools. There the tasks have been in understanding the central perspective and photography and to apply it to digital imaging and stereoscopy. The subjects we have dealt with have been biology, physics, mathematics, informatics and geography.

1. INTRODUCTION

The actual need for creating a new curriculum in Finland for geomatics, and for photogrammetry, originates from the new two-phase structure of academic graduate studies in Europe. According to the Bologna agreement future graduate programmes would consist of three years of studies for completing the Bachelor's degree and two years for Master's degree. The postgraduate studies should follow in three years and complete the doctors' degree. Currently we have had one programme for the Master's studies, from which the diploma engineers have graduated, and the post graduate studies have been individual for each student.

Another important reason to configure again the studies in photogrammetry has been the recent development in Europe, that the academic interest on photogrammetry has become low and the chairs of photogrammetry tend to disappear. Research in photogrammetry appears as it has become accomplished. The fields of application are diversifying and it has been hard to see or prospect any extraordinary photogrammetric argumentation for future academic research. Photogrammetry may have reached its culminatum as a field of science. Therefore it shall seek real content and relevance as part of much more general field of spatial information sciences.

The professionals in photogrammetric research have for long had the ultimate goal to automate the entire complex process of transforming the images to maps and to 3-D models. The analog stereo instruments were developed in order to avoid computations, and the analytical plotters in order to replace

analog computing. In conclusion, analog images are now replaced by digital sensors and the automation has become complete. In parallel to this, the orientation procedures have developed from aerial triangulation to direct and global positioning. The surveyors or at least developers of photogrammetry have made themselves obsolete, or have they?

The dilemma is, that at the same time as the academic resources seem to disappear, the number of new and alternative imaging techniques for building geographic data acquisition processes has become manifold. There are laser scanners, polarized SAR, SAR interferometry, digital imaging sensors, mobile phones with digital cameras and GPS, hyper spectral imagers, full waveform lasers - and many are still coming. As a consequence, each new type of image or 3-D data will expand the needs of academic research. The topics like sensor modelling and orientation, registration of data to each other, error propagation in estimation, network simulation, multi scale processing, or multi-temporal processing, and visualization of the models and scenery, etc., are all current topics for photogrammetric research. Are we not able to take use of this rapid development in academic research? Or are the current academic frameworks somehow outdated?

Taking all the above mentioned evidences into account, it is obvious, that there is a need of reorganize or restructure the academic studies of photogrammetry on national level, not only to react to the Bologna agreement. In order to keep academic education of photogrammetry in Finland viable, it is necessary, that a) we will have high international

competence of photogrammetric research by our own, and, b) we maintain an academic curriculum in surveying, which will provide courses for the entire span between under and post graduate levels, between the basic theory of photogrammetry and its high-technology applications. We also consider, that it is important to recognize photogrammetry as a self-determining part of spatial information sciences.

These have been the objectives when building up the new curriculum. We will present both the current and new curriculum in this paper. The current one is described as an evolution product, which has resulted from the technological development of photogrammetry and its application to surveying and mapping processes. We consider, that in order to live with ever limiting domestic resources we have to develop efficient e-learning models, and not only apply the internet. In this paper we will present our experiences with progressive learning network, PLN. It is a network, in which collaborative learning practices will be developed based on progressive inquiry. We expect that progressive inquiry is a suitable pedagogical theory for developing future photogrammetric curricula, rather than to continue with the traditional evolution model.

2. EDUCATION OF PHOTOGRAMMETRY

Helsinki University of Technology, TKK, is the only academic institute in Finland providing a curriculum in surveying. It dates back to 1849, when the Helsinki Technical School was founded. The school gradually developed to an academic level and changed to a university of technology in 1908. It was also given the right to grant the highest academic degrees in technology. The degree programmes were for architecture, civil engineering, machine engineering, chemistry, and land surveying. The first doctorate in surveying was granted in 1944 in geodesy. The first one in photogrammetry was completed in 1951 by our first professor, namely Dr. R.S. Halonen.

2.1 Education and academic research

The education of photogrammetry has been an essential part of the surveying curriculum since 1940's (Halonen, 1968). Professor E. J. Nyström, who was professor in applied mathematics at TKK, lectured the geometric basics of photogrammetry and his assistant R.S. Halonen, taught photogrammetric practices. At Military Academy, photogrammetry was taught by lieutenant colonel K.G. Löfström. He had been in 1930's the primary technical developer of the Zeiss Ikon-camera. He also published the first Finnish lecture book in photogrammetry in 1947. In 1957, the chair of photogrammetry was established in TKK, and, in 1960, Halonen was nominated the first professor in photogrammetry in Finland.

At Tampere University of Technology, photogrammetry has been part of the chair of geodesy and has belonged to the degree programme of civil engineering since 1965. In 1960's, photogrammetry became part of education for foresters at University of Helsinki and since 2000, also for geographers. At the Technical School of Helsinki (later Helsinki-Vantaa Institute of Technology) photogrammetry has been an essential part of education of surveyors since 1970's.

Research has always been important part of the university activities in photogrammetry in Finland. Prof. Halonen initiated the research on analytical photogrammetry and especially he led the group developing the bundle block adjustment methods in 1960's. During 1975 to 1993, Prof. Dr. Einari Kilpelä continued the research on analytical photogrammetry and, in particular, he initiated activities in digital image processing and applications on satellite remote sensing. As a consequence, in 1987 the institute changed its name to cover both photogrammetry and remote sensing, which since then have formed separate major subjects as part of the degree programme of surveying.

Since 1994, Prof. Dr. Henrik Haggrén has chaired the institute. Research on digital photogrammetry has dominated the work, and applications have covered widely applications of close-range photogrammetry as well, like real-time photogrammetry in industrial use, or use of digital cameras in archaeological documentation. The institute has also started comprehensive research projects on basic theory of projective geometry and its use in photogrammetry. It has also expanded the research area of photogrammetry to cover the processing of airborne and terrestrial laser scanner data and its application to environmental and civil engineering.

2.2 Photogrammetry at TKK

Since 2001, the degree programme of surveying has been divided into two degree programmes, which are for geomatics and for real estate economics (Virtantausta et al., 2000). The degree programmes divide further in four specializations, called as options. They are for geoinformatics, surveying engineering, land management and law, and real estate management (Figure 1).

Within the department, the degree programme of geomatics relates to three research laboratories, Institute of Photogrammetry and Remote Sensing, Laboratory of Cartography and Geoinformatics, and Laboratory of Geodesy. The degree programme of real estate economics relates to two research laboratories, Institute of Law, and Institute of Real Estate Studies. The number of personnel in the entire department is slightly over 50.

Currently the annual intake for surveying is 90 and the number of surveying students counts for approximately 450. There are eight professors, and they are within photogrammetry, geoinformatics (2 professors), geodesy, land consolidation, real estate evaluation, facilities management, and economic law. In 2001, the annual intake to the degree programme of geomatics was also increased from 25 to 40.

The major subjects of "Remote sensing" and "Photogrammetry" are produced by the Institute of Photogrammetry and Remote Sensing. There are 18 study courses which are organized, most of them on annual basis (Table 2). In addition, the institute contributes to and provides two crossdisciplinary major subjects of HUT, namely "Imaging technology" and "Information science" together with the degree programme of automation and systems technology. Laboratory of Space Technology offers specialization in remote sensing as part of the degree programme in electronics, especially as far as it concerns instrumentation and microwave remote sensing.

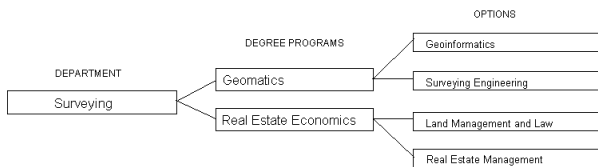


Figure 1. The organization of the degree programme for geomatics within the surveying curriculum at Helsinki University of Technology since 2001. The major subject of remote sensing has been within geoinformatics, whereas photogrammetry has been within surveying engineering. This will change in the new curriculum. Beginning in Fall 2005, the two options of geomatics will be for geodesy and photogrammetry, and for geoinformatics. Navigation includes to geodesy and remote sensing includes to photogrammetry.

Master's degree	180
<u>Undergraduate level</u>	<u>120</u>
Part I, Engineering sciences and languages	70
Geomatics	30
Optional studies and practical training	20
<u>Graduate level</u>	<u>60</u>
Major, within geomatics	20
Minor, within geomatics and engineering	20
Master's thesis	20

Table 1. The current structure of the study content according to the degree programme of 2001. The entire degree counts for 180 credit weeks. One credit week equals to 40 hours of work.

Courses in Photogrammetry	
•	Fundamentals of Photogrammetry (2 cr) Prof. Henrik Haggrén, M.Sc. Katri Koistinen
•	General Photogrammetry (2 cr) Prof. Henrik Haggrén, M.Sc. Petri Rönholm
•	Photogrammetric Mapping (2,5 cr) Prof. Henrik Haggrén, Lic.Sc. Eija Honkavaara
•	Close-Range Photogrammetry (2 cr) Prof. Henrik Haggrén, M.Sc. Petteri Pöntinen [*]
•	Digital Image Processing (2,5 cr) Lic.Sc. Keijo Inkilä
•	Analytical Photogrammetry (2,5 cr) Lic.Sc. Keijo Inkilä
•	Digital Photogrammetry I (2,5 cr) Lic.Sc. Keijo Inkilä
•	Digital Photogrammetry II (2 cr) Lic.Sc. Keijo Inkilä [*]

Courses in Remote Sensing	
•	Fundamentals of Remote Sensing and Photography (2,5 cr) M.Sc. Anita Laiho-Heikkinen and M.Sc. Jussi Heikkinen
•	Fundamentals of Microwave Remote Sensing (2 cr) Lic.Sc. Teemu Tares

- General Remote Sensing (2 cr) M.Sc. Markus Törmä
- Digital Image Processing (2,5 cr) Lic.Sc. Keijo Inkilä
- Radar Remote Sensing (2 cr) Prof. Juha Hyypä, Prof. Jouni Pulliainen, Prof. Jarkko Koskinen, M. Sc. Jaan Praks, M.Sc. Mika Karjalainen, M.Sc. Marcus Engdahl, M.Sc. Leena Matikainen [*]
- Remote Sensing I (4 cr) M.Sc. Markus Törmä
- Remote Sensing II (6 cr) M.Sc. Markus Törmä

- | Courses for creating academic competence | |
|---|--|
| • | Seminar on Photogrammetry, Photo-interpretation and Remote Sensing (1,5 cr) Instructor: Prof. Henrik Haggrén |
| • | Exercise in Imaging Technology (5 cr), Instructor: Prof. Henrik Haggrén |
| • | Special Assignment in Photogrammetry, Photo-interpretation and Remote Sensing (5 cr), Instructor: Prof. Henrik Haggrén |

Table 2. Totally 18 courses have been provided within photogrammetry and remote sensing. Courses marked with [*] are given every 2nd year.

2.3 New Curriculum According to Bologna Agreement

In Fall 2005, TKK will change its curriculum system to the common European one according to the Bologna agreement. The degree programme in surveying will be changed to a two-phase academic programme structure starting Fall 2005. It will consist of successive degrees for Bachelor and Master of Science in Technology, and the studies are scheduled for a three years' and for a two years' duration. The Master of Science degree corresponds to the diploma engineer degree, which has been the first academic graduation given by TKK until now. The Master's degree programme will prepare for post-graduate studies for the degree of Doctor of Science. This continuation is scheduled for three years. The duration of the complete academic study programme is approximate and corresponds to the 3+2+3-model of Bologna.

Currently the courses are counted and valued as credit weeks. These will be changed according to the European Credit Transfer System (ECTS), which is regarded as a prerequisite for potential interchange of the degrees within Europe. One full year of studies will count for 60 ECTS points, and the degree of diploma engineer or Master of Science after five years' studies will count for 300 ECTS points. At TKK, the first third, i.e. 100 ECTS points will be granted for fundamental studies on engineering and technical sciences, as well as on respective discipline, like surveying (Table 3). The second third will concentrate on studies of the degree programme itself, like on geomatics. It will build up the major and the minor. In geomatics, there are three options, geodesy and navigation, photogrammetry and remote sensing, and geoinformatics. From the remaining third 50 ECTS points will be used for the academic education, including the Bachelor's and Master's theses, and 50 ECTS points for freely chosen courses, and for example, for a specialization supporting the chosen majors

The studies for the Bachelor's degree count for 180 ECTS points and for the Master's degree for 120 ECTS points

(Figure 2). The Bachelor's programme concentrates on building the fundamental of technical sciences, of mathematics, physics, and information technology and of engineering. The Bachelor's studies within surveying are made in two degree programmes, namely in geomatics and in real-estate economics.

Master of Science in Technology (Diploma Engineer)	300	Bachelor's studies 180	Master's studies 120												
Technical sciences, engineering sciences, common basics of surveying.	100	<table border="1"> <tr> <td>P</td> <td>80</td> </tr> <tr> <td>O</td> <td>20</td> </tr> </table>	P	80	O	20									
P	80														
O	20														
Geomatics profession.	100	<table border="1"> <tr> <td>A1</td> <td>20</td> </tr> <tr> <td>A2</td> <td>20</td> </tr> <tr> <td>B1</td> <td>20</td> </tr> </table>	A1	20	A2	20	B1	20	<table border="1"> <tr> <td>A3</td> <td>20</td> </tr> <tr> <td>B2</td> <td>20</td> </tr> </table>	A3	20	B2	20		
A1	20														
A2	20														
B1	20														
A3	20														
B2	20														
Diploma Thesis, Bachelor's Thesis. Competence in performing research and scientific tasks. Social impact, technical implementation, economy and finances, ...	100	<table border="1"> <tr> <td>V</td> <td>10</td> </tr> <tr> <td>K</td> <td>10</td> </tr> </table>	V	10	K	10	<table border="1"> <tr> <td>C</td> <td>20</td> </tr> <tr> <td>W</td> <td>20</td> </tr> <tr> <td>M</td> <td>10</td> </tr> <tr> <td>D</td> <td>30</td> </tr> </table>	C	20	W	20	M	10	D	30
V	10														
K	10														
C	20														
W	20														
M	10														
D	30														

Table 3. The general structure of the new curriculum at TKK. The modules (**P**, **O**, **A1**, etc.) are explained in Figure 2. The entire degree counts for 300 ECTS points. One study year corresponds to 60 ECTS points or to 1600 hours of work. The curriculum is divided to the Bachelor's programme of 180 ECTS points and to the Master's programme of 120 ECTS points.

The Bachelor's degree will not validate for a professional graduation, but is considered as a milestone, which the students should pass before entering the studies of the Master's programme. The students will learn the necessary basics for the field of science. However, the Bachelor's programme should also prepare the student for professional and engineering related preparedness for education at work. Similarly, those who have graduated from a technical institute should complete respective basic studies in technical sciences, before entering the Master's programme.

One of the goals set when renewing the curriculum has been to facilitate a common European academic system or degree

structure. This would regard both competitiveness and complementariness. The Bachelor's programmes at different universities could prepare for comparable competences and they should give necessary prerequisites for corresponding Master's courses. A Bachelor's degree in geomatics from TKK should for example enable completing Master's degree at KTH in Stockholm, or *vice versa*.

The studies of 120 ECTS points for the Master's degree will complete the competence of a diploma engineer. This would provide a graduate student with necessary skill and ability to manage technical-scientific tasks. Within surveying, the major subjects will remain as now, namely facility management, real-estate economics and assessment, land consolidation, economical law, geodesy, positioning and navigation, photogrammetry, remote sensing, geoinformatics, and cartography. These cover tasks of our profession as modern surveyors widely. The tasks are partly very local and national, but in general mostly international. One aim of the Bologna agreement has been also, that one could include to a personal curriculum separate modules from other disciplines or universities, for example from exchange studies.

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 the most students at 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 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 finish geomatics studies at this point. Therefore it also contains everything, that all land surveyors at least should know about surveying.
- The module **A1** is common for all geomatics students. It contains that part of the theory of geodesy, positioning, navigation, photogrammetry, remote sensing, cartography, and geoinformation techniques, which every geomatics student at least must know. It also must give an insight to mapping processes.
- The module **B1** is a parallel to A1 and is aimed for those who want to become a "land surveyor" in a broader sense. In case the major would be on geodesy and photogrammetry, the primary option for B1 would be on general application of geoinformatics, and the secondary one on basics of real-estate economics. Optional **B2** modules for geomatics students are for example the ones on practical application on geoinformatics or geodesy, or on cartography, media technology, information technology, and computer science.
- The module **A2** is the module for general application of geodesy and photogrammetry. Together with the thesis **K** it will complete the Bachelor's degree. At this point a student will have a good insight on essential tasks of surveying. He might not have detailed knowledge on surveying expertise, but he should be competent in finding out necessary information to carry out the tasks. The professional competence depends also on chosen B1 and on freely chosen courses **V**.

- The module **A3** is the practical application of photogrammetry or remote sensing. Together with the thesis **D** this will complete the Master's degree. It will give the student the competence to accomplish professional tasks in engineering and project management, or in application development and research.
- The module **C** provides the student the option for deeper specialization in his profession. This might relate to science, engineering, as well as to business issues. As far as it regards postgraduate studies in photogrammetry, the **C** module would provide the necessary basis.

When we compare the new diploma engineer curriculum at TKK to the old one, it is obvious, that the weight of technical-scientific base, i.e. the module **P** with 80 ECTS points, will largely remain as it has been, whereas the expertise and specialization in every major subject, like photogrammetry or remote sensing, becomes thinner 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. As it practically consists of annual modules, every student must every year choose a new root to proceed. For example, the chain in photogrammetry will consist of 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 with 300 ECTS points covers about 20 weeks of studies less than the previous degree program of diploma engineers. During the last fifteen years the content and coverage of the courses within photogrammetry and remote sensing have increased. Although the amount of practical exercises has decreased, the education material covering all relevant theory and new technology has more likely become manifold. As this is the reality not only in photogrammetry but also in entire technology, there is an attempt during the renewal to reassemble the education at TKK in a more efficient way. Therefore, the contents of all new modules and respective courses will be analyzed and divided according to different types of didactic objectives. First, core knowledge is something what a student must gather and learn in order to go forward. Second, supplementary knowledge would be regarded as useful and will be included to the content as secondary. However, relevant material will be given but not necessarily processed during the course. Third, special knowledge is something that is regarded as relevant and some of the students might have an interest in. However, this will not be included into the course material. Only references are given. The content analysis of the courses is still underway and will be adjusted according to the professional and pedagogical objectives, which were set for the modules.

Modules of Bachelor's Program				Modules of Master's Program	
Common basics for Engineering and Technical Sciences P 80		Freely chosen Bachelor's courses V 10	Bachelor's Thesis K 10	Freely chosen Master's courses W 20	Master's Thesis
		Common basics for Minor B 1 20		General application of Minor B 2 20	
					D 30
					Scientific methodologies M 10
Common basics for Surveying O 20	Common basics for Geomatics A 1 20	General application of Major A 2 20		Practical application of Major A 3 20	Specialization C 20

Figure 2. The new degree programme in geomatics. In case the major on level A3 is either on photogrammetry and remote sensing, the minor **B2** would be e.g. on geodesy, geoinformatics, information technology, or media technology. The specialization **C** will prepare for research and development of new applications, as well as for post-graduate studies.

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

Figure 3. Courses of photogrammetry in the new curriculum.

2.4 Postgraduate schools

Since 1951, eleven doctor's degrees in photogrammetry and remote sensing have been granted by TKK. Traditionally postgraduate studies in Finnish universities have been organized as individual study programmes and as postgraduate seminars or tutorials. In mid 1990'es, the Ministry of Education initiated a postgraduate school system on national level. These schools are founded only by application and on demand, and they usually last for a preset period at a time. The system has been reviewed and managed by the Academy of Finland.

Photogrammetry and remote sensing was first included in the postgraduate school of "Forests in GIS 1998–2002", which was primarily sponsored by a private foundation (Metsämiesten säätiö, Forest professionals) and partly by the Academy of Finland and the Ministry of Agriculture and Forestry. Currently, a post graduate school in Remote Sensing (2003-2006) has been organized where we have two students from total of five. TKK is currently (2004-2006) financing two additional students within its own doctor's school in geomatics. However, the number of postgraduate study positions is much less than what is needed in photogrammetry and remote sensing, as the number of our active students is currently about fifteen.

The postgraduate courses and tutorials are arranged by TKK annually. Their topics are selected to meet actual needs in academic research, and both internationally and nationally renowned academicians are invited for lecturing (Figure 4).

- 1998-1999, Multi-dimensional modelling and visualization, Prof. Klaus Tempfli, Prof. Martti Mäntylä, Prof. Tapio Majahalme, Prof. Hannu Salmenperä, Prof. Tapani Sarjakoski, Dr. Tiina Kilpeläinen, and Dr. Eberhard Gülch
- 2000-2001, Lasers in surveying, Prof. Georg Vosselman, Prof. Juha Hyypä, Dr. Kari Pulli, Mr. Benedikt Wolff
- Positioning and navigation, 2001, Prof. Christian Heipke, and Dr. Helén Burman
- Geomatics, 2002, Prof. Timo Tokola, Prof. Petri Pellikka, and Prof. Jouni Pulliainen
- Projective Geometry, Multiview Geometry and Uncertainty, 2003, Prof. Wolfgang Förstner
- Deformation Dr. Michael Cramer
- 2003-2004, The measurement of the shape of the Earth surface, Prof. Hans-Gerd Maas, Prof. Juha Hyypä, and Prof. Petri Pellikka
- 2004, Laser scanning, Prof. Karl Kraus
- 2004, Deformation measurement, Prof. Olaf Hellwich, and Dr. Aleksey Sharov
- 2005, Alternative sensor orientations, Prof. Clive Fraser

Table 4. Postgraduate courses and tutorials arranged by TKK.



Figure 4. Prof. Dr. Wolfgang Förstner lecturing on his tutorial on “Projective Geometry, Multiview Geometry and Uncertainty” in 2003 at TKK.

3. PROGRESSIVE LEARNING NETWORK

The curriculum of photogrammetry at the university in Finland has been at least for the last fifty years of the structure, that the basics of the theory is given in the first study year, following with the general theory, analytical photogrammetry and practical mapping applications during the second and third year, and ending with special courses in the fourth or fifth year. The special courses have been on close-range photogrammetry, digital photogrammetry, and computer vision. In parallel to photogrammetry, the education on remote sensing has had in principal the same gradually advancing scheme. This course structure can be called an evolution product. The new and most

advanced topics have been first lectured as special courses at postgraduate seminars, and gradually they have become part of regular graduate studies.

Progressive Learning Network, PLN, is a model for applying the learning theory of progressive inquiry to an individual’s life-long learning career. As an approach PLN was initiated in our “Academy Suite”-project. The model is developed in order to promote scientific research and utilize academic research knowledge and material in all phases of learning. The primary aim is to stretch the photogrammetric curriculum to the entire education line of an individual (Figure 5). We expect that progressive inquire is a suitable pedagogical theory for developing future photogrammetric curricula, rather than to continue with the traditional evolution model.

PLN is also considered as a kind of network, where collaborative learning practices will be developed based on progressive inquiry. The network is vertically oriented along growing or aging dimension. On each level it is horizontally directed as for example our scientific and professional society. With the vertical networking our scientific community will be connected to children’s learning career. According to PLN, parts of the academic activities can be associated with the primary and secondary schools or with gymnasias, if the learning model is based on theory of progressive inquiry. The network will be social and it will enhance pupils’ interest both to the subject and the common local environment, where they live. The model and network can naturally be applied to the post-doctoral or continuing professional study levels as well.

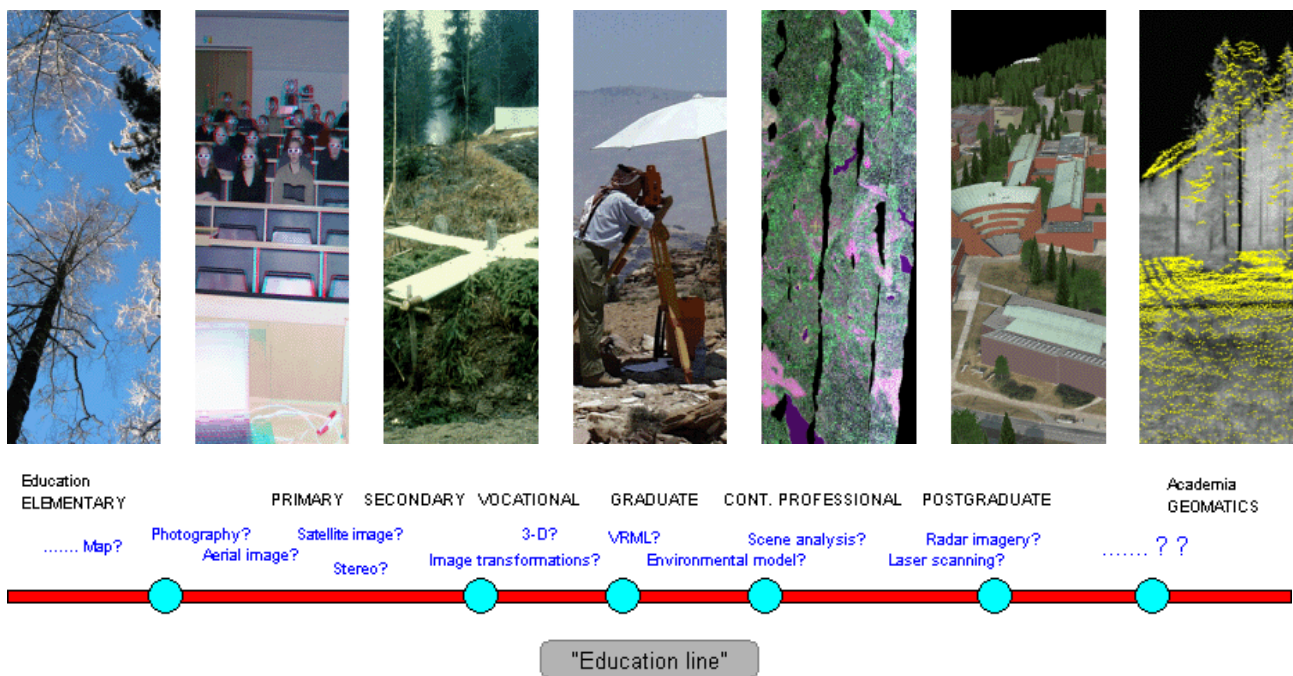


Figure 5. The phases of progressive learning. The range of topics starting from our local environment and its maps, proceeding through photographs, land surveying, images and 3-D models, and ending at modern imaging technologies, can be stretched along the life-long learning career of an individual.

The learning process of progressive inquiry follows the consecutive phases of problem solving. The concept describes the idea of a potential solution, the algorithm is a part of its analytical description, the simulation provides necessary trust on its validation, and finally, the procedure will describe the practical tooling for its realization. The tools are most probably available, like digital cameras and local orthophotographs, satellite images and maps. The necessary technology of scene reconstruction will be provided by the learning platform.

In 2004, we prepared and experienced first experiments in progressive learning with the secondary school of Maininki in Espoo. The core research group in photogrammetry was our group at TKK. The tasks were for stereo photography and imaging, and for parallax measuring (Figure 6). The schoolteachers in information technology, mathematics, physics, geography and biology did the exercises. The results were promising. However, it became evident, that the current workload of the teachers will not allow anything, which will only increase the content of the curriculum. New tasks can be adapted to individual courses only if there is an indication of positive effects to the entire learning process in the schools.

In 2005, we have proceeded with our experiments jointly with Luma Centre. Luma Centre serves as the network for education, research, development and co-operation, and is coordinated by the Faculty of Science of the University of Helsinki. It is promoting teaching of biology, chemistry, geography, mathematics, physics and technology and enhancing interaction between schools, universities and business and industry. It seeks to encourage children and young people to become involved in scientific activities. The co-partners of the departments in the Faculty of Science come from education administration, business and industry, industrial organisations, municipalities, and from the Faculty of Biosciences and the Faculty of Behavioural Sciences.

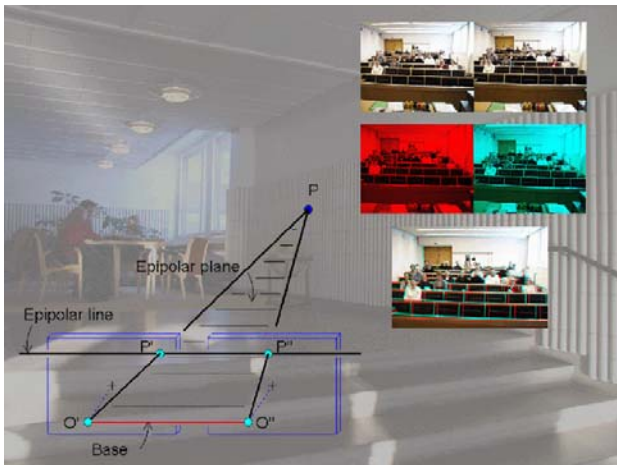


Figure 6. One of the first steps towards progressive learning in photogrammetry has been experienced with the secondary schools. The issue was stereo photography.

4. CONCLUSION

We have described the education of photogrammetry in Finland and its relation to the academic curriculum of surveying. In the new curriculum, there is more substance of photogrammetry to be included, but less room to study than in the previous one.

There are also more students in surveying but less of those, who potentially study the complete set of courses in photogrammetry. If the number of students will drop, it will have the consequence, that there will be even fewer resources to organize all courses.

The same diverging evolution is obvious in the entire academia, although there are differences between disciplines. The old engineering disciplines have lost students, whereas new disciplines like, telecommunication, information technology, or biotechnology, have gained. As a consequence, the number of graduate students, who annually complete their diploma theses for example in photogrammetry and remote sensing, has been slightly declining. The average during the last years has been two graduates.

There are several approaches to control and manage this development. In the new curriculum the common basis in engineering and technical sciences will slightly increase. The courses in mathematics and physics could include more surveying related details than before. Some exercises in surveying, which have required present assistance, will be replaced by individual assignments or project works, where more instructions can be given as documents. Course material is also prepared in electronic form and delivered via network. If we further consider active and ongoing developments in E-learning, there will be more options to share resources. The structure of our new curriculum allows exchange of modules within the degree programs between European universities.

Reducing costs, not that much the pedagogical arguments, has primarily motivated these approaches and our innovations in education have usually been technology driven. The Bologna agreement, which was the origin for reorganizing our academic curriculum, was based on political issues. We introduced here the concept of Progressive Learning Network, PLN. This is a model for applying the learning theory of progressive inquiry in order to promote scientific research and academic education. However, the primary aim is to stretch the photogrammetric curriculum to the entire education line of an individual. First experiences convince, that academic activities can be associated with the primary and secondary schools, and with gymnasias.

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