

## Tools and Techniques for E-Learning

GeoForschungsZentrum (GFZ) Potsdam, Germany

June 1 - 3, 2005



Hosted and organized by:

- Institute of Geodesy and Geoinformation Science, Technische Universität Berlin
- Geoforschungszentrum (GFZ) Potsdam
- Deutsche Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation (DGPF)

The Workshop is combined with the meeting Innovationen in Aus- und Weiterbildung mit GIS organized by Deutscher Dachverband für Geoinformation e.V. (DDGI)

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## ON THE DIDACTICAL POTENTIAL OF E-LEARNING COURSEWARE

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**KEY WORDS:** Pedagogy, Design, Evaluation, Content Development, Learning Environment, e-learning Competences, Quality Assurance, Project Management

### ABSTRACT:

The use of information and communication technology (ICT) is becoming an inherent part in higher education. According to recent reports, however, the actual use is concentrated on its qualities as an organisational and logistical tool. The didactical potential does not come into account in teaching scenarios where learning management systems or the like are used to spread materials and announcements. Teachers should become aware of the didactical values new media can bring about through a large diversity of scenarios. In order to realise an appropriate use of ICT in higher education, a variety of competences is needed in the scope of the four dimensions in e-learning (didactics, technology, strategy and multi-media based learning objects).

It is needless to say that these competences can hardly be comprised by one person. Therefore, it is common practice to engage several people in the process of e-learning. This implies a need for a mutual basis for arrangements and action. In other words, a process oriented and team based course of action is necessary for a successful implementation of e-learning. In our contribution, we will demonstrate a process model that takes into account the characteristics of e-learning design and project management. The goal is to establish a common foundation for all participants involved in the processes of an e-learning project, and to provide incentives for teaching/learning scenarios with didactical value. Furthermore, we will show how the didactical attributes of e-learning can be described and visualised for quality assurance and self evaluation means.

### KURZFASSUNG:

Informations- und Kommunikationstechnologien (IKT) entwickeln sich zu einem festen Bestandteil der Hochschullehre. Neuesten Erkenntnissen zufolge beschränkt sich ihre eigentliche Nutzung allerdings auf ihre Vorzüge als Organisations- und Logistikwerkzeug. Das didaktische Potential kommt in Lehrszenarien nicht zum Tragen, wenn Lernmanagementsysteme oder ähnliches lediglich genutzt werden, um Materialien und Ankündigungen zu verteilen. Lehrende sollen des didaktischen Mehrwerts Neuer Medien bewusst werden, den sie durch eine Vielzahl an Einsatzmöglichkeiten erreichen können. Um den angemessenen Nutzen von IKT in der Hochschullehre zu verwirklichen, sind eine Menge an Kompetenzen im Rahmen der vier Dimensionen des Handlungsfelds E-Learning notwendig (Didaktik, Technologie, Strategie und multimediale Lernobjekte).

Es wird deutlich, dass diese Kompetenzen kaum von einer Person beherrscht werden können. Deshalb ist es Gang und Gäbe, dass mehrere Personen im Rahmen eines E-Learning-Vorhabens beteiligt sind. Dies setzt voraus, dass es eine gemeinsame Basis für Vereinbarungen und Arbeitsschritte gibt. Mit anderen Worten ist ein prozess- und teamorientiertes Vorgehen notwendig für eine erfolgreiche Implementierung des E-Learnings. In unserem Beitrag werden wir ein Prozessmodell vorstellen, das die Eigenschaften des E-Learning-Designs und des Projektmanagements berücksichtigt. Das Ziel ist es, eine gemeinsame Grundlage für alle Beteiligte an einem E-Learning-Projekt und Anreize für Lehr-/Lernszenarien mit einem didaktischen Mehrwert zu schaffen. Weiterhin werden wir zeigen, wie didaktische Komponenten des E-Learnings zur Qualitätssicherung und Selbstevaluation beschrieben und visualisiert werden können.

### 1. INTRODUCTION

E-learning is in the process of becoming an important factor in higher education. During the last year, several studies could be carried out covering a larger group of students than it was possible before. The results were not disillusioning, but they gave cause for concern. When asking students about what they found most profitable in using information and communication technology (ICT) for learning, the largest part preferred the possibilities of spreading and organising material and information (Hanekop et al., 2003). It becomes clear that students do not see more than that in the potential of e-learning because they have not been exposed to learning environments with the advanced use of ICT yet (Kleimann et al., 2005). However, they can imagine experiencing it.

So, it is a task of teachers to offer such environments which involve cooperation and collaboration via ICT. And how do

they consider the potential of e-learning? In the project *eLearning Academic Network* (ELAN), where the authors are members of, were two categories of teachers involved in e-learning. The tendency of technology-close teachers (such as computer scientists or engineers) who explicitly saw potential of e-learning was in contrast to technology-distant teachers (such as teacher educators or landscape architects) who were quite critical about it. Remarkably, it was the second category of teachers who made use of our workshop offers and advisory services (cp. Albrecht et al., 2005).

On the other hand, the first category of teachers was mostly interested in technological solutions for their e-learning projects, whereas technological aspects are less important for the second category of teachers. . These findings gave cause for concern that the underrepresented aspects of e-learning are not utilised adequately in respect to their potentials of learning and teaching (cp. Frommann & Phan Tan).

This leads to the following two essential questions:

1. What is the didactical potential of e-learning?
2. How can teachers be equipped with the competencies to make use of this potential?

One thing is clear no matter what factors speak for potentials in e-learning: it takes a number of competencies that are hardly coped by one person. As a consequence, it is - even now - common practice to involve several people in the process of e-learning design, development, implementation and evaluation. This in turn makes a consequent quality improvement more difficult, because different parties are involved: teacher, technician, author, designer, evaluator...

We believe that a special procedure is necessary to get all participants at one table. It is necessary to provide competence teams for a comprehensive planning.

At L3S Research Center, we have established the *eLearning Service Team* (eST) covering different expert disciplines and connections to central institutions that might be involved in the e-learning process. Some of our activities that help utilising the potential of e-learning serve as a practical example for necessary measures.

## 2. THE POTENTIALS OF E-LEARNING

Which potentials seem to be realistic as state-of-the-art? Kerres (2004) specifies three aspects that will be presented with practical examples in the following:

1. other possible teaching and learning methods
2. a chance to better organize learning with increased flexibility of time and place
3. shorter study time

### 2.1 Other possible teaching and learning methods

Two examples shall make the possibilities of other teaching and learning methods clear:

#### Additional exercise options

The primary goal of assigning exercises is to ensure the students' learning outcomes. Questions foster the active dealing with the learning material and focus on the demands of the educational objectives. Students get feedback on their own educational level and are eventually motivated to rework a topic or a problem. Questions also foster the construction or reconstruction of knowledge. This constructive thinking accomplishment in turn fosters memory. The effectiveness of exercises is influenced by two factors:

1. The level of requirement has to be high enough for an active work on the task.
2. The feedback should activate thinking processes (reacting on true and false answers) and should not end up in "right" or "wrong".

Face-to-face teaching rarely offers enough time for comprehensive exercises. In addition, students will not get instant feedback if they work on the tasks at home. The possibilities of interactivity in new media solve this problem.

Especially intelligent feedback given by a learning system can foster learning.

### Descriptiveness

A special case of vivid learning can be realized with simulations. Practical exercising and testing usually takes place during internships or trainings. The time schedule is very tight and devices might be highly valuable. Not all students get the chance to make experience with every device. The possibility to learn by experience is therefore very restricted. Nowadays, the medial preparation of laboratories or experimental set-ups can be profoundly enhanced with different presentation methods (e.g. 3D, zooming functions).

Virtual laboratories and simulation can offer an adequate alternative, even though the experiences are conveyed through media. Students get the possibility to control their learning activities while this is not possible in real-life experiments. It is possible to set values and make "mistakes" that do not destroy the experiment set-up but lead to "learning from mistakes". In addition, time and place flexibility increase the access possibilities and repetition rate.

On the basis of existing knowledge, hypotheses are built and checked. The topic is gradually explored on self-directed grounds. So, the learner is able to connect newly learned with existing knowledge in a constructive way.

### 2.2 A chance to better organize learning with increased flexibility of time and place

The following example of project-oriented learning in virtual teams shall illustrate the manifold possibilities of a different learning organisation with increased flexibility of time and place.

In the course of a lecture, it is planned to enhance the active knowledge processing by intensively involving the students. In order to spend less time on the mediation of facts knowledge during face-to-face time, the students are provided with according online learning material for preparation. The students work in project teams and organize themselves independently. The starting point is usually a project-oriented task. Specific collaborative tools (e.g. forum, shared workspace) can support the team-work for communication and documentation. The team outcomes can be presented during the lecture. For different programs of study, this method is used to practice distributed cooperative work as a key qualification for future occupations.

### 2.3 Shorter study time

Shorter study time is Kerres' third aspect as a potential of e-learning. One important possibility for efficient learning is instructional courseware. It is focussed on clearly outlined learning goals and is based on principles of instructional design. Therefore it is mainly aimed at self-directed learning. Due to the high development effort, this form of e-learning is recommended only with large target groups or frequent use. There are, however, attempts to reduce the development effort with according templates (e.g. Catalkaya & Golze, 1999). These learning materials are characterized by the following features:

- The processing order of the learning matter is set. The students are provided with a suggested or a given learning path.
- The organisation and order of the processing do not follow the subject's taxonomy but are based on didactical consideration, mainly about educational objectives.
- The processing method is determined by the implementation of instructive elements. Tutorial components such as exercises, transparent educational objectives, abstracts, variations of tasks and problems, or combinations of image and sound are some examples.

These potentials do not evolve automatically from the implementation of e-learning. It is, moreover, a complex designing task to realize these potentials. In order to do so, a lot of different technological, didactical and organisational tasks have to be accomplished. In the end, the success of e-learning depends on the felicitous implementation in the given teaching-learning-context.

### 3. SUCCESS DEPENDS ON THE EDUCATIONAL CONTEXT

Naturally, the benefit of multimedial educational courseware only comes into account when it is implemented in practice. This may sound self-evident, but it surely is not a trivial task. Developing multimedial teaching holds the danger of producing courseware by exploiting the possibilities of highly developed technology. The outcomes, however, are usually hard to be implemented in practice.

It is therefore important to focus on the implementation of the courseware in everyday teaching during conceptual development. In this way, it is possible to ensure the value of developed material at an early stage. These considerations shall be illustrated by three aspects for implementation of e-learning in an educational context:

- *Acknowledgement of course credits*: If it is possible to obtain course credits from multimedial courseware, the students' acceptance of e-learning and their motivation will increase, because the individual benefit is clear.
- *Relationship to face-to-face teaching*: The use of e-learning courseware does not necessarily mean that face-to-face teaching becomes obsolete. It is, moreover, a matter of consideration how both teaching and organisation modes intertwine in practice and how they are coordinated for a successful implementation.
- *Supporting the students*: The students' requirements and their working methods change with the implementation of new media. Sometimes, it is necessary or possible to support them in new ways depending on the respective educational scenario.

### 4. SUPPORTING PROJECT DEVELOPMENT

This chapter deals with the implementation of the above mentioned potentials in an actual e-learning project. We will focus on the first phase of project development by presenting concrete recommendations. Our operative starting point is the

design of introductory phase in an e-learning project. These considerations are based on the experiences and research activities of the *eLearning Service Team* (eST) which is part of the *eLearning Academic Network* (ELAN) in Lower Saxony.

Two theses shall introduce our considerations:

1. E-learning projects (especially interdisciplinary projects) need an external moderation during the introductory phase for an objective-oriented project processing.
2. Expert advice (technical and didactical) is already necessary during the conceptual design of the project.

The following sections will clarify the two theses by specifying what actually has to happen during the initial phase of a project. Furthermore, the third section of this chapter shows how we have put our considerations into practice.

#### 4.1 Directing the project

In most cases of larger e-learning projects, there are people involved with different backgrounds. Especially these interdisciplinary teams have - because of their different perspectives on the topic - the potential to reach high-quality results:

1. Mutual encouragement enables teams to develop many, creative ideas.
2. Distributed competence can be useful for one common goal.

The risk lies in the one-dimensioned view of the project. Experts concentrate on their special topic and interpret their project objectives and the evolving tasks from their point of view. At the end of the project, it takes great effort to integrate all different parts to an outcome if possible at all.

An external moderation can help making the maximum use of these potentials by keeping an eye on the project scope, structuring the communication process and methodically supporting it as well as involving all participants in the process. Especially, the last aspect is essential for a successful outcome, for it is common practice that singular opinion leaders evolve from the group who might oversee hidden potentials.

#### 4.2 Finding adequate solutions

Especially when project participants are rather inexperienced concerning e-learning, the project team might lack of knowledge about the prospective effort and an adequate procedure to reach the objectives in the scope of implementing tools or a didactical concept.

In order to call upon the potentials, external know-how is needed which cannot be provided by the moderation alone. This expert knowledge is integrated into the process of project design. This may be:

- the responsibility to consider the central parameters of didactical planning within the project scenario,
- a solicitor of awareness that a technical solution is not a solution for learning but that it is always the communication between the learning object and participating persons as well as the integration of e-learning in an educational concept,

- supporting decision processes during the selection of technical tools while sourcing out the phase of decision-making from the actual course of project, and
- the responsibility to develop the scenarios on the basis of realistic potentials.

### 4.3 The course of project introduction

In the following, we will present different steps that are gone through during the very first conceptual phase of a project. In the *eLearning Service Team*, these steps are realized during the first counselling interview with new project teams. These steps shall foster the transparency about common objectives, the initiation of creative processes for project design and the design of the developing process in a comprehensive but effective way. In practice, this leads to a thoroughly structured talk and a consequent visualisation of the working outcomes.

The course of the counselling interview is structured into seven steps:

1. The general conditions of the project are requested by a comprehensive questionnaire. The participants of the projects can review their situation and the advisors get a picture of the given conditions.
2. In the second step, all participants develop a visual sketch of the project. They collect central ideas and correlate them in a *concept map* (figure 1). During this phase, the most important coordination processes concerning conceptual decisions come to pass. Expert advice plays a crucial role, too, in order to answer different questions, e.g. about the technical possibilities or didactical potential.

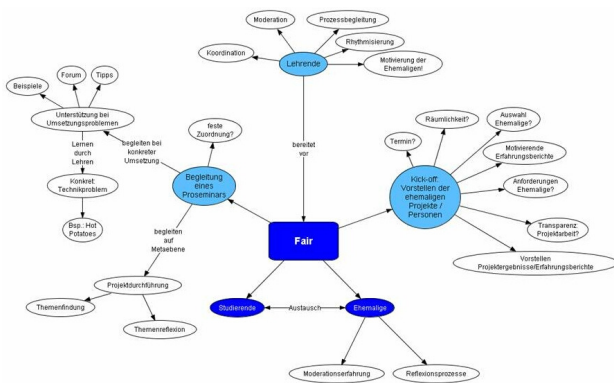


Figure 1. Collection and correlation of central ideas in a concept map

3. Different goals and advantages are collected and structured on moderation cards. During the following coordination process, they are put in order by priority. As an outcome, possibly heterogeneous objectives are harmonized in a catalogue of objectives and - most important - accepted by all participants. From this catalogue of objectives, it is possible to extract work packages (step 6).
4. The risk management is the fourth step, before starting with a detailed collection of ideas for development. It functions as a filter for possible miscalculation. Especially the consideration of preventive measures during planning has proven to be successful in practice.

5. In the fifth step, a combination of *brainstorming* and *mind mapping* leads to ideas in the fields of organisation, methods/tools, materials and social architecture. The collected ideas are eventually arranged in a rough draft for the sequence plan of the course.
6. The work packages extracted from the catalogue of objectives, risk management and collected ideas resemble the obligatory ending of the consultation.
7. Finally, further steps are discussed, e.g. making use of services, planning the evaluation and identification of work packages.

As an outcome, the participants as well as the *eLearning Service Team* have a comprehensive documentation of the project. On the one hand, it is a common basis for further planning and, on the other hand, it is used for preparation and orientation for further advice.

We have experienced that the counselling concept enables a very focussed and objective-oriented processing of the project, mainly due to the systematic visualisation of the working outcomes. The three-hour counselling interview sets an ideal ground for further processing of the project.

## 5. E-LEARNING ELEMENTS

Even though moderation and expert advice are crucial for beginning projects with many people involved, they are sometimes unnecessary for everyday teaching. We have developed the tool *e-learning elements* for the purpose of quality assurance and self-evaluation of e-learning courses\*. E-learning involves teaching and learning modes that exceed traditional patterns. This also means that the complexity and variability of teaching very much increase. It is then helpful to have a visualisation of one's own teaching concept. The *e-learning elements* support the teacher to keep a general view of his or her teaching.

The *e-learning elements* consist of 15 attributes of e-learning (figure 2), each of them completed with typical specifications (figure 3). Each specification is described and annotated with examples, hyperlinks or literature (figure 4). The characteristics of a course can then be described by colouring the specifications. So, it is possible to see at a glance which attributes are implemented. Unapplied e-learning elements are still on the screen and do not fall into oblivion. They might motivate the teacher to apply them in another course or initiate further studying about didactical topics in e-learning.

\* The prototype can be downloaded at <http://www.l3s.de/elan/kb3/index.php?id=640> (L3S Research Center, 2002)

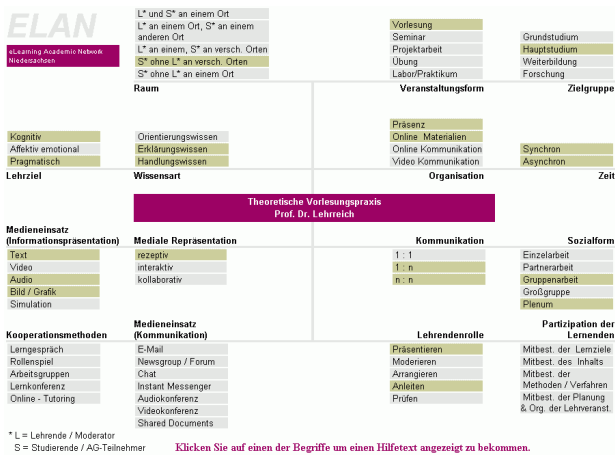


Figure 2. Screenshot of the e-learning elements at a glance

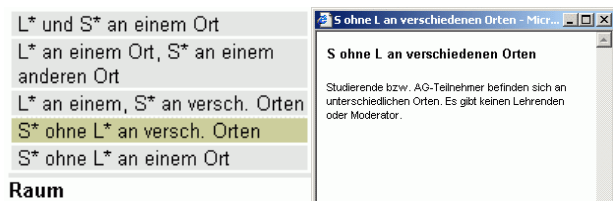


Figure 3&4. Screenshot of an attribute, its specifications and descriptions

The *e-learning elements* can be applied in different phases of e-learning: planning or evaluation. The number of coloured attributes and specifications is not relevant for the quality of an e-learning course. The qualitative aspect lies in the overview of didactical aspects so that the teacher recognizes them as an inherent part of e-learning. The variability of the e-learning elements comes into account when a teacher applies the tool on several courses.

Further possibilities to use the *e-learning elements* are as a presentation tool in class, e.g. to present the objectives of the course, or for peer-evaluation with other teachers.

## 6. CONCLUSION

To sum it up, our experiences in the ELAN project have led to a consolidation of central aspects for the didactical potential in e-learning. As an outlook for the next two years, it is planned to communicate and implement our measures in Lower Saxon universities. Furthermore, the network of experts will grow by connecting local experts and central competences at different locations.

Our *e-learning elements* tool can help to visualise e-learning courses and courseware. On-the-job, teachers can reflect on their plans and adopt didactical basics relevant for e-learning.

The overall goal is to reach an early majority of e-teachers (cp. Rogers, 1995; Albrecht et al., 2005) and improve their teaching qualities. Until now, e-learning has been practiced in the scope of funded projects. Teachers involved may belong to a category of early adopters who are intrinsically motivated to practice innovative teaching. However, in order to achieve a university-wide acceptance of e-learning, the early majority is absolutely necessary. It may include sceptical teachers who are critical about the advantages of e-learning. Therefore, these have to be clearly stated as we have done so in this contribution.

The goal to reach a sufficient number of teachers is only reasonable, if it is accompanied by high-quality teaching measures. Novice teachers have to be equipped with competencies that enable them to use ICT purposefully. We believe that a support from competence teams and a structured project monitoring can lead to a didactical improvement of face-to-face and online-teaching. Especially during the introductory phases of a project, we suggest to fall back on external moderation and get expert advice in technical and didactical matters from the beginning. Technology and didactics shall not be just a stopgap or a fig leaf but systematically integrated in the project development.

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## 8. FURTHER INFORMATION

The *eLearning Academic Network* (ELAN) in Lower Saxony consists of three major net pilots spread all over the federal state. The first phase of the project went from 2002 to 2004; the second phase will prospectively continue until 2006. One of the net pilots is situated in Hanover and Brunswick and deals with the effective and economically sustainable development of e-learning services. For this objective, a substantial concept has

been developed which guarantees the support of Lower Saxon universities with the use of multimedia.

The essential element of the net pilot is a central service group (*eLearning Service Team*) which supports the participating universities with the production of a manifold content portfolio in different faculties. The *eST* consists of experts in the following disciplines: didactics/evaluation, multimedia technology, authoring tools, information and communication systems, and indexing/archiving. It offers support to teachers in higher and further education through advisory service, training, information and technical operation and works in close cooperation with institutions of the participating universities, such as the computer centres, the didactic centre, the didactic centre of Lower Saxony and the German National Library of Science and Technology (TIB). The authors are members of the *eST*.

# COPYRIGHT ISSUES FOR DIGITAL MATERIAL AND ITS DISTRIBUTION

Margo Bargheer

State and University Library Göttingen, University Press Göttingen

## Commission VI, WG VI/4

**KEY WORDS:** electronic publishing, e-learning, copyright

### ABSTRACT:

Passing on information within the traditional model of teaching face-to-face had been mostly volatile and for a circumscribed audience. It therefore required less attention on possible copyright infringements unless the courses had been published outside this audience. E-learning due to its digital existence offers new possibilities of archiving, re-use and distribution. Hence the scientific communities worldwide have been developing networked public repositories and retrieval mechanisms. These new information structures now allow worldwide verification of contents that so far were only locally available. In order to fully use the potential of e-learning materials special care is needed to avoid unwanted copyright infringements or other legal problems. This refers to the local teaching situation as well as to storage, reuse and distribution – be it via local intranets or the internet. The paper gives a general introduction to the legal concepts of intellectual property right and copyright, looks at the different use-scenarios of e-learning material and analyses potential problems like copyright infringements. A few practical examples are used to show one hand national characteristics of the respective legal framework and on the other hand material-specific problems.

## 1. INTRODUCTION

Electronic publishing and the Internet as a powerful distribution and communication medium have brought new opportunities for scientific work. Primary data can be exploited in new ways [data mining], more and more scientific information is available in the Internet, copy-and-paste allows easy and fast compilation of already existing materials, server technology has opened new possibilities of providing retrodigitised or born-digital material, E-learning material – once compiled – can be stored and reused. The digital nature of information distributed in the Internet has opened new horizons not only for using one's own data but especially the use of work accomplished by others.

But these new possibilities alongside have brought new legal problems like unintended copyright infringements or uncertainty on how to use scientific material found in the Internet. The following article aims at giving a short introduction into copyright issues regarding digital material, focussing on teaching scenarios. Nevertheless the article is not to be understood as legal counsel or device.

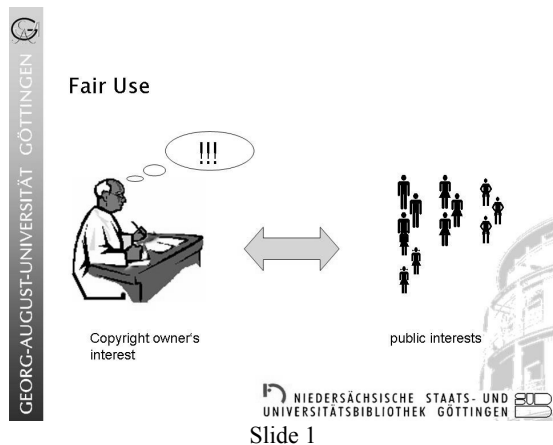
The regulating and legal base of sharing scientific results is the intellectual property right and copyright as part of it. Copyright refers to intellectual scientific work and the creative realm like music, literature, fine arts or others, whereas patents aim at protecting ideas (such as the principle of a certain effect or action) for industrial / [commercial] use. Copy right can turn into a legal weapon in the hands of those determined to use it if infringements – be they unintended or not – harm personal rights or economic interests derived of intellectual property rights. It is therefore useful to get acquainted with basic structures of copy right.

Copyright law rests on concepts of ownership, property and rights, namely on a concept that intellectual creations belong to the individual who claims them successfully to be his or hers.

Every culture in the world has a distinctive concept of property and corresponding exploitation rights like owning land and distributing the harvest it bears. Intellectual property however is a rather odd idea for certain cultures, especially those with an egalitarian social structure or with a political system rejecting individual property. China for example has only until recently, when entering the global market on a large scale, picked up the idea of copyright laws and protection of intellectual properties. Because concepts of ownership and derived rights are not laws of nature like gravity but have grown historically and are based on cultural concepts copyright legislation differs nationally. There is, however, something like a minimum standard of international copyright agreement expressed in the "Berne Convention". Since 1967 the Berne Convention is handled by the World Intellectual Property Organization and refers to all countries who are members of the World Trade Organization. In order to reduce uncertainty copyright is – theoretically – tied to territorial principles. Wherever somebody decides to claim his or her copyright that certain national legislation comes into force. Obviously this is however complicated in the digital age and the Internet and we leave it as such for the time being.

In a technical sense all copyright legislation refers to manifestations of ideas – be it in a tangible, digital or volatile form. The mere idea however like a royal tragedy taking part in Denmark or drawing conclusions about large-scale social phenomena by analyzing representative samples is not protected by copyright law. Nor can a formula like Kekulé's discovery of the carbon ring or a simple collection of publicly available data like the sequence „Monday-Tuesday-Wednesday“ enjoy protection. Even simple data collections like a telephone book at least in German legislation enjoy a certain amount of protection and this refers especially to data collections which systematic compilation represents a certain intellectual effort. But we can leave this aside for the moment. An individual manifestation of an idea is the prerequisite of any copy right protection.

## 2. FAIR USE



Slide 1

Copy right has initially been formulated to grant economic rights to those who have put effort in creative work like fine arts, writing, or composing and yet balance these individual with social interests. German copyright for instance recognizes that scientific or cultural ideas stem from social and cultural interaction which therefore limits the individual's property right on the idea's manifestation. Another conceptual limit to copy right rests upon the very act of publishing. By publishing a certain piece of work the property right holder gives up a certain degree of individual ownership and transfers it to the public. However legislation has recognized that in order to give incentives for creators to publish results of their creative work – from which society at large would benefit – those creators should have the chance to exploit their work economically in a more or less exclusive fashion. Public interests, the creator's interests and those of the ones who wish to use other's intellectual work is balanced by concepts of „fair use“, or in German „Schrankenregelung“.

Let us simply talk of „fair use“, although German copy right does not use this term or the underlying concept exactly the way continental copy right uses it and other legislations like from the United States have a detailed understanding. With permission of the copy right holder there are hardly any limits what you can do with the work of others. „Fair use“, however refers to those rights that do not need any particular permission.

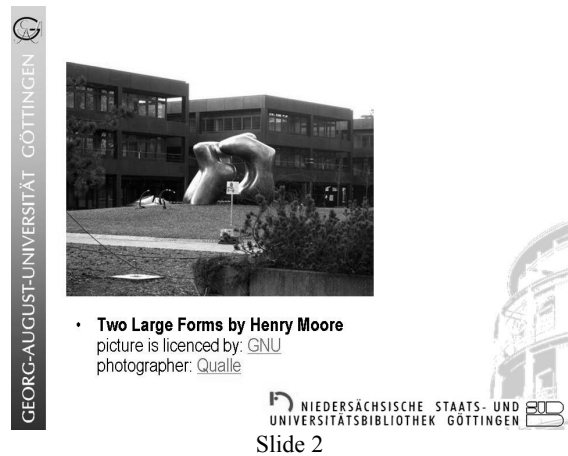
But fair use may not be what our common sense might assume it is. For example nonprofit, educational use or giving credit for the source of the work, or limiting access to materials to students in the class is not automatically fair use. The US-American understanding of fair use depends on a balancing of four factors, which may be addressed by a variety of means. The four factors are:

1. Purpose of the Use
2. Nature of the Work
3. Amount of the Work Used
4. Effect of the Use on the Market for the Original

Those four factors do not apply to all national copy right legislation but there is something like a general understanding that they apply when in case of conflict a copyright infringement is in question – especially No. 4.

Fair use is a framework of limited freedom we can operate in when using other's work for our own purposes like teaching. However if your efforts of compiling teaching material might

allow further economic exploitation like selling your work you are well advised to carefully check whether fair use regulation gives you the right to do so. If in doubt refrain from economic use of your work or seek to get permission of the copy rights holder. Especially in academic teaching scenarios where „economic exploitation“ might just mean to distribute a CD at expenses-covering costs to a handful of students permission to use the work of others is often easy to attain without involving monetary transactions. What belongs to fair use? „Gemeinfreie Werke“ or works that due to certain reasons belong to the public domain can be used freely and don't need fair use regulations. Nobody can prevent you for instance to take a picture of the art work “Two large forms” and sell it. Not because Moore doesn't have a copy right on it but because it is exhibited in a public place. Interestingly “Qualle”, the photographer has licensed his picture so I was free to use it within the limits of the GNU license.



Slide 2

After a certain amount after the death of a creator you are usually free to use that material if you please to do so. But beware: very successful creators like Walt Disney or Erich Kästner might have heirs who have prolonged copyright protection! If your library is one of the lucky few to own a precious piece like the first print of “Kosmos” by Alexander von Humboldt: go ahead, produce a high-quality faksimile reprint and sell it – the publishing house Eichborn might then just be one among others to distribute it.



Slide 3

But: the „Mona Lisa” might be free of any copy rights. Its images however that have been taken by the Louvre staff still belong to the museum and are protected by property law. There will be limits how to economically exploit the image even if

you have purchased it as a slide at the museum shop. You might not even be allowed to use it in your teaching material if the printing on the slide says so. So, what belongs to “Fair Use”?

### Fair Use

- Private Copies
- Right to Cite
- Copy for scientific Use
- Copy for Educational Use
- Right to Archive



### 2.1 Private Copies

are widely allowed within fair use – but that’s your private business so we leave it aside for the time being.

### 2.2 Your Right to Cite

Scientific work intrinsically has a referential and dialogical nature. We cite each other not just out of politeness but due to our understanding of “objectivity” or intersubjective traceability. Therefore you may include pieces of other peoples work in your own. But: if without the citations of others there is not much left of your own work or there is no obvious connection between your own creative work and the citation your right to cite does not help in your teaching scenario. You may simply compile citations but you can not publish such a work nor use it in teaching. Copyright (and scientific fairness) asks however to properly attribute the work of others, especially the continental copyright laws give the copyright holder the right to restrain modifications, distortions and mutilations of his or her work.

### 2.3 Copy for Scientific Use

Generally copyright owners have to accept that others may copy their work for scientific use. What about sharing it? Often you may copy a piece of work and distribute it within closed circles. There might be strong limits to what a „closed circle“ means. Members of an organizational well defined research team might be regarded as a closed circle, a loose network of peers at different institutions might not. The same goes for your teaching scenarios. A doctoral colloquium or a seminar of twenty people can be regarded as a closed circle, a lecture however belongs to the public realm regardless whether on the last date before Christmas only 15 people show up or only those students are allowed in the lecture who have passed their first exams.

### 2.4 Right to Archive?

Libraries may and should archive. A single scientist however usually has very limited rights to do so – even within fair use. This means that you might be allowed to use a certain compilation that includes other people’s work in your teaching scenarios, you might be allowed to store it on a server for your

students to download with a password, but you may not display it on your institute’s homepage for general use. Most copyright legislations might even prevent you from storing it to reuse it at other times.

Note however, if your material does not pose any copyright problems (because you have sought for permission f.e. or have used Open Access material) you can make full use of digital supply, distribution, access and archiving.

### 2.5 Copies for Educational Use

Education is almost generally a realm of fair use, usually with the most limited possibility for copyright owners to prevent the use of their work. Still, under most national legislations you would only be allowed to use parts of a work or just a very small number of copies. German copyright however treats academic education as outside this special protection. Only in official exams like the diploma exams those “educational use” regulations apply. Make sure whether your national copyright legislation includes academic education within fair use. Otherwise the fair use agreements for scientific use should be applied.

## 3. OUTSIDE THE LIMITS OF FAIR USE?

a) *Look for other possible exceptions to the rights of copyright owners*

You might need legal advice to find such alternatives but there are possibilities.

b) *Obtain Permission to Use the Copyrighted Work*

This is always the safest road to travel. Make sure that you state the planned use correctly (like print runs, audiences, amount of material to be cited). If no permission had been asked in the first place and conflict arises it might still be argued it happened out of ignorance – but in worst-case-scenarios ignorance does not protect against punishment. To seek permission on false data however is definitely a form of deception and therefore should be avoided.

c) *Look for alternatives*

- Replace the materials with alternative works.
- Alter your planned use of the copyrighted works.
- Conduct a risk-benefit analysis (benefits might outgrow the risks and there is a German saying “wo kein Kläger, da keine Klage”; *But:* large publishing houses might fight copyright infringements as a principle even if the actual harm is minor. They usually have good lawyers and copyright infringements can become a lot more costly than simply having to take down material from a server.

Or ...

- Use Open Access Material
- Look for licensed material such as under a Creative Commons License

<http://creativecommons.org/>



Or...

Look for work that has been published Open Access, especially if it has been published under a license such as Creative Commons License. For these materials many of the rights have been transferred to the public domain as more and more authors recognize that widespread and impact of their work is a lot more important for them than financial revenue. Make free use of those Open Access materials and consider contributing your own work in an Open Access fashion by licensing it as such.

#### 4. ACKNOWLEDGEMENT

I am grateful to Prof. Gerald Spindler from our Jurisprudential Department at the Georg-August-University for his efforts to sensitize his non-jurisprudential partners from the interdisciplinary research project "Mediaconomy" for copyright issues. My special thanks go to Joachim Dorschel from the same department for his precise and helpful advices. Mistakes however are solely within my responsibility.

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## E-LEARNING AND E-TEACHING - MEDIA DEVELOPMENT AT UNIVERSITÄT STUTTGART

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Commission VI, WG VI/1 - VI/2

**KEY WORDS:** media development, eLearning

### ABSTRACT:

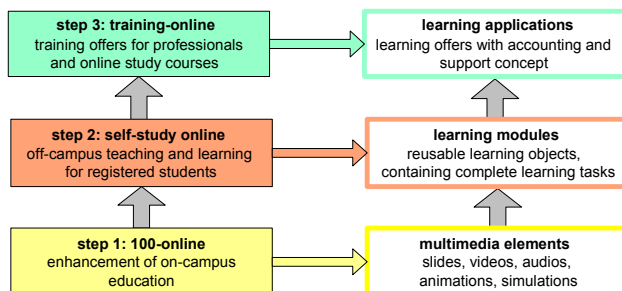
Teachers at Universität Stuttgart are highly motivated to improve teaching through multimedia. With campus-online education the university has started a programme to give university teachers the possibility of acquiring knowledge in multimedia applications on a broad basis and to provide them with financial, technical and didactical support. The realisation and organisation of the programme campus-online education are described in the contribution.

### 1. INTRODUCTION

In 2001 the headship of Universität Stuttgart decided to improve teaching and learning through multimedia elements and web technologies in lectures, seminars and exercises. So the headship of the University of Stuttgart has developed a broad strategy on

- how to improve teaching and learning by means of multimedia technologies,
- how to bring the knowledge gathered in the university to the public,
- how to improve the didactical competence of teachers on a broad basis
- how to gain direct economic impact from the university's teaching and learning products,

For the realisation of this strategy a general three step concept "campus-online education" has been worked out.



In a first step multimedia technologies were to be introduced or enhanced in the lectures and classes on-campus. The result of this would be multimedia elements like slides, videos, audios, animations and simulations

accompanying the scripts. This was achieved by the program "100-online".

In a second step those multimedia elements were to be integrated in re-usable learning modules which contain complete learning tasks and tests for self-assessment. These learning modules can be used by registered students for instruction and learning off-campus. The program "self-study online" in which such learning modules are produced is still going on.

In a last step the learning modules are intended to build complete learning applications which can be used as training offers for professionals or as online study courses. "Training online" is the provisional name for this program to be started in the near future.

In 2001 quite a few institutes developed and applied already media solutions and the majority of teachers of Universität Stuttgart was motivated to start with new media methods in their lectures however a framework program like "campus-online education" was necessary to support teachers in their doing and thus to set in motion the entire university.

### 2. REALISATION

Campus-online education is one of the strategic measures of the university. This fact and the support of the headship of the university guaranteed the success of the program. It was obvious from the very beginning, that the university, which consists of 10 faculties and is attended by about 20.000 students, has to start its concept from the very bottom. The framework program "campus-online education" had to give university teachers the possibility of

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acquiring knowledge and skills in multimedia applications on a broad basis and to support them in the adjustment and enhancement of their teaching methods with the new media.

For the realisation of the strategy a quite strong management structure and a very effective support structure were set up.

## 2.1 100-online

The main intentions of the program 100-online were

- to improve on-campus teaching and learning by the use of multimedia elements and web technologies in lectures and classes of all study courses
- and to give an impetus for future online-learning for students, graduates and professionals.

The headship of the university and his rectorate wanted to encourage lecturers to experiment and work with the new media in order to find out the appropriate use in their field of study. Within this context, it was hoped, they would continue to employ the new media in the future without extra funding as well.

The more detailed objectives of 100-online were

- to create or digitalize multimedia elements (like photos, graphics, audios, videos, animations, simulations etc.)
- to design re-usable online teaching material
- to start interactive online communication between students and teachers
- to develop the technical and didactical competence of lecturers.

From this resulted the framework of the program. Projects were to be supported with 10.000 DM (approximately 5.000 €). Projects were considered to last six to twelve months. All faculties were supposed to get involved, so special experience or knowledge were not a condition for participation and no special requirements were demanded. In the end, up to 100 projects were hoped to be initiated; thus the name of the program.

243 applications for projects were handed in. This response was much better than expected. This high number motivated the headmastership to provide more money for the program. This was successful. The university dedicated 2.3 million DM (1.2 million €) of its budget for the funding of the projects and finally 230 applications were approved. This meant that 50% of the professors (or one of their staff) took part in 100-online.

The projects were as distinct as the institutes which conducted them. They differed as much in their content as in their technical complexity. They included

- the generation of the institutes own web-sites for teaching
- the publication of slides and scripts of the lecture

- online communication and tutorials
- material for the preparation and wrap-up of on-campus lectures
- preparation of online exercises and self-tests
- simulations of processes
- online self-learning modules
- computer based trainings which were distributed on CD-ROM.

The publication of a regular e-letter was a quite effective way to bring in the same way information to the project and give guidance to the project participants. All lecturers had to hand in a preliminary report of his project. This was published in an e-letter (<http://www.uni-stuttgart.de/100-online/e-letter/>). The publication in the e-letter was the pre-condition to obtain the second half of the projects funds (the first half had been paid at the beginning of the program). This gentle pressure proved to be very effective. The participants took note of the e-letter very vividly. It was the best visited part of the 100-online web-site. Only 16 projects never handed in the preliminary report and were apparently abandoned at an early stage.

The institutes were supported in their production by courses organized by the computer centre which covered didactical and technical issues. The subsequent support was restricted to "help to help yourself" because there was (and still is) no manpower in the computer centre to provide programming or multimedia-producing services on a larger scale. A second part of the services of the computer centre were the first constituents of a technical infrastructure for eLearning: the groupware BSCW, a chat, a newsgroup, and a mailing list.

Moreover, the on-campus teaching was assisted by a better hardware infrastructure in the lecture halls which were largely equipped with beamers, micro ports, and access to the internet. In addition a lending for other hardware like camcorders, digital cameras or portable beamers was established.

The program was rounded off by a final event on the 11<sup>th</sup> of July 2002. On this occasion the 100-online award was bestowed, which the university had donated and announced in April. 37 projects applied for the award. A jury chose five candidates to present their project and the audience appointed the winner. The e-letter continued to be published until the end of the year, thus forming the unofficial end of the program 100-online.

## 2.2 self-study online

The program self-study online followed directly on 100-online and started in autumn 2002. It is funded one half each by the Universität Stuttgart and the Ministry of Science, Research and the Arts Baden Württemberg. The main intentions of the program were

- to improve off-campus learning by the use of self-study units and online cooperation in lectures and classes of all study courses
- and to develop central support structures.

For the projects the transfer from step 1 to step 2 was mainly a work to assemble their material of step 1 to self-contained learning modules. This meant supplementing the material with learning tasks, exercises, self-tests, and online-support. On the other hand the central program management at the computer centre had to provide a software environment which would support important standards (like LOM and SCORM) and allow the input of metadata. Moreover, the central management had to establish and make available central evaluations.

The organizational frame was quite similar to that of 100-online: each project was carried out in an institute, supported with 5.000 € and intended to be finished after 12 month. With the programs duration of three years three calls for applications were planned. The funds of the projects were split in two halves again; the first being paid at the beginning of the projects, the second after the preliminary report which was once more published in an e-letter.

To improve the information exchange and to support project participants Know-how Forums were newly implemented. These Know-how Forums are groups of participants with similar interests. In 100-online the projects were carried out relatively unconnected. The exchange between lecturers was rather a matter of coincidence. Accordingly the Know-How Forums serve the internal communication about specific topics, the knowledge transfer between the projects, lectures with subsequent discussions, Workshops, and the general exchange of ideas and experiences. The topics covered the production of teaching modules, modules for exercises, self-tests, tutorial support, and evaluations. Each topic had mainly a technical and a didactical aspect. The regular attendance at – at least – one Know-How Forum was required for the participants.

The e-letter of self-study online was structured in a new way (<http://www.campus-online.uni-stuttgart.de/self-study/e-letter/>). The e-letter met two demands of the lecturers and the producers of the material: information about tools and practical information for the realization of the projects. Thus the projects were asked to describe their course of action step by step and to describe their problems and solutions.

self-study online e-letter Nr. 4

Dieses Jahr kam die Universität Stuttgart als erste und bislang einzige deutschsprachige Universität mit einem eLearning-Konzept in die Finalrunde des Medida-Prix. Der Medida-Prix, der Oskar des eLearnings, wird jährlich im Rahmen einer Fachtagung der Gesellschaft für Medien in der Wissenschaft vergeben.

Dieses Jahr nahmen 186 Bewerber am Wettbewerb teil. Von diesen wählte eine Jury neben der Universität Stuttgart sechs weitere Kandidaten aus und lud sie zur Finalrunde nach Graz ein. Gewonnen hat die Universität Stuttgart am Ende leider nicht. Aber der Projektstand und der Vortrag über das Stuttgarter eLearningkonzept stießen auf großes Interesse bei Vertretern anderer Universitäten und von Ministerien. Die Universität Stuttgart hat die Gedanken des eLearning-Breiteneinsatzes und der Vermarktung sehr erfolgreich vertreten und verbreitet.

Weitere Informationen über den diesjährigen Medida-Prix und den Auftritt der Universität Stuttgart finden Sie unter [www.uni-stuttgart.de/online/aktuelles/](http://www.uni-stuttgart.de/online/aktuelles/)

Dr. David Boehringer, RUS

Furthermore they were asked to make evaluations of the tools they had used and to give recommendations for

others. These evaluations of tools are very useful because the computer centre is not able to give support for most of the tools discussed there. The acquaintance with the tools and the need for the tools are both on the side of the institutes. The tool evaluations are an instrument to distribute the requested knowledge and experience about the tools in a standardized manner. In the future the tool evaluations will be incorporated in the general web-pages and user groups will be established.

As a technical eLearning environment the computer centre started to build – mostly – client-server-architectures in consideration of the existing software applications (<http://www.uni-stuttgart.de/online/dienste/#elearning>). Up to now these eLearning services consist of a learning management system (ILIAS), a streaming server (Helix), a tool for lecture recordings (Lecturnity), and an upload-interface programmed by the computer centre. The individual components have open interfaces and can be adapted to individual needs, whether they are open source or commercial products. This keeps the whole architecture flexible and open for future developments and necessities.

Lecture recordings are a new feature in the eLearning activities of the Universität Stuttgart. They started in the summer term of 2004 with the first 14 lectures. Each recording project was supported with 1000 €. A few of the lecture halls were adapted to the new demands, but mostly new hardware components (touch-sensitive boards, VGA-signal splitter, portable micro-ports) were added to the lending of hardware which was rearranged in the course of this. The lecturers were trained to make the recordings themselves and the new web-interface of the upload-service allowed them to publish the recordings comfortably right after the lecture

(<http://www.uni-stuttgart.de/online/dienste/aufzeich/>).

The evaluations show a very good acceptance and a wide use of the recordings by the students. They appreciated especially the possibility to recapitulate complicated parts of the lecture and to be able to use the recordings for the preparation of their exams.

In the summer term 2004 evaluations of online supported classes were – for the first time – realised centrally. The results showed that a good integration of the online material and exercises in the course of the classes and a clear transparency of the goals and the kind of the modules are most important for the acceptance and therewith the success of eLearning offers. In the end of the third year an evaluation of all classes is intended on the large scale.

### 2.3 training online

In the third step of the eLearning concept, starting in near future, training courses for professionals will be designed and offered to the public for payment. The main intentions of training online are

- the commercialisation of existing eLearning contents
- and the development of study programs organized in a blended learning scenario.

The first part, the commercialisation of existing eLearning contents, will probably be realised in a network of universities and universities of applied sciences from Baden-Württemberg in the project "ok-bw" (online-knowledge Baden-Württemberg). All partners will contribute content for a common platform which is provided by a commercial partner who will also take care of accounting procedures and marketing.

### 3. SUMMARY

The campus-online education of Universität Stuttgart is to be realized by a media concept consisting of three steps. The first step, the program 100-online, was finished in 2002. Multimedia-material was produced which was designed to be used in on-campus lectures, but also published in the www. Building on this learning modules are created in the program self-study online, which started in autumn 2002 and will end in 2005. The learning modules of self-study online are meant to provide self-learning possibilities for registered students of Universität Stuttgart to deepen their knowledge. In the third step, training online, the learning-modules will be extended to teaching units. These are supposed to be used in a commercial context as self-training programs in professional web-based scientific trainings, but also at university in courses of study with blended learning scenarios.

The results that were reached until now are quite impressive. 60% of all university teachers came in touch with eLearning which became a part of their daily work. Almost all students of the university are involved in more than one of their classes. The reactions of both, lecturers and students, are very positive.

In the development three key factors proved to be essential for success:

- Initiative and support of the rectorate of the university
- Central coordination and technical and didactical support
- Openness and engagement of the lecturers.

The development of the eLearning concept was a strategic decision of the rectorate and the official support of the eLearning programs was an important sign for the whole university. The small central management proved to be very effective and established very effective support structures. Last, but not least the success of the programs rested on the shoulders of the many university teachers who tackled a completely new way of producing and maintaining their teaching material.

The main lesson learnt by the Universität Stuttgart in all this is that sustainability proves to be the central point in multimedia and eLearning projects and that sustainability of eLearning at universities can be reached if people

- do it broad
- do it themselves
- do it continuously
- do it like us.

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## DEVELOPMENT OF E-LEARNING MODULES IN SPATIAL DATA MANAGEMENT

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### SUMMARY:

GI Science is as well as many other scientific areas characterized by an increasing volume of information and a decreasing validity of knowledge at the same time. This trend requires new learning methods using tools for visualization of learning content, which then heighten effectiveness of knowledge acquirement. In that context, buzzwords like e-learning, blended learning, lifelong learning or multimedia has appeared and a large number of GIS e-learning projects resulted from this development. The latest example is FerGI (Fernstudienmaterialien Geoinformatik - engl.: distance learning material for GIS), which will be introduced in the beginning of the paper. We then highlight the didactical as well as the technical aspects of developing e-learning-Modules in Spatial Data Management and conclude the paper with the results evaluation of the first module.

### 1. INTRODUCTION

The management of spatial data has gained more and more importance. Emerging object-oriented spatial database systems and servers, new OGC and ISO standards and different types of web services are indicators of this trend. Therefore, spatial data management is an important part of any GI curriculum and of most GI e-learning initiatives like the FerGI-project. The following section describes the organisation and the goals of this project.

### 2. THE FERGI PROJECT

The FerGI project started in October 2003. The aim of the three years lasting project will be to produce and evaluate 18 e-learning modules. These modules will not reflect the whole GI curriculum, but concentrates on special GI topics. Dividing the whole content into small compact modules (with ECTS points from 0.5 to 3) guarantees a better content exchange and a greater acceptance amongst GI lecturers (Schiewe, 2004). The contents of the modules will be given in German and / or English.

FerGI is a cooperative project of the Center of Excellence in Geoinformatics in Lower Saxony (GiN) and the e-learning network VIA Online. The GiN partners – five institutes from the University of Hanover, the University of Osnabrueck and the University of Applied Sciences in Oldenburg will develop the contents whereas VIA Online, represented by the University of Hildesheim gives didactic support.

### 2.1 MODULES IN SPATIAL DATA MANAGEMENT – CONCEPTIONAL ISSUES

The FerGI modules on spatial data management are mainly provided by the Institute for Applied Photogrammetry and Geoinformatics (IAPG) in Oldenburg. Altogether, five modules about spatial data management are intended. Figure 2 gives an overview of these modules and the connections between them. The size of the modules ranges between 1 and 3 ECTS points. Three of the modules are building the foundation of the other two, more application-oriented modules. Especially, the module “Standards for Spatial Data” is required or at least useful in many other GI modules.

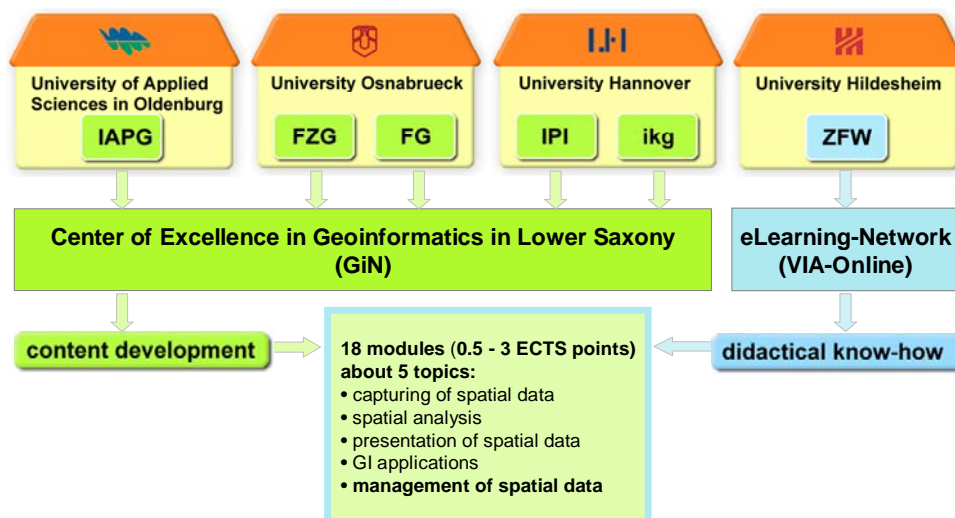


Figure 1: Organisation of FerGI.

## 2.2 TARGET GROUP AND PRACTICAL EXERCISES

In order to produce a sustainable solution with high effectiveness, e-learning projects have to consider several aspects. An early definition of the target group and of the project aims is essential in order to avoid conceptional changes, which can be extremely costly. The module of the topic “spatial data management” will be used for teaching students of geoinformatics, geodesy, geography and environmental sciences. Blended learning at universities, i.e. a combination of long-distance learning and face-to-face learning, is the main application case of the modules. In a second phase, it is intended to expand the target group to participants of further education programs.

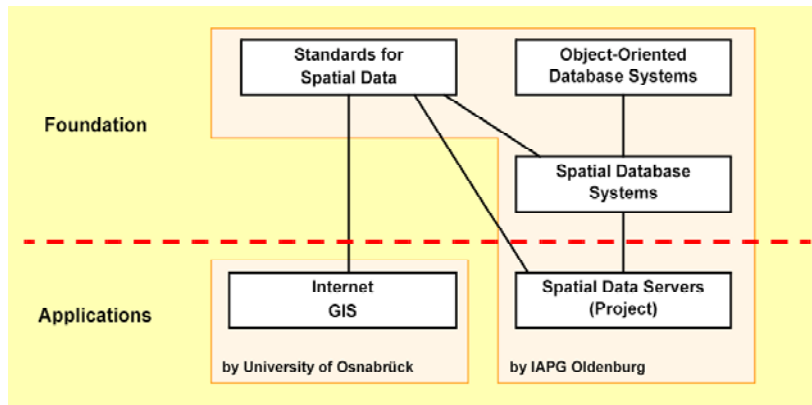


Figure 2: Modules about spatial data management.

In order to motivate learners over a longer period of time and to consolidate knowledge, the modules are particularly connected with practice. Studying with the modules should enable the student to develop competence on cooperation, self control and multimedia usage, which is essential with web-based learning methods.

## 2.3 MODULE CONTENT

Two of the modules developed by the IAPG Oldenburg, “Standards for Spatial Data” and “Spatial Database Systems” are completed and have already been integrated into lectures since September 2004. They are described in detail in the following paragraph.

The course “Standards for Spatial Data” consists of ten chapters starting with an introduction to data modelling. Afterwards, the basics of describing data models will be explored; in that context plenty definitions of terms like objects, classes and relations between objects are given in order to explain object-oriented modelling concepts. In addition, UML class diagrams are introduced in that section. Then, the course provides an overview of organisations for

standardization of spatial data such as ISO/TC 211 and OGC. Three chapters present information about the Feature Geometry Model (Geometry and Topology package) and the Simple Feature Model. Both models are the foundation of the Geography Markup Language. The chapter on GML includes a short introduction to the basics of XML. Finally, the ISO standard 19115 “Geographic Information: Metadata” is topic of the last chapter.

The second course “Spatial Database Systems” focuses on the management of spatial data in databases. The introduction consists of a presentation and discussion of different techniques to store spatial data and of the concept of object-

relational spatial database systems like the Informix Spatial DataBlade and Oracle Spatial. Then, the course provides an overview of standards for representing spatial data in databases including a short repetition of the Simple Feature Model and an introduction of the ISO standard SQL/MM Spatial. Oracle Spatial is presented as an implementation of such models. In this part, students can exercise spatial data modelling by using a special spatial SQL tool (see also next section). The last part of the module treats spatial query processing. Several techniques are introduced including approximations, quad trees, and r-trees. Again, students can exercise with Oracle Spatial and the spatial SQL tool.

## 2.4 MODULES IN SPATIAL DATA MANAGEMENT – TECHNICAL ISSUES

All FerGI courses present themselves in a unified layout using the same icons, font sizes and colors in order to give students a familiar setup. The design is based on an HTML template using a central Cascading Style Sheet (CSS).

```

1 <!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
2
3 <html>
4 <head>
5 <meta http-equiv="content-type" content="text/html; charset=iso-8859-1">
6 <title>1. Einführung Geodatenbanksysteme - 1.1 Geoinformationssysteme (GIS)</title>
7 <script type="text/javascript" src="../../skripte/script.js"></script>
8 <link rel="stylesheet" type="text/css" href="../../formate.css">
9 </head>
10
11 <body>
12 <table class="rahmen" cellspacing="0" cellpadding="0">
13 <tr>
14 <td class="titelleiste">1. Einführung Geodatenbanksysteme</td>
15 </tr>
16 <tr>
17 <td class="navi"><a href="0.html"></td>
18 <td class="content">
19 <h1><a name="1.1"></td>
20 </td>
21 </tr>
22 <tr>
23 <td class="content"><p>Üml-blicherweise unterscheidet man bei einem Geoinformationssystemen
24

```

```

1 #media all {
2 A:link { color: #00549f; font-style: normal; font-weight: normal; font-family: Arial; text
3 A:visited { color: #800000; font-style: normal; font-weight: normal; font-family: Arial;
4 A:active { color: #404040; font-style: normal; font-weight: normal; font-family: Arial;
5 A:hover { color: #606060; font-style: normal; font-weight: normal; font-family: Arial;
6 dfn a:link { color: #606060; font-style: normal; font-weight: bold; font-family: Arial;
7 dfn a:visited { color: #606060; font-style: normal; font-weight: bold; font-family: Ari
8 dfn a:active { color: #606060; font-style: normal; font-weight: bold; font-family: Ari
9 dfn a:hover { color: #606060; font-style: normal; font-weight: bold; font-family: Ari
10
11 p { line-height: 17px; font-family: Arial; color: #000000; font-style: norm
12 #titelleiste { color: #000000; font-weight: bold; font-size: 10px }
13 #normal { color: #000000; font-style: normal; font-weight: normal; font-size: 13p
14 #zusatz { color: #000000; font-style: normal; font-weight: normal; font-size: 13p
15 #beschriftungen { color: #000000; font-weight: bold; }
16 #titel { color: #000000; font-style: italic; font-weight: normal; font-size: 14px;
17 #beschriftungstext { color: #000000; font-style: italic; font-weight: normal; font-size: 13p
18 #beschriftungsnummer { color: #000000; font-style: italic; font-weight: bold; font-size: 13px;
19 #autor { color: #000000; font-size: small; font-weight: normal; text-align: left }
20 #copyright { color: #000000; font-style: normal; font-weight: normal; font-size: 13px;
21
22 #kap { color: black; font-style: normal; font-weight: normal; text-align: left
23 #inhaltsverzeichnis { color: #327094; font-size: 13px; font-weight: bold; }
24 #inhaltsverzeichnis { font-size: 12px; font-weight: bold; }

```

Figure 3: HTML template with CSS stylesheet.

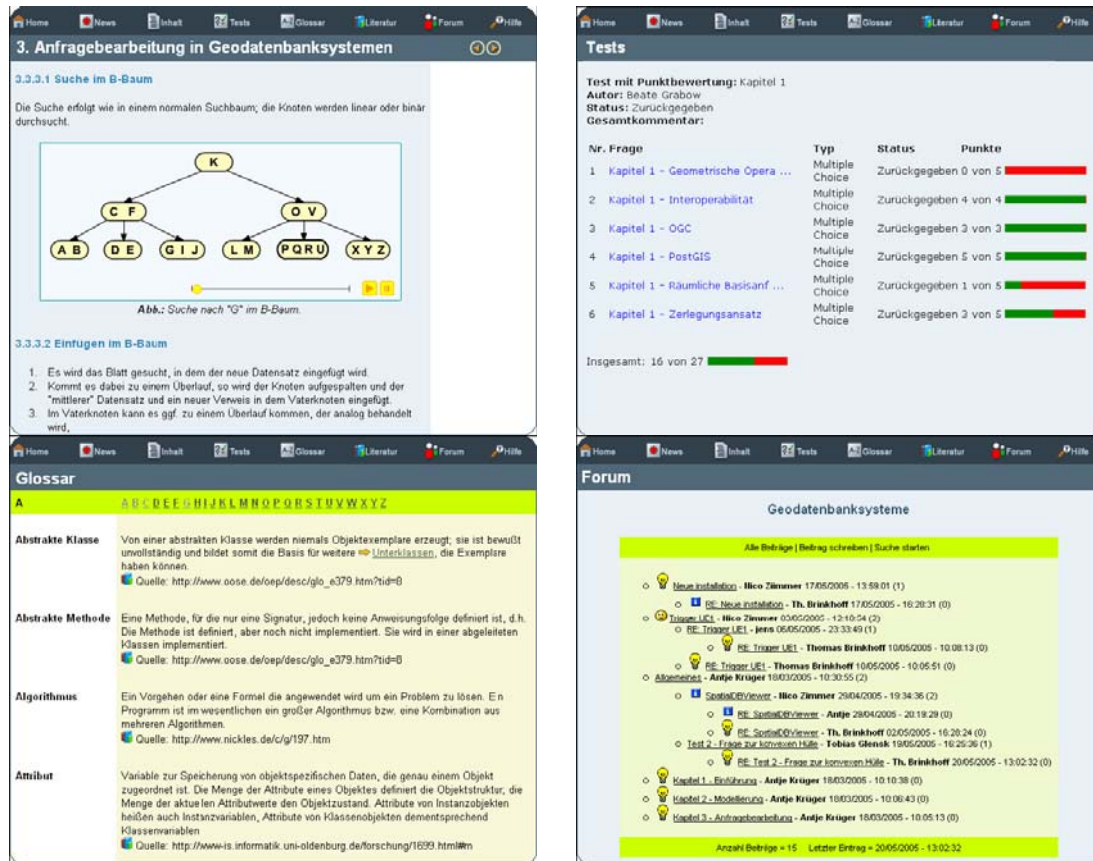


Figure 4: Screenshots of the module "Spatial Database Systems".

## 2.5 ANIMATIONS

Animations are very helpful for explaining complex learning contents. By using animations deliberately, the time of learning can be shortened and the comprehension can be increased. Since it is fairly time-consuming and costly to produce them, it is advisable to analyse deeply the effectiveness of using animations. Sometimes a single picture can express the same content as good as an animation, but producing it is much faster and cheaper.

## 2.6 SPATIAL DATABASE VIEWER FOR EXERCISES

As mentioned before, theory lessons should be tightly connected with exercises. In case of standard database lectures, this is typically achieved by (web-based) SQL interfaces; examples can be found in (Kudraß 2003). Using such an interface, the user can enter an SQL statement. After that, he gets an alphanumeric result – typically the query result (i.e. a relation) or an error message. In case of spatial database systems, such an approach is insufficient because the contents of tables as well as the results of queries may include spatial attributes. A textual or numerical representation of spatial data is difficult to interpret. In consequence, students would have difficulties to decide whether the SQL command or query computes the right result or not. In order to solve such problems, a spatial SQL Tool – the so-called "Spatial Database Viewer" – has been developed.

This tool allows the formulation of SQL statements. In addition to standard database tools, it

- supports the visualization of the (complex) structure of system- or user-defined objects,

- visualizes the content of tables with spatial attributes by displaying a map,
- visualizes the results of spatial queries (i.e. spatial attributes as well as the results of spatial operators) by a map, and
- depicts metadata of spatial attributes.

The visualization of tables and maps will be updated if a database update is performed using the Spatial Database Viewer. Spatial attributes of selected objects are highlighted in the corresponding map. The tool supports a German as well as an English user interface. Currently, it works for Oracle Spatial (Oracle, 2003a), release 9 and 10. Figure 5 illustrates the visualization of a spatial table, of a complex spatial attribute and of spatial metadata. The visualization of the spatial buffer operator is depicted in Figure 6.

The Spatial Database Viewer is implemented in Java 2 Standard Edition, v1.4. It runs as a standalone application as well as a Java applet. Oracle's JDBC library (Oracle, 2003b) and SDOAPI library, the Java Topology Suite (JTS 1.4) (Vivid Solutions, 2003) and the Oracle Spatial library of (Geotools, 2004) are used. The principle steps for performing a spatial query are depicted in Figure 7.

## 3. EVALUATION

In December 2004 the first module "Standards for Spatial Data" has been evaluated by about 20 students at the University of Applied Science in Oldenburg. Although these students had not yet worked with e-learning content, they found the module intuitively accessible and most of them were convinced that the presented media was more motivating compared to a traditional lecture. Furthermore, most students liked the idea to use such modules to support

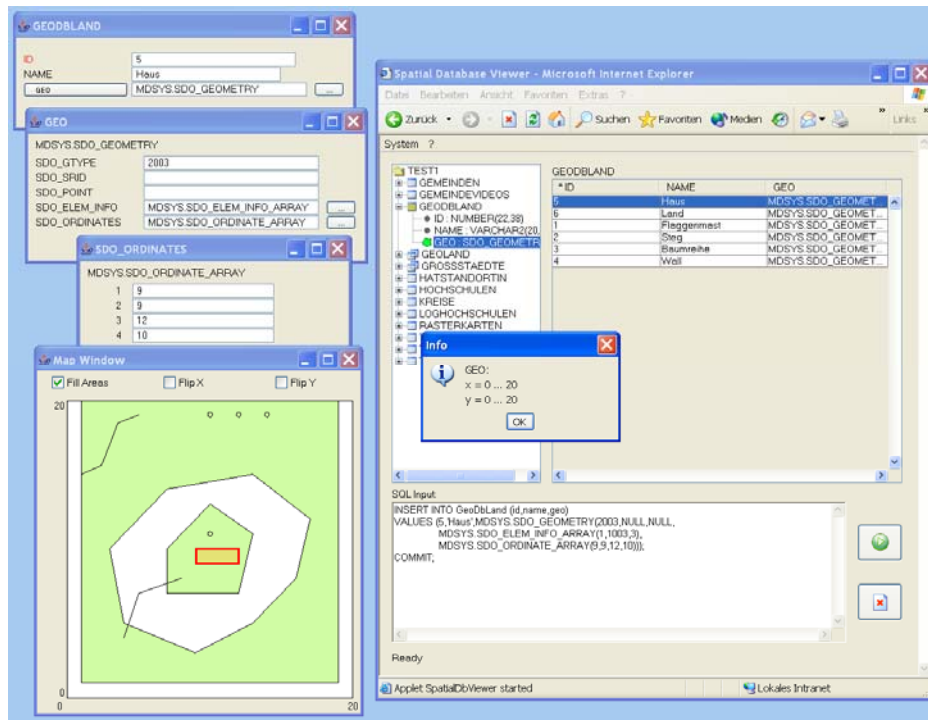


Figure 5: Visualization of spatial tables, complex attributes and metadata by the spatial SQL tool.

face-to-face-lectures, but not to substitute those. So FerGIs aim to develop modules for blended learning usage was the right choice. Concerning flexibility in time and place and the effectiveness of learning, there was a definite positive tendency.

#### 4. CONCLUSIONS

In this paper, we presented the FerGI-project with its conceptual design and technical issues for developing e-learning modules about spatial data management. Up to now, two modules have been integrated into lectures. The current

feedback of students in the discussion forum and the results of their tests were positive and show a broad acceptance of the courses. Finally, it will be important for the success of FerGI to develop a business model for the time after the end of governmental funding in September 2006. To finance further e-learning activities, a co-operation of FerGI with other GI e-learning initiatives in Germany and Europe would be necessary.

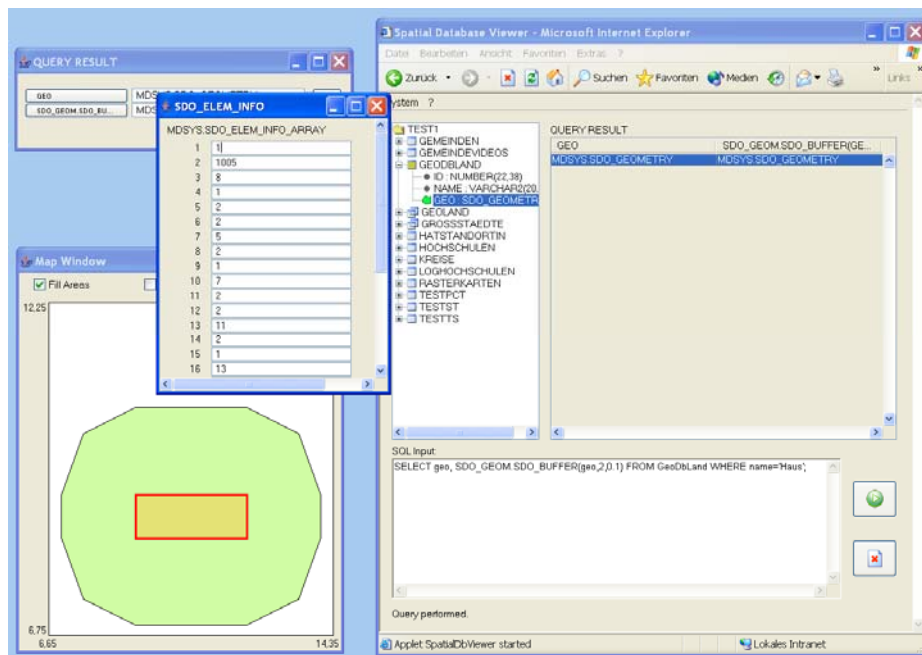


Figure 6: Visualization of the spatial buffer operator by the spatial SQL tool.

## 5. ACKNOWLEDGEMENTS

The FerGI project is funded by the German Federal Ministry for education and research and the Ministry for Science and Culture of Lower Saxony. This support is gratefully acknowledged.

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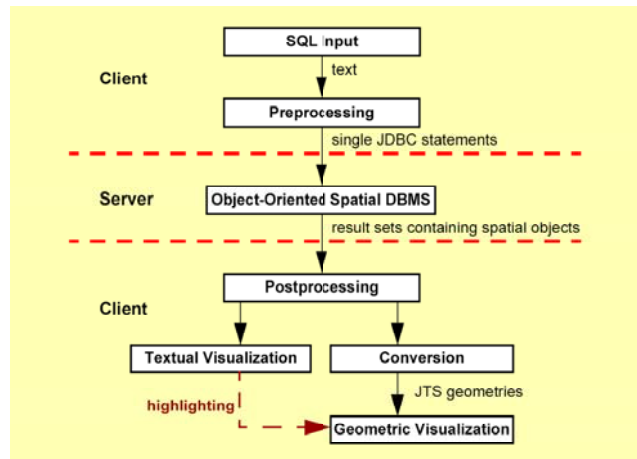


Figure 7: Processing of spatial queries by the spatial SQL tool.

## Eye Learn - An interactive WEB based e-Learning Environment in Photogrammetry and Remote Sensing

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### Commission VI, WG II

**KEY WORDS:** Internet/Web, Photogrammetry, Remote Sensing, Learning, Education, Teaching

#### ABSTRACT:

This paper presents the e-Learning project Eye Learn. The main aim of this project is to integrate in the Bachelor courses Fundamentals of Photogrammetry (FoP) und Remote Sensing (RS) given by the Photogrammetry and Remote Sensing (PRS) Group, a WEB-based interactive e-Learning environment. These courses are compulsory and introductory, forming the base for many more courses at the Master level. The e-Learning framework and tools that will be developed based on the content of each course will allow the lecturers to communicate information in a more engaging and effective way to the students. Rich media and efficient didactic methods will be employed. Interactive processes, dynamic objects and virtual experiments will stimulate understanding through a number of learning objects. The learning objects will include in addition to text, images, videos, WEB-links with an associated Assistant, interactive quizzes, simple on-line programs and possibility to use own data, acronyms and glossaries of used terminology, cross-links between the different learning objects, related literature and case studies. Emphasis will be given to the understanding of theory through own problem-solving oriented work. Evaluation and self-evaluation procedures will allow better control of what is learnt and how well and will allow a refinement of the e-Learning environment. This project will be exploited as a base for using similar techniques in the other courses of our Group and to introduce e-Learning technologies to all teaching personnel.

### 1. INTRODUCTION

The Photogrammetry and Remote Sensing (PRS) Group of the Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology has currently initiated the integration of a WEB-based e-learning environment in the two Bachelor courses, Fundamentals of Photogrammetry (FoP) and Remote Sensing (RS). The focus in this paper is to present the aims and concept of the e-learning framework, the target audience, the methods and tools that will be utilized and their adaptation to the current structure of these courses, the didactic scenaria and interactive media utilised, and the evaluation methods. The term Eye Learn has been adopted as the name of the e-learning environment, where the word Eye is used to point out the extensive use of visual media and methods and the strong relation of both courses to images and vision.

In the sciences of Photogrammetry and Remote Sensing a number of tutorials, on-line courses and exercises exist but in most of the cases are not transparent and have poor structure, are very static (including usually only text and images) or targeted for high-level students or have a very broad content. An example is the WEB tutorial of NASA on remote sensing (<http://rst.gsfc.nasa.gov/Front/overview.html>) which includes a large amount of information but without exploiting the use of interactive tools and without being transparent. The last period some academic institutes have started to integrate e-Learning tools in teaching and learning in Photogrammetry and Remote Sensing courses. Some of these developments are listed below with some remarks on their weaknesses and strengths.

The on-line course for Photogrammetry, Remote Sensing and Digital image processing from TU Berlin (<http://www.fpk.tu-berlin.de/wbt/fernerkundung/>) is transparent, but covers a small part of the course contents and has limited interactivity (quizzes). Tokai University, Japan has developed a Remote Sensing tutorial which includes a set of interactive experiments, for

which the correct answers are found by a trial and error approach (<http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/RS-fun/>). Intermap Technologies Corporation, Canada, has presented recently a professional tutorial on interferometric SAR, which apart from images and script includes also a narrator. Promising on-line courses have been developed from the University of Hannover (Haig et al. 2004, <http://ipi.uni-hannover.de/elan>) and the University of Vechta (<http://www.fzg.uni-vechta.de/airlaser/>) and include apart from the course material also a set of interactive exercises, in an informative and transparent way. However, the exercises are restricted only to interactive quizzes. There are several other related developments (notably at the University of Stuttgart and several N. American universities), which can not be mentioned here due to lack of space. Some work refers to nationwide teaching and learning activities, e.g. the project GITTA in Switzerland (Bleich and Nebiker, 2004). In other cases, e-Learning material has been developed by professional organizations, e.g. the courses of EuroSDR on Digital Cameras and Data Fusion, Co-ordinate Reference Systems, etc (EuroSDR, 2005).

In this project, we built upon and exploit already performed work on e-Learning, especially in similar courses but we intend to expand on used didactic forms and teaching material in the various aspects (see section 3). Most of existing e-Learning material is developed to cover specific course requirements at an institution, thus they are not directly transferable to course of other institutions, which have a different structure.

### 2. AIMS OF EYE LEARN

#### 2.1 Current situation and motivation

FoP and RS are included in the curriculum of Bachelor studies in Geomatics Engineering and Planning and are both introductory courses in the sciences of Photogrammetry and Remote Sensing respectively. Within these courses, the basic theoretical

principles are taught and the core knowledge in the respective scientific field is acquired, which serves as a basis for several courses of master studies in the fields of Photogrammetry, Remote Sensing and GIS. FoP and RS are related and have a certain overlap regarding the taught data processing methods and algorithms. Both courses deal heavily with image processing, analysis and mensuration, thus are strongly visually oriented and well suited for multimedia teaching approaches. They include sometimes complicated processes that are difficult to understand, if not practically working with them. The course material, especially in Remote Sensing is too much, thus often it can not be covered fully, while time restrictions do not allow exercises and labs to a sufficient extent. Furthermore, the course contents are subject to frequent changes due to rapid technological changes (e.g. new satellites and sensors). The students taking the courses have often different background (e.g. RS is taken by environmental engineers or students of other departments who have not taken first the FoP course). Although teaching material is made available on the WEB and first steps towards e-Learning have been explored, the current scheme of the learning methodology follows mostly the traditional lecturing approach, with its known deficiencies.

FoP consists of a theoretical part and a set of exercises. Based on the theory that is taught in the classroom the students have to use the acquired knowledge to perform some exercises in the lab. Most of the exercises are place-dependent, namely performed only in the lab, and for a number of them the students have to use complex commercial software. As a result, it is difficult to repeat the exercises outside the lab at the own pace and improve understanding based on the student's individual learning style. Furthermore, since the number of available software licenses and workstations is limited and the students have multiple obligations, the labs have to be performed at specific time slots, with multiple students working per workstation, some of which watch passively, while a colleague works.

RS is divided in thematic modules, a number of which is taught by different specialists. While students profit from the information provided by the different specialists, the drawback is that the students need to adapt themselves to different teaching and script styles. Exercises using data and programs have not been yet integrated in the course program, due to the following difficulties: (a) the students would have to use existing commercial packages for remote sensing applications to perform simple tasks. However, these software packages include hundreds of functions, are relative complex and require investment of significant time to learn them; (b) the number of hours of this course is too low and time spent outside lectures is not allowed to exceed half of the total number of teaching hours.

## 2.2 Aims

The main aim of this project is to improve the teaching and learning methods in these fundamental courses by developing an interactive WEB-based, place- and time-independent, e-Learning environment. A secondary aim is to exploit the work of this project as a base for using similar techniques in the other courses of the PRS Group and to introduce e-Learning technologies to all teaching personnel, so that e-Learning becomes a permanent part of teaching and learning, leading to an increase of the learning amount and learning rate at lower costs.

Regarding the main aim, our work will have the following characteristics:

- a) Improved structure of the teaching material and division in thematic modules, easier update of it, and more homogenization for RS.
- b) Avoidance of overlaps and double development effort between FoP and RS, by developing one thematic module and using it in both courses where necessary.
- c) Enrichment of the teaching material with additional information, e.g. glossaries<sup>1</sup>, list of acronyms<sup>2</sup>, data sources and project cases.
- d) Cross-linking of various information sources (e.g. between thematic modules, literature links etc.) and enabling of rollback (retrieval and refresh of material previously learned) and parallel learning (simultaneous learning of multiple information, as opposed to sequential learning).
- e) Selection of important WEB links (e.g. tutorials, data etc.) and establishment of a WEB-Link Assistant. This tool will provide critical metadata information on the content and quality of the WEB links and their relation to the courses, speeding up considerably the selection of suitable information for a certain purpose.
- f) Possibility for the students to use the material anytime, anywhere via Internet or CD.
- g) Increased interactivity and use of dynamic objects (implemented using Macromedia Flash and Java) with visual or numerical feedback, so that students can work independently, try different scenaria (e.g. variable processing parameters) in labs and quizzes, understand better processes etc.
- h) Increased use of media, especially images, videos and graphics.
- i) More capabilities for doing practical work and learning-by-doing by providing simple easy-to-use programs and test data, possibility to do practical work alone (and learn more) and repeat it if needed, thus increasing the knowledge acquired but also the student motivation and making clearer the practical relevance of the learned methods.
- j) The above aim will be supported also by setting up an ensemble of interesting case studies and projects (there, also project work of our group and research results will be embedded).
- k) Choice freedom, which increases motivation and interest, in using the images and the application of interest to each student, although the problem to solve is common (e.g. when teaching students how to generate a 3D model from two stereo images, a student interested in architecture may use her own camera to image a nice architectural object, while another student may use other images).
- l) Procedures for better control and self-control regarding what has been learnt and how well, providing mechanisms for self-evaluation. Latter will be achieved among others by a feedback, including explanations on frequently made errors, which we will initially set up based on experience and will refine as years go by, and proposals for alternative correct solutions.
- m) Higher flexibility for the students on how much to learn, e.g. for students with gaps in prerequisite knowledge some introductory modules can be set up, while for students with higher interest and ambitions higher-level optional modules can be offered.

<sup>1</sup> Since there are some multilingual dictionaries in Photogrammetry and Remote Sensing we will try to make use of them, for providing the terms (and maybe also their explanation) in English, German, French and Italian.

<sup>2</sup> This is very important for Remote Sensing where hundreds of confusing acronyms are used.

- n) Higher flexibility for the students on when to learn (enabling of asynchronous learning) and how, and revisiting capability of the learning material (recall of information).
- o) Support of the students to show more initiative, be more self-confident and curious (exploratory learning), and closer to the conditions they will face in their professional life.

The approach we will follow is realistic and will use mainly existing technologies and software packages. The advantages of each of the above aspects for the students will be carefully monitored through evaluation procedures and necessary amendments will be made.

### 2.3 Target audience

The main target group will be students taking the FoP and RS courses. They are compulsory and are taught in the 4th and 6th semester with 4h and 2h per week respectively. The students do not include only ones that follow the Bachelor in Geomatics Engineering and Planning (their expected number is more than 30) but also other students who take these courses as elective ones, e.g. environmental engineers but also from other departments, including Master and Ph.D. students. Thus, the pre-existing knowledge of the students vary and also their interests. Although both courses are introductory, they partly rely on pre-existing knowledge and additionally since FoP comes first, RS partly relies on it. Regarding Master students, since at the Master level we expect to have students with different background and also outside ETHZ, this work for the two basic Bachelor courses, could be used by them to cover quickly knowledge gaps and thus better and faster follow the more advanced Master courses of Photogrammetry and Remote Sensing. This material can be further distributed to other institutions, especially in developing countries, within the framework of ISPRS, where our Group is very active on education, training, capacity building, international cooperation and technology transfer.

## 3. DETAILED DESCRIPTION OF THE PROJECT

### 3.1 Didactic scenaria

Although lectures, even in their classical frontal teaching form will not be totally replaced, the Eye Learn environment will enable learning processes mainly outside the classroom. Our didactic concepts include:

- Extensive use of rich media able to convey easier and/or faster information.
- Increase of the motivation, personal activity, interaction and responsibility of the students.
- Adaptation to the different backgrounds, interests and learning styles of the students.
- Better understanding of theory through closer linkage to applications and projects, and extensive use of learning-by-doing and problem-solving oriented methods.
- Better integration of research (including our own) into teaching.
- Provision of tools for self-evaluation, search for correct answers and development of a critical attitude.

The WEB environment can be used by the students before and after the lecture and for exam preparation. The advantages for the course lecturers are that they can better communicate the course information, control the performance of the students and

improve the course quality. We believe that such an e-Learning environment will be also a motivation for the lecturers to increase their engagement in their courses.

### 3.2 Use of media

Currently, mostly Powerpoint presentations and material on the WEB (incl. the existing dedicated WEB page of each course) are used to communicate the material of the lesson. The new media elements to be used include:

- Extensive use of images, videos and graphics which are essential for both courses. These will be used in all learning approaches (teaching, exercises and quizzes, case studies and project examples etc.). These media will be made available on the WEB but partly they will be also acquired by the students themselves, e.g. taking images with their cameras. Videos will be used for showing dynamic processes (e.g. different techniques of image acquisition) and visualisation of geodata and results, e.g. fly-throughs over 3D terrain models, walk-throughs in 3D city models etc., simulation and animation.
- The presentations will be enhanced with the integration of dynamic objects and interactive examples, which will be used on-line especially by the students themselves (e.g. in quizzes) but also by the lecturers for teaching and demonstration purposes. E.g. a student can change the flying height of satellite and see in real-time the effect of this change on the area imaged, the image scale and resolution etc.
- We will further explore the possibility to use existing technologies (e.g. similar to the MS Messenger) to use audio and video for communication between lecturers and students, in addition to the classical email.
- CDs and DVDs will be used to enable (a) access of material when the students have no Internet access and (b) for distribution and use on the own computer of programs and datasets that would be too slow to run via Internet. This material can be further distributed to other institutions, especially in developing countries, with poor or non-existent Internet access.

### 3.3 New elements of the project

Eye Learn (see also Figure 1) builds upon and exploits already performed work on e-Learning, especially in similar courses but also includes new aspects regarding used didactic forms and teaching:

- Development of simple, easy-to-use, stand-alone programs with associated instructions.
- Development of a WEB Links Assistant which will ease making efficient use of the plethora of the existing WEB material.
- Extensive use of dynamic interactive objects.
- Freedom in selecting (or even collecting) own data (images) to be used for a given exercise and lab.
- Support of self-evaluation, not just by a right/wrong answer or providing the correct answer but also by developing a list of frequently made errors and guiding the students to explore alternative solutions.

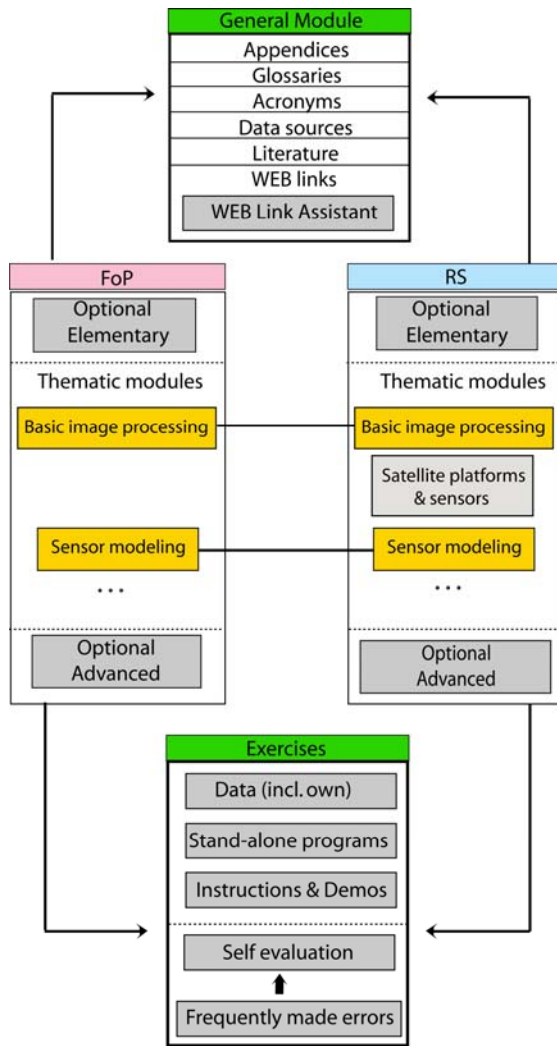


Figure 1. Structure of the e-Learning environment. The general module is used by both FoP and RS. Both courses included optional elementary and advanced modules and the exercises are built upon the same concept.

### 3.4 Expected life of the e-learning material

The used methods and technologies will be selected such that:

- They are as much as possible long lasting, using common, standard IT tools and being supported by many WEB browsers (and their versions) and operating systems ;
- They allow integration of new teaching and learning modes and media and easy change of the scientific content, by using a modular software concept with a decoupling of the software material from the course content.

Regarding data (images, video, graphics etc.), we will use formats that are stable and de facto standards. Furthermore, the contents and the technologies of the teaching environment will be related to content management systems, thus enabling easier change of the used technologies. Content management systems, like OpenCMS (2005) and Silva (2005), facilitate the easy and cost efficient management and update of the structure and content (text, images, videos, etc.) using pre-defined templates. Although clearly we have no control over rapidly changing technologies, we expect the e-Learning environment to be usable for several years without major modifications.

### 3.5 Evaluation methods

The evaluation procedures and the data to be collected will be decided right at the beginning of the project, so that the necessary data can be collected throughout the duration of the project. The main evaluation is planned after the learning environment is implemented for each course. Questionnaires will be distributed to the students, and will include specific and targeted questions on learning methods and content developed within the project. The questionnaires will be set-up in cooperation with DiZ (didactic center of ETHZ), which will be also invited to contribute, using its own evaluation methods. The questionnaires will be evaluated and the results will be discussed with the students. Furthermore, we will track using standard WEB statistics collecting tools how often each student is using each of the WEB pages and downloads files, as a measure of related interest. An indirect method of evaluation that we will use is the number of students that perform a Bachelor thesis in Photogrammetry and Remote Sensing and continue to take such courses in the master studies.

## 4. SUMMARY AND CONCLUSIONS

We have presented the project Eye Learn, a WEB-based interactive e-Learning environment for basic courses in Photogrammetry and Remote Sensing. Eye Learn will utilize rich media and efficient didactic methods, while interactive processes, dynamic objects and virtual experiments will stimulate understanding through a number of learning objects. Emphasis will be given to the understanding of theory through own problem-solving oriented work. Evaluation and self-evaluation procedures will allow better control of what is learnt and how well and will allow a refinement of the e-Learning environment.

The developed e-Learning environment will very probably be used by students of the Master in Geomatics Engineering and Planning, but maybe also students of other departments of ETHZ and outside institutions, especially in developing countries, as already mentioned. We will also advertise the courses to related Swiss professional societies, as there is a great need for life-long and continuing education, especially in disciplines of rapid technological changes. The material will also become publicly available. For such users, a registration and log-in via username and password would be required for statistics and security purposes. Through involvement and training of assistants for all courses given by our Group, it is expected that this project will have positive influence on other courses as well and that modern e-Learning methods will become a permanent tool in teaching.

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## AN E-LEARNING TUTORIAL FOR RADAR REMOTE SENSING WITH RAT

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Commission VI, WG VI/1 - VI/2

**KEY WORDS:** Content development, Assessments and Tests, Blended Learning

### ABSTRACT:

E-Learning materials and courses are becoming increasingly established at German universities. One reason for this is that technical prerequisites for successful e-learning – such as private internet access – have improved considerably. Furthermore, cost has been a driving force for the increase in online professional education. At the Technical University Berlin (TU Berlin), the Departments of Geodesy and Computer Vision are engaged in online education, offering a tutorial for remote sensing.

The tutorial, which is divided into several chapters that are accompanied by exercises and tests, allows for performance linked control. User actions and test results are recorded in a personal data file. This information is used to adjust the exercises and to guide students through the course depending on their knowledge. Techniques for processing radar images are a main focus of the tutorial. Hands-on exercises covering SAR (synthetic aperture radar) topics are introduced as practical work to improve the students' understanding of remote sensing algorithms. For this purpose, test data of several study areas are available, and are employed to convey practical experience in the use of radar tools developed at the TU Berlin. Communication between the students happens by means of a forum, where ideas and problems are discussed and solved collaboratively.

RAT (Radar Tools) is a collection of tools for processing SAR remote sensing data, developed at the TU Berlin for ongoing research and education. Students are encouraged to actively participate in software development, adding new functionality to the SAR-toolbox. In practice, it has been observed that students are significantly more motivated when they realize that their work contributes to an ongoing, bigger project which is of general use. RAT is an ideal platform for experimentation and learning, as it is easy to extend and provides a convenient data handling framework.

The development of RAT is motivated by the fact that modern remote sensing software systems like ERDAS IMAGINE or ENVI provide only basic SAR functionality. Advanced algorithms have to be implemented by each researcher independently. RAT aims to bring modern SAR algorithms to a wider user-base by simplifying the data handling and processing of complex SAR data. RAT can be run inside the free IDL virtual machine on various operating systems.

### 1. INTRODUCTION

In 2003, an analysis of six learning programs developed at German universities was done by random sampling. The analysis determined that most e-learning initiatives do not tap into the full potential of the unique modes of presentation and communication available to online systems. In particular it was found that students' diverse learning needs weren't sufficiently accommodated (Schiewe 2003).

This shortcomings could partially be corrected by the initiative "Neue Medien in der Bildung", an effort endowed with considerable funds from the German Ministry for Science and Culture of Lower Saxony and Federal Ministry of Education and Research (BMBF). Especially projects *geoinformation.net* (Quadt et al. 2004), *Virtual Landscape* (Katterfeld 2004), *ELAN* (Haig et al. 2004) *Norddeutscher Methodenlehre-Baukasten* (Bill et al. 2004), *gimolus* (Müller 2004) and *FerGI* (Schiewe et al. 2004) accelerated the progress in development of internet based learning modules.

How well these projects can be sustained after government funding remains to be seen.

Despite good technical advances, only few approaches which consider personalized instruction at an adaptive, appropriate pace are realized.

In this paper the authors describe a tutorial for remote sensing, which is used for students' education at the Technical University Berlin.

### 2. E-LEARNING APPROACH

#### 2.1 General Objectives

The central idea of the tutorial, which was initially developed at the Department of Photogrammetry, was to offer students learning material which allows individual navigation depending on respective previous knowledge and skills. The contents of a chapter must be offered in a manner that allows different ways of achieving the learning goal and gives access only to those materials that are relevant to the goal. If

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for an average student, for example, five pages are required to understand, the subject will have to be explained in more detail for students with less knowledge, while advanced students could complete the chapter in three steps. This modular conception requires the linking of the pages to be adaptive, which implies a separation of content and links.

This central idea requires the development of small segmented learning modules, each tailored for a certain level of difficulty. Moreover, it is necessary to continuously measure and verify students' knowledge level. This is the only means to control the operation sequence.

### 2.2 Database concept for realization

To attain this goal, the information needed must be stored in a database. Figure 1 gives an overview of the tables necessary for realization. Yellow tables refer to user administration, while green tables correspond to content maintenance.

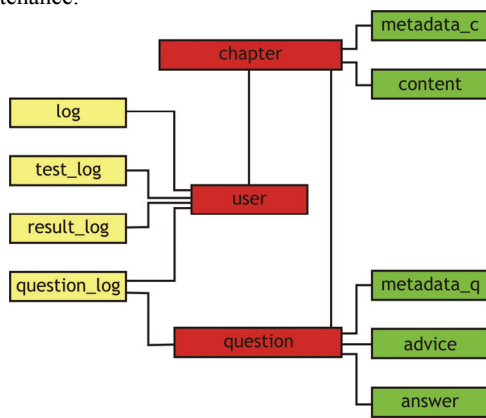


Figure 1. Database tables overview.

MySQL, the popular Open Source alternative, is used as the database management system. Database access and tutorial guidance are programmed in Java using Java Server Pages or servlet technology. For more detailed information, see the paper published for the ISPRS congress in Istanbul (Koenig, Weser 2004).

### 2.3 Controlling navigation

As mentioned earlier, acquiring information on an individual progress is a prerequisite for adapting the training course to the student's skills. The sequence of actions is controlled by tests, which need to be analysed carefully. As a measure affecting the workflow, the weighted ratio of correctly answered questions in relation to all answered questions is calculated. This weighted performance factor is determined after every test and is stored in the user database. The student is guided through the lecture based on this performance factor.

Test questions are also assigned different ratings. Differentiating between easy, moderate and difficult questions allows for a more precise determination of the learners knowledge, and for a better guidance through the training course.

Depending on his or her knowledge, the student is assigned to one of three classes: beginner, intermediate, advanced. The system allows for a student to answer questions of different levels of difficulty. Two indices, set by the course author, determine the probability of how the questions are

distributed. As illustrated in Figure 2, advanced students could expect 20% questions to be easy, 30% to be medium and 50% to be difficult, whereas a beginner can expect a ratio 50:40:10. The final assignment is handled by a random number in the interval [0,100]. Assuming that 61 is selected randomly advanced students have to answer a difficult question, beginner and average students a medium one.

Questions' level of difficulty			Students' knowledge	Distribution key
easy	moderate	difficult		
1	2	3	low	(50:90)
1	2	3	moderate	(30:70)
1	2	3	excellent	(20:50)

Figure 2. Indices (30, 70) and a random number (61) influence the decision about the questions to put.

This approach allows a faster jump to another class and a more sophisticated adjustment to the learner's knowledge.

### 2.4 Question Pool

Another idea in this tutorial is to implement a pool of questions, which allows an individual selection. The main advantage of this approach is that in case of retaking a test, the same questions are not asked again. Figure 3 shows how, at a specific moment, only a limited part of the pool of questions can be chosen. The relevant questions, determined by the chapter in use, limited to the appropriate level of difficulty and reduced by the questions already asked, are ascertained by the information in the database.

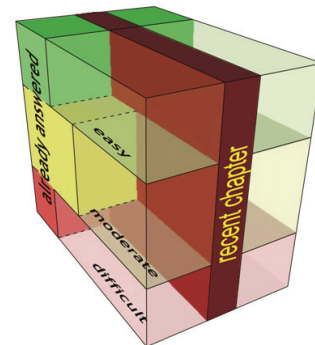


Figure 3. Question database

### 2.5 General Workflow

Figure 4 illustrates the general workflow of the tutorial in form of a closed loop. If a student decides to participate in the radar remote sensing course, he is requested to login. New users are asked to register. After the initial authentication, the level of existing knowledge is determined by solving questions on a multiple choice basis. This gives the system the ability to relate the user to one of the three classes described earlier.

The student may then select a chapter of interest and proceeds to work through the pages covering the topic. Each chapter is divided into several lessons or sub-chapters, which

are themselves divided into several pages illustrating the logical context, forming a hierarchical tree structure.

Small tasks must be solved in the process of going through the lessons. These include simple multiple choice questions, but also hands-on exercises based on integrated examples. Data sets are available for download as well as a software toolbox, which is necessary for radar image processing. Simple questions are evaluated automatically, while the solutions to more complex exercises must be sent to a tutor, who checks the result and provides comments and advice if the solution is not satisfactory.

When questions are answered incorrectly, the system gives expert's advice to find the correct solution. These pre-tests have no influence on learners' assessment, but control the sequences of learning modules.

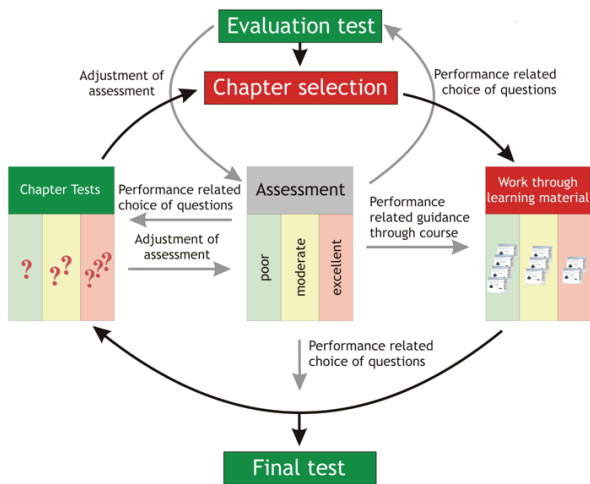


Figure 4. Course loop

After completing the main chapters, new tests follow to determine the participants' marking. The more tests the user has fulfilled, the more precise the personal assessment of his knowledge will be.

At the end of the tutorial, students must pass a final test, in which a representative selection of all questions covering remote sensing topics is chosen from the question database

## 2.6 Content

At the time of writing, the course covers a number of topics in Remote Sensing. Chapters contain information about the physical principles, analogue and digital data acquisition techniques, sensor platforms (aerial photography, scanner and radar systems) as well as information about how and where Remote Sensing imagery can be obtained. Special attention is paid to online catalogues maintained by the different data suppliers. Data analysis methods, such as visual interpretation, photogrammetric and digital image processing, form another main focus of the tutorial. Finally, a brief overview of applications in several fields is given.

Section 3 of this paper discusses the integration and functionality of a software tool developed for radar remote sensing tasks in more detail.

## 2.7 Design Aspects

The tutorial must be clear and self-explanatory to the course participants. An unambiguous screen design is an important

requirement for successful learning. Therefore, the screen is divided into different sections (see Figure 5). The right frame includes the table of contents. Its appearance varies depending on the selected chapter and is modified dynamically as the student moves from one chapter to another. Coloured highlighting is used for emphasis and allows for easy orientation and for discerning the lessons already completed at first glance.

Other information and navigation tools which influence the sequence of the program are available at the bottom of the frame. Arrow buttons for scrolling to previous or following pages are also part of this frame.

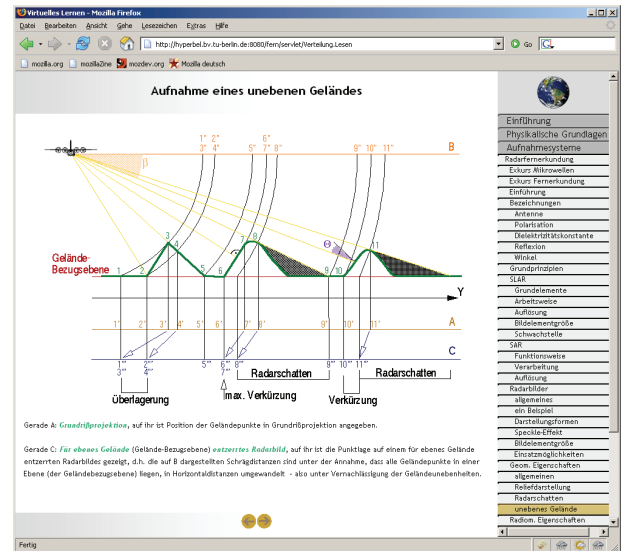


Figure 5. Radar page – example

## 3. RADAR TOOLBOX (RAT)

### 3.1 Integration of radar image processing software

In the current summer term, the tutorial is used as a platform for the course in radar remote sensing. Learning material discussed during the lectures is integrated in the training course. The tutorial is not yet complete, especially implementation of multimedia-based content is still in development. Hands-on exercises are added to the lectures, to be solved using a software tool (RAT) developed by the Computer Vision group. The present chapter will give an overview of the current development status of RAT.

### 3.2 Radar Toolbox (RAT)

RAT (Radar Toolbox) is a collection of tools for advanced image processing of SAR remote sensing data, originally started as a student's project and under development ever since. The main motivation for RAT is to provide an experimental platform for advanced SAR image processing. Licensed as open-source software, the complete source-code is available to anyone who is interested in adding their own algorithms. RAT can be downloaded and used free of charge. This makes it an ideal tool for student exercises, since the source code can be modified, corrected and even used in other projects. The programming interface of RAT is kept simple, such that adding new functionality is quite easy. Function templates and a step by step description of how to program a RAT module are part of the distribution package.

RAT is based on IDL (Interactive Data Language) and uses IDL widgets as graphical user interface.

Basically, the core module of RAT contains GUI routines and functions for data handling and optimized display routines for most commonly used types of SAR data, including complex multi-channel images, decompositions, segmentations and more.

Current features include speckle filters, polarimetric basis transforms, decompositions and classifications, as well as interferometric routines such as coherence calculation and interferogram filtering. RAT runs on various operating systems including UNIX/LINUX, MacOS X and Windows.

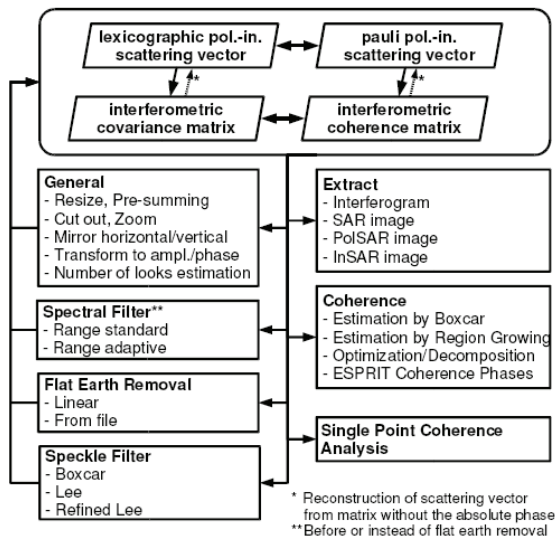


Figure 6. Diagram of possible program flow in PolInSAR-RAT.

RAT can import the native formats of DLR's E-SAR sensor and ENVISAT-ASAR data. Additionally, RAT supports import of POLSARPRO and RSI-ENVI format, generic binary, and generic pixmap formats (PNG, JPEG and TIFF). Export options exist to RSI-ENVI, generic binary as well as PNG, JPEG and TIFF. With different files in the RAT specific format, RAT can construct InSAR, PolSAR and PolInSAR datasets. Generic methods for any data representation type are: binary transformations; mirror transformations; image cutting, pre-summing and resizing; number of looks calculation; zoom; value measure and single channel extraction.

The single channel SAR module contains numerous functions for conducting speckle filtering and edge detection, as well as routines for spectral analysis, texture, point- and distributed-targets. The SAR image can be projected from the slant range into ground range; and the weighting functions can be applied or removed in the spectrum.

The module for handling polarimetric data is already well developed. It has a big variety on decompositions and classifications. They are based on, among others, Entropy/Alpha/Anisotropy, Moriyama, Wishart, Freeman-Durden, etc. This module also includes methods for speckle filtering, basis transformation, calibration, polarimetric CFAR edge detection and polarimetric target analysis.

The interferometric part of RAT is in continuous development and enhancement. For the moment, it contains different functions for co-registration, filtering range spectra

and for removing the flat earth phase. Also the user can estimate the coherence, to filter phase noise, and to conduct phase unwrapping. As a matter of course, different methods are implemented for each of these routines.

Polarimetric SAR interferometry (PolInSAR) is, as implied by the name, the combination of SAR polarimetry (PolSAR) and SAR interferometry (InSAR). The PolInSAR-module offers, on the one hand, the necessary basic functionality and, on the other hand, already implements some recently developed and very promising methods for image data processing which are shown in Figure 6.

### 3.3 Hands on exercises with RAT

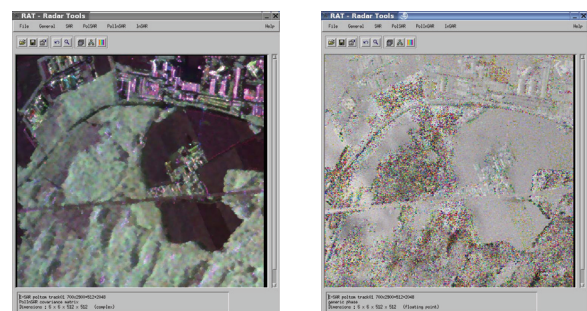
In the frame of the current course in radar remote sensing, RAT will be used for practical exercises, in contrast to the more theoretically oriented course material. It will allow students to gain experience in applying the studied methods on real data and to improve in this way their understanding of SAR remote sensing techniques.

Currently it is planned to prepare three main work packages in RAT, each of them about a different important topic in SAR remote sensing:

- *Speckle Filtering*: RAT includes several different SAR specific statistical filters, in addition to conventional ones like boxcar and median filters. The first exercise will focus on a comparison of these different filtering approaches. The filters will be applied on different types of data. Image quality descriptors, like effective number of looks or spatial resolution, will be derived and compared for different target types. Additionally, students will have to find optimum filtering strategies for certain given applications.

- *Interferometric SAR*: RAT includes all the basic processing steps for SAR interferometry. Based on a interferometric image pair of a mountainous region, students can test different variants for interferogram generation. In this way, the various dependencies of interferometric variables (coherence, phase) on system parameters and preprocessing steps can be discovered experimentally, supporting theoretical derivations given within the course itself.

- *Polarimetric SAR*: In the topic of SAR polarimetry, RAT is quite complete and offers a very rich set of functionality. Students will have to try out and test the effects of polarimetric basis transforms, decompositions and classification methods. Additionally, the different representations of polarimetric SAR data (scattering vector, covariance matrix, etc.) can be well explained using the polarimetric tools of RAT.



a) Refined Lee Speckle filter (b) Polarimetric Interferogram

Figure 7. Basic methods in RAT-PolInSAR module

For all work packages, students will have to prepare a brief elaboration, including answers to some specific questions concerning the experimental part with RAT. The elaboration has to be submitted via Email to the lectures and will be corrected and returned.

### 3.4 Forum

Besides personal support and e-mail, the students may contact the lecturers as well as discuss with other students via a web-forum (Figure 8). Forum communication has the advantage that it can be read by everybody, i.e. it helps avoiding multiple answers to the same question and offers a kind of database of already discussed topics.

In addition, the forum contains a section about RAT, dedicated for bug reports and questions related to programming issues in RAT itself. This section has no connection to the course material, but helps improving the RAT framework and people who would like to extend RAT on their own.

Forum	Topics	Posts	Last Post
<b>RAT forum</b>			
Bug reports / Installation	8	29	Wed Apr 06, 2005 9:05 am [closed] [↩]
RAT Usage How to use RAT to get what you want	4	11	Thu Apr 21, 2005 8:17 am [closed] [↩]
<b>SAR forum</b>			
SAR data analysis	14	26	Wed Mar 09, 2005 2:39 pm [↩]
SAR processing	14	37	Thu Apr 14, 2005 11:14 am [closed] [↩]
SAR interferometry	11	40	Tue Mar 29, 2005 1:52 pm [closed] [↩]
SAR polarimetry	11	35	Wed Apr 06, 2005 9:13 pm [closed] [↩]

Figure 8. RAT Forum

## 4. CONCLUSIONS AND OUTLOOK

The authors proposed a tutorial for remote sensing, including a database system for supplying test questions to students based on their ability. Students are assigned one of three levels - low, moderate and high - based on answers given in an initial test. The questions they are supplied with are then individually tailored to suit their ability. As this knowledge increases, so does the difficulty of the questions.

Moreover, the content itself is administered by a database, which allows first steps to be adapted to the individual knowledge of the students. Pages constituting the chapters are offered to the learner depending on his or her knowledge. This means that a beginner is guided through the course gradually and in easy steps, while advanced students are presented with more condensed material and will not necessarily be burdened with annoyingly basic pages and questions.

There is still much work to do, research and development is ongoing. Future activities will concern administration tools for facilitating the deployment of content in the database.

Also, the short supply of questions has to be extended to form a comprehensive question pool. And of course, even more interactive multimedia applications need to be integrated.

Up to now, the Web-based information is produced in German. The start of the new Masters course "Geodesy and Geoinformation Science" at the TU Berlin in winter 2005 requires the translation into English, which will make the course open for other students around the world.

We are open for discussion, cooperation and data exchange with other groups engaged in the development of e-learning material, and invite interested parties to have a look at the tutorial: <http://www.fpk.tu-berlin.de/fern>

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Tutorial: <http://www.fpk.tu-berlin.de/fern>

# INTRODUCTION INTO SECOND GENERATION WEB APPLICATIONS APPLYING XML

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**KEY WORDS:** Mark-up Language XML, Scalable Vector Graphics, Extensible 3D, PHP

## ABSTRACT:

Second generation Web applications, are based on Extensible Mark-up Language (XML) and related technologies. HTML based applications are directed towards publication. In future, XML will be focus on structured information storage, interaction and distributed processing of data.

XML is a meta language for structuring data. XML uses tags, keywords in angle brackets, and attributes, followed by values embedded in double quotation. Comparing to HTML, the meaning of the tags and attributes is not defined in XML. Interpretation follows the application. XML files are plain text files, readable with simple text editors. Applying XSL (Extensible Style Sheet Language) provides translation into formats for Web browsers or print media.

SVG (scalable vector graphics) stands as a Web standard for two-dimensional graphics, formulated in XML. Vector graphics need less storage memory and display as enlargement better quality as raster graphics can do.

VRML (Virtual Reality Modelling Language), the former Web standard for three-dimensional graphics, is now redeemed by the standard document type definition for extensible 3D (X3D).

Members of the XML family of languages will become in a short time period substantial impact in the field of E-learning. XML documents can be downloaded from a server and published on any client sided platform. Dynamic Web applications provide documents upon user requests with access to a XML database. Software vendors take advantage from XML files because of the powerful support by object oriented programming languages, like Java or PHP. In addition, the open standard of XML makes it an ideal tool for E-learning communication.

## 1. STATIC AND DYNAMIC WEB SITES

### 1.1 Client-Server Architecture

Applying a client-server architecture does not require a computer network configuration. One can install a Web server and a Web browser on the same computer. The client (here the browser) sends a request to the server, addressed by *localhost*. The server is looking for the requested document, transfers the document to the client and the browser is rendering the file information into a readable format. The language, a browser understands, is HTML Hypertext Mark-up Language. Communication between server and client is agreed via a protocol, the Hypertext Transfer Protocol. The process is known under the term static Web application. Major software components of the Web are the Web browser, the http-protocol, the description language HTML and the Web server. static Web publication. Some of the software enhancements are mentioned later in this contribution.

### 1.2 Client Sided Dynamic

While a Web site is changing its appearance or content by user interaction without loading a new document, we talk about client sided dynamic. The document object model DOM enables access to any object (element) and its attributes, that is

included in a Web document. The DOM is implemented in JavaScript, an extension to Web browsers. We focus here to a small application calculating control points by spatial intersection.

JavaScript has a hierarchical structure of application objects. Under the document level there are form objects existing. A form itself, is followed by elements. Forms and elements can be identified by names. If we want to set the value of one of the input fields in the sample shown in figure 1, we have to code `document.vws.xctrlpt.value = "100.00"`; *vws* stands for the name of the form, *xctrlpt* is the name of an input field, value is the attribut for the content. The HTML coding, applying the input-tag, reads as follows:

```
<form name="vws">
<input name="xctrlpt" value=" "
      type="text" >
</input>
</form>
```

Inside the angle brackets more attribute definitions can occur. This short explanation will help understanding the data exchange between a Web site and PHP programs.

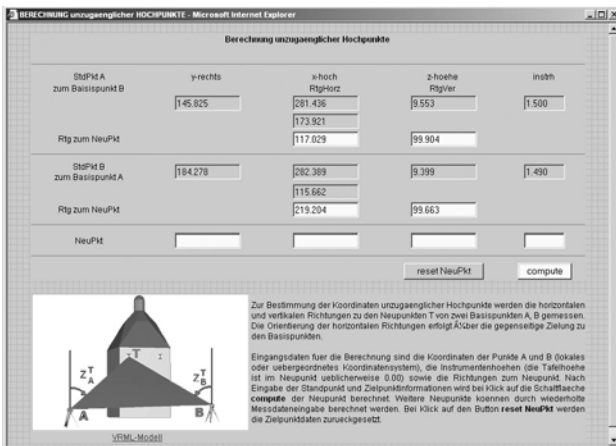


Figure 1. Calculating control points

### 1.3 Server Sided Dynamic Applying PHP

PHP Hypertext Pre-Processor is a server extension. The language is embedded in HTML documents. If the server detects PHP commands, the code will be carried forward to the PHP interpreter where the HTML code will first generated and after processing submitted to the client. The PHP code is not visible for the client. The browser receives the resulting HTML code only. The PHP interpreter supports amongst others XML processing, SQL data base functions, graphics and file access.

## 2. DESIGN OF A XML STRUCTURE

### 2.1 XML Extensible Mark-up Language

XML Extensible Mark-up Language is a meta language to structure information. XML uses tags, keywords in angle brackets with additional attributes, to enclose content. Compared with HTML, the denotation of the tags are defined not and will be interpreted first by the application.

XML files are plain text files. Rendering XML files require other technologies. XML documents are starting with a prologue, followed by the root element. The prologue basically displays details for the (DTD Document Type Definition) as stated below. The data used in the following examples are taken from a close-range photogrammetric Application.

```
<?xml version="1.0" encoding="ISO-8859-1"
standalone="yes" ?>
<!DOCTYPE imageBundle SYSTEM
"imageBundle.dtd">
<imageBundle>
  <!--Inhalt des Dokuments -->
</imageBundle>
```

The root element *imageBundel* instances a document class, that is defined in the *!DOCTYPE* statement. An element and its subelements are represented by nodes in the tree structure. The element itself consists of a start-tag, the content and an end-tag. Attributes can be found in the start-tag. A photogrammetric camera definition may look as follows:

```
<cameraData>
  <camera>
    <type>nikon_28</type>
    <ck>-18.23718</ck>
    <xh>-0.09973</xh>
```

```
<yh>-0.01304</yh>
<a1>-3.03846E-004</a1>
<a2>6.43569E-007</a2>
<formX>23.462</formX>
<formY>15.600</formY>
</camera>
</cameraData>
```

A Web browser displays the tree structure of that document. By simply clicking the symbols, the nodes can be closed or opened, as shown in figure 2.



Figure 2. Tree structure of an XML document

### 2.2 XSL Extensible Stylesheet Language

Translation into another format is provided by the XSL Extensible Style Sheet Language. A XSL processor can be applied by the Web browser or server sided by the application. An off-line translation results in a HTML document to be stored on the server. Another important tool is XPATH. XPATH provides search patterns and enables extractions form XML documents. An external XSL file has to be referenced in the prologue by the statement:

```
<?xml-stylesheet version="1.0"
href="template.xsl" type="text/xsl" ?>
```

We do not discuss the details of XSL here. An application of the for-each and value-of select statement may be give an idea how a XSL document is parsed by an XSL processor:

```
<xsl:for-each
  select="the search pattern">
  <tr>
    <td class="tab_value"
      <xsl:value-of select="type"/>
    </td>
  </tr>
</xsl:for-each>
```

HTML tags are combined with XSL statements. The prefix `xsl:` defines the namespace, the class definition defines the appearance of the element in the browser.

### 2.3 DTD Document Type Definition

XML documents can be well formed or guilty. A well formed document becomes a guilty document by adding a DTD. A DTD defines the grammar for information processing of the XML file. All elements, attributes entities and specifications about quantity, content and nesting of elements must be predefined in a DTD. An extract of the DTD applied in the example is shown partly as follows:

```
<!DOCTYPE imageBundle [
  <!ELEMENT imageBundle (controlPoints*,
    cameraData* ,
    photoPositions*,
    orientationPoints*,
    graphicElements*)>
  <!ELEMENT controlPoints (point*)>
  <!ELEMENT point (pnr*, code*, x+, y+, z+)
    <!ELEMENT pnr (#PCDATA)>
    ...
  <!ELEMENT cameraData (camera+)>
  <!ELEMENT camera
    (type+, ck+, xh+, yh+, a1+, a2+,
    formX+, formY+)>
    <!ELEMENT type (#PCDATA)>
    <!ELEMENT ck (#PCDATA)>
    <!ELEMENT xh (#PCDATA)>
    <!ELEMENT yh (#PCDATA)>
    <!ELEMENT a1 (#PCDATA)>
    <!ELEMENT a2 (#PCDATA)>
    <!ELEMENT formX (#PCDATA)>
    <!ELEMENT formY (#PCDATA)>
```

Details can not be discussed here. It must be annotated, that the DTD will be replaced by the more powerful Xschema in future.

With XML, XSL and DTD structured information is separated from processing and prepared for further processing with object-oriented programming languages in client-server environments.

## 3. PARSING XML FILES WITH PHP

### 3.1 The Parser

We try to explain parsing and processing XML-documents by using the photogrammetric example from above. Requested are the camera values for the camera referenced by the description *nikon\_28*. The client's request typed in the address line of the browser:

```
http://www.imagefact.de/zitadelle-wesel/
parse_camera.php?camera=nikon_28
```

will be submitted to the server.

A parser will be needed for going through the file until the requested camera is found. The parser analyses and validates the file structure. Expat is an event driven parser and provided by PHP. Events are the occurrence of tags and content. An instance of the parser is created with the statement `$parser = xml_parser_create();`

It is necessary to set parameter for the parser and handler for the elements, for example:

```
xml_set_element_handler( $parser,
  "start_element", "end_element" );
or
xml_set_character_data_handler(
  $parser, "inhalt" );
```

`start_element`, `end_element` and `inhalt` are functions called by the parser, if it meets one of the defined events.

### 3.2 Processing Data

The function `inhalt` will be processed, if the content of a tag was *camera*. The camera data will be stored in arrays.

```
function inhalt($parser,$data ){
  global $curr_tag,$index,$camera
  switch ($curr_tag){
    case "type": $index=$data;break;
    case "ck": $camera[$index][ck]=$data;break;
    case "xh": $camera[$index][xh]=$data;break;
    case "yh": $camera[$index][yh]=$data;break;
    case "a1": $camera[$index][a1]=$data;break;
    case "a2": $camera[$index][a2]=$data;break;
    case "formX": $camera[$index][formX]=
      $data;break;
    case "formY": $camera[$index][formY]=
      $data;break;
  }
}
```

After getting the camera data, the arrays must be evaluated and the requested data, embedded in HTML-tags, has to be generated and must be passed to the client. PHP uses the echo-function for writing HTML commands. Figure 3 shows a request including image data as rendered by the browser. The complete examples can be found on the Web under [www.programmierpraktikum.de](http://www.programmierpraktikum.de), follow the navigation to the readers section (leserbereich), select there PHP&XML.



Figure 3. Parsing XML-Information and displaying the result on a Web page

## 4. PROCESSING GRAPHIC DATA

### 4.1 SVG Scalable Vector Graphics

Scalable Vector Graphics SVG is the XML formulation of 2D vector graphics. It includes drawing of vector data, displaying of image data, interaction and animation. Structure and appearance of graphic elements is separated by using style sheets

Applying a SVG viewer as a plug-in for the Web browser enables zooming and panning in the graphic area.

Here is a small sample including raster and vector graphics and interaction. Embedded is a script using ECMA (JavaScript), style sheet definition, mouse over events and referencing of external files. The displayed code is a fragment for documenting the integration of Web tools. Visit the a.m. Web site and click into the SVG area with the right mouse button. You have access to the complete code via the context menu.



Figure 4. Interaction with SVG

```
<svg width="640" height="480">
<title>SVG Interaction</title>
<script type="text/ecmascript">
<![CDATA[
function objekt_sichtbar(
  evt,sichtbarkeit){
  var svgDokument;
  svgDokument=
  evt.getTarget().getOwnerDocument();
  ...
}</script>
<style type="text/css">
<![CDATA[
  path.sp {
  fill      :rgb(192,192,192);
  stroke    : #0000ff;
  stroke-width:2px;
  opacity:0.2;
  }
  ]]>
</style>
```

```
<g id="guide"transform="translate(50,50)">
<g id="fritz">
<image xlink:href="fritz.gif" x="0"
  y="112" width="138" height = "263"
  onmouseover="objekt_sichtbar(evt,'1')"
  onmouseout ="objekt_sichtbar(evt,'0') "
></image>
</g>
...
</g></svg>
```

The bubble in figure 4 at first is hidden. Moving the mouse over the image displays the bubble. The text inside the bubble references links to external files.

### 4.2 X3D Extensible 3D

3D graphics data for the Web is well known as a VRML Virtual Reality Modeling Language description. That format is updated to the XML-version and named as X3D. The OCTAGA viewer can be applied for VRML and X3D in stand-alone mode or as a plug-in.

## 5. CONCLUSION

XML as a meta language is designed for structuring information and separating information from processing. The family of XML-languages and tools, like XSL, XPATH, SVG or X3D, provide device and platform independent processing. XML structured information can be prepared for displaying on monitors and PDAs or printing. The above given examples, taken from a photogrammetric project, stay for a variety of application potentials. The sketched code here, is printed to give an impression of the need for teaching and learning XML based Web technology.

#### References from Books:

Pomaska, G., 2005. *Grundkurs Web-Programmierung*. Vieweg-Verlag, Wiesbaden.

#### References from Other Literature:

Pomaska, G., 2003. Introduction of SVG as a data interchange format for architectural documentations. CIPA International Symposium, Antalya, Turkey.

Pomaska, G., Dementiev, N. XML basierte Datenformulierung zur Web-konformen Dokumentation photogrammetrischer Bauaufnahmen. PFG Zeitschrift für Photogrammetrie, Fernerkundung und GeoInformation, DGPF 2005, in Vorbereitung

#### References from Web sites:

<http://www.programmierpraktikum.de>

<http://www.imagefact.de/zitadelle-wesel>

<http://www.adobe.com/svg>

<http://www.octaga.com>

# USE OF SVG AND ECMASCRIPT TECHNOLOGY FOR E-LEARNING PURPOSES

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**ISPRS Workshop Commissions VI/1 – VI/2  
Tools and Techniques for E-Learning, Potsdam, Germany, June 1-3, 2005**

**KEY WORDS: Web Technologies, Content Development, Standardization, Future Trends**

## ABSTRACT:

SVG (Scalable Vector Graphics) is a XML based markup language used to describe and integrate vector graphics, raster graphics and text. SVG is developed by the W3C web consortium as an official web standard, with the support of major computer graphics and mobile phone companies, such as Adobe, Canon, Corel, IBM, Kodak, Nokia, Opera, Sun, etc. SVG Mobile was furthermore adopted by the 3GPP consortium as a part of the 3GPP mobile phone standard. SVG graphics can be animated and enriched with interactivity. Scripting languages and network interfaces help build interactive applications. SVG's rich visualization options and the support of interactivity make it a natural candidate for providing graphics and interactive examples in e-learning environments. The ability to access the SVG source code and have a glance "under the hood" to see how things are made, is especially useful for learning and sharing purposes. SVG also provides a fun way to introduce programming and illustrate the functionality of algorithms. Students are usually motivated if they can graphically visualize what they program. The paper first summarizes SVG's capabilities. The second part will discuss strengths and weaknesses of the SVG approach and explain why SVG is a useful technology for e-learning purposes. The following section describes usage scenarios and gives a number of e-learning examples. Domains will include mathematics, geometry, electronics, programming and GIS. Development tools and authoring systems will be mentioned. The last part will discuss and outline current developments regarding the upcoming SVG 1.2 version.

## 1. INTRODUCTION

### 1.1 What is SVG?

SVG (abbreviation for Scalable Vector Graphics) is a webstandard for describing two dimensional vector graphics. It integrates vector graphics, raster graphics and text. SVG graphics can be interactive and animated. Bindings for scripting languages and network interfaces enable developers to build rich interactive graphics applications. Like many other W3C webstandards, SVG is based on XML and can therefore benefit from other neighbor technologies in the XML world and the ever increasing number of XML development tools. The open nature of SVG and the rich visualization options make it an ideal technology for visualizing scientific results or explaining and communicating complex learning topics. Interactivity in SVG applications, if implemented correctly, can stimulate intellectual curiosity and be an invitation to explore complex phenomena.

### 1.2 Current Status

SVG 1.0 became a W3C recommendation in September 2001. The W3C (World Wide Web Consortium) combines and coordinates the interests of research institutes, companies and universities and develops interoperable technologies, such as specifications, guidelines or software, with the overall goal to make the information on the web more accessible to both humans and machines. SVG 1.1 is the current recommended SVG version and became a recommendation in January 2003. The main goal of SVG 1.1 was to introduce profiles for mobile devices: SVG Tiny for very constrained devices, such as mobile phones, and SVG Basic for stronger mobile devices, such as PDAs and Smartphones. Version 1.2 is currently under development, a major upgrade that will help SVG to be a better foundation for interactive applications. Improvements include

multimedia (audio, video), streaming, text-wrapping support, better network interfaces, vector effects, better compositing and blending and a new binding language (sXBL) that will allow content developers to share SVG building blocks more easily. The new SVG 1.2 features will be discussed in more detail in the last part of this paper. The development of SVG specifications is an open process. Anyone can give feedback on the public mailing lists and can read the current status of the working drafts at the SVG W3C homepage (Lilley et al, 2005).

### 1.3 SVG viewer implementations

Although SVG has been existing as a W3C recommendation for a while, native SVG support in webrowsers is still in its infancy. At the time of writing, SVG content is best deployed using the Adobe SVG plugin, available for all major platforms and browsers (Linux, MacOSX, Solaris, Windows) which can be downloaded from the Adobe SVG homepage (Adobe, 2005a) or for developers at the beta viewer download area (Adobe, 2005b). Adobe will release a new version of its plugin after the SVG 1.2 specification is finalized.

Fortunately, three major browser projects are currently introducing native SVG support. Mozilla SVG (Mozilla, 2005) already has a rather stable SVG implementation that supports scripting but no SMIL animation. Mozilla SVG will be enabled by default in the next major Mozilla/Firefox upgrade. Opera introduced SVG Tiny support in their latest browser (version 8) which supports animation but still lacks CSS and scripting support (Opera, 2005). The Unix KDE browser Konqueror already introduced SVG support last year and includes scripting and basic animation support (KDE, 2005). At the time of writing, it is not yet clear if the other browser projects (Apples Safari and Microsoft Internet Explorer) will follow the trend to native SVG support.

A very good standalone SVG viewer based on Java is the Apache Batik viewer, which consists of a viewer, a rasterizer and converter, a pretty printer, a serverside framework and a font-converter. The Batik SVG viewer can be embedded as a rendering component into other Java Applications. Batik can also convert SVG files to PDF format for printing. (Apache Batik, 2005) SVG mobile viewers are available from Bitflash, Zoomon and Nokia. The SVG mobile specifications are now also part of the 3GPP mobile phone standard.

## 2. SVG CAPABILITIES

### 2.1 Document Structure and Rendering Model

SVG documents are built upon a regular XML document tree, consisting primarily of a header, processing instructions, comments, XML elements and attributes. Elements that appear first in the document tree are rendered first, subsequent elements are drawn on top of the previous elements, taking into account opacity, blending, filters, clipping and masking. As in any other XML file, elements may have unique ids that can be used to reference other elements. Element instances (<use /> elements) can reference other elements and override their attributes. The <defs /> section serves as a repository. Elements in this section are not rendered, but may be referenced elsewhere in the file. Typically, the <defs /> section contains gradient and pattern definitions, symbols and markers. Elements may also be grouped, which is particularly useful when several elements form a logical group or share common attributes. Elements or groups may be temporarily hidden from the document tree, a mechanism that helps simulate map layers. Description and title elements help describe the content of elements, groups or files in a verbal form, a technique that helps make SVG files more accessible to disabled persons or search engines. Switch elements help conditionally process the document tree, e.g. based on the system language or available SVG features.

### 2.2 Coordinate Systems and Transformations

The origin of the coordinate system in the SVG canvas is in the upper left corner with the positive x-axis pointing right and the positive y-axis pointing downwards. This implicates that in order to represent map coordinate systems one either has to multiply the y-axis by a factor of -1 or has to transform all elements within the map group. The latter approach has disadvantages when using text labels within the map, as they would appear upside down. Supported units are em, ex, px, pt, pc, cm, mm, in and percentages. Of particular interest to cartography and GIS is the viewBox attribute that allows to establish a new coordinate system inside the existing coordinate system. This way one can have nested coordinate systems, e.g. a device oriented coordinate system in screen pixels in the SVG root element and one or more nested map oriented coordinate systems. It is therefore possible to introduce real world coordinates, such as meters or kilometers, which helps if one has to merge different data sources. Geographic coordinate systems are not directly supported. If one has to reproject data one has to do it in a GIS or spatial database system prior to conversion to SVG. However, it is possible to include metadata about the projection system.

### 2.3 Basic Geometry Elements

SVG knows the following basic shapes:

- Rectangle (<rect />)
- Circle (<circle />)

- Ellipse (<ellipse />)
- Line (<line />)
- Polyline (<polyline />)
- Polygon (<polygon />)
- Path (<path />)

The above listed geometry types are more or less self explaining. The most powerful and interesting geometry type is the <path /> element. Path elements can describe all other basic shapes. Path elements can contain quadratic and cubic spline curves and arc segments. Geometry can be described in either absolute or relative coordinates (relative in the sense that a subsequent coordinate is related to its previous coordinate pair). Path elements can contain holes, and several disjunct paths can be combined to one single path. Paths can be open or closed. The symbol element can contain any SVG code. A symbol can be made of basic shapes and may also contain animations.

### 2.4 Text and Fonts



Figure 1: Some of the Text options in SVG, Source:

<http://www.carto.net/papers/svg/samples/ext.shtml>, © André Winter

Text support in SVG is very sophisticated. Almost any text feature available in DTP or graphics software is also available in SVG. Like any other basic shape, text can also have fillings, strokes and can be clipped or masked or can serve as a clipping path. Individual glyphs or groups of glyphs can be shifted or rotated and text can also be aligned on path elements. It is even possible to animate a text along a path. The <tspan /> element allows the attachment of common attributes to a group of glyphs. SVG fully supports internationalization, including Unicode support, left to right text, bidirectional text or text that

runs from top to bottom. Together with the <switch /> element one can also deploy multilingual content in one single SVG file. To ensure that the SVG file displays the correct font, one can include the fonts in the SVG file, using the SVG font format. Glyphs in SVG fonts can basically contain any geometry and they can also contain animations. The individual glyphs usually contain SVG path geometry. SVG fonts also support kerning tables, although not all SVG renderers do. SVG fonts can be converted from other font formats (e.g. truetype, opentype and type1) using the Apache Batik project (Batik, 2005) or the Fontforge application.

One major problem with text in SVG up to version 1.1 was the missing text wrapping feature. Until now, one had to manually introduce linebreaks, using <tspan /> elements nested in the text-element. SVG 1.2 introduces this missing feature by supporting text wrapping in arbitrary shapes.

## 2.5 Filling, Stroking, Opacity

SVG elements can be filled with uniform color, linear and radial gradients and patterns. Pattern tile definitions can contain raster data, vector elements and animations and are repeatedly drawn to fill the polygon. Gradient parameters can be animated as well. As to stroking, one can define the color, stroke width, linecaps and linejoins, miter angles, dash arrays and dash offsets. Opacity can be separately defined for strokes, filling or both. Group opacity treats elements as a group as opposed to treating each group element individually. Of particular interest to cartography and GIS are the markers. Markers are symbols that are placed at each vertex of a shape or path. One distinguishes start-, end- and mid-markers. Markers can be automatically oriented to adapt to the bisector angle or tangent vector of two adjacent line or curve segments. Markers can be used to attach arrows to shapes or to represent objects at vertices, such as poles along a power supply line.

## 2.6 Styling

There are alternative ways to style elements in SVG. One can use CSS styles (internal and external) as in XHTML, XML presentation attributes or XSLT. However, not all of them are implemented in every user agent. XML presentation attributes are supported by any SVG user agent, while CSS are only implemented in some (Adobe, Batik and Mozilla SVG) and XSLT support is still in its infancy. It is also possible to define media dependent styles. This is potentially useful to hide user interface elements when printing SVG graphics or to provide different styling options for handhelds or projection systems.

## 2.7 Filters



Figure 2: Filter example: combination of a gaussian blur, offset, specular lighting and composite filter, Source: <http://www.w3.org/TR/SVG11/images/filters/filters01.svg>  
© W3C consortium

Filter features are unique to SVG. They aren't currently present in competing formats, such as Flash or CGM. Filters can be attached to both raster and vector elements. Vector elements are rasterized during the rendering pipeline, hence there is an opportunity to include filters. Typical applications for filters are color corrections, brightness and contrast adaptations, blurring and sharpening, illumination filters, generation of drop shadows and halo effects, convolution filters, displacement and morphology filters, generating turbulence, etc. Filters may be combined in any order and the output of one filter may be piped to the input of the next filter. Every filter parameter can be animated which can lead to very interesting effects. Filters are very powerful visualization options, but may require a fair amount of computing power.

For examples on SVG filters have a look at the excellent examples and tutorials by Michel Hirtzler (Hirtzler, 2002; Hirtzler 2005a) and Kevin Lindsey (Lindsey, 2003).

## 2.8 Interactivity and Scripting

Interactivity and scripting are key parts when it comes to making SVG appealing for e-learning applications. SVG graphics are by default zoomable and pannable. Many SVG viewers support additional interactions, such as search for text, or start/pause animations. SVG supports hyperlinks and custom cursors.

Various event types enable script or SMIL operations to react to user or system events. Supported events are the following:

Status Events	SVGLoad SVGUnload SVGAbort SVGError
Zoom and Scroll Events	SVGResize SVGScroll SVGZoom
UI Events	focus focusout activate
Mouse Events	click mousedown mouseup mouseover mousemove mouseout
Keyboard Events	keydown keyup keypress
Animation Events	beginEvent endEvent repeatEvent
Mutation Events	DOMSubtreeModified DOMNodeInserted DOMNodeRemoved DOMNodeRemovedFromDocument DOMNodeInsertedIntoDocument DOMAttrModified DOMCharacterDataModified

Any of the events listed above can trigger either a script function or a SMIL interaction. Mutation events listen to changes within a particular node in the XML document tree. Currently, they aren't implemented in the Adobe SVG viewer version 3. SMIL is a declarative way of specifying interactions or animations. SMIL constructs generally contain a trigger (either time based or event based), the target, the attribute to change, duration and interpolation parameters. SMIL can be regarded as a simple, declarative scripting language.

The other, more flexible, way of modifying SVG documents is to use a clientside scripting language. Scripts can either be embedded in the SVG files or referenced (external files). SVG defines a language independent API to access and manipulate the SVG DOM. The most widely used and implemented scripting language in conjunction with SVG is ECMAScript (the standardized version of Javascript). One reads or changes attributes, creates, moves or deletes elements and loops over the document tree as it is the case with any XML or XHTML document. (Neumann et al, 2005a) is a tutorial about manipulating SVG documents using ECMAScript and the DOM. SVG also provides network interfaces to directly talk to serverside applications. `.getURL()` and `.postURL()` are methods which allow transferring and retrieving of data from and to the server without having to reload the SVG file. SVG 1.2 will add more network options for client-server communication.



Figure 3: Yosemite National Park Hiking Map - Example of a highly interactive mapping application that makes extensive use of SMIL and scripting. Source: <http://www.carto.net/williams/yosemite/>, © Juliana Williams

A very useful attribute regarding interactivity is the “pointer-events” attribute. This attribute controls the sensitivity of graphic elements regarding the reaction to mouse events. One can either set the attribute to “none” (no reaction to mouse events), “fill” or “stroke” (and a few more options). Using this attribute one can forward the events to the underlying elements or even receive events from invisible elements. This is useful for receiving events from invisible layers or to avoid “flicker effects”, which is the case when smaller elements “steal” the event-sensitivity from the underlying larger elements. This is often the case with text elements above a polygon layer.

## 2.9 Animation

Almost any element and attribute can be animated in SVG. There are currently two ways to implement animations in SVG: the first way is to use Javascript and a timer that repeatedly changes attributes in elements. This approach requires programming know-how but guarantees maximum flexibility when it comes to interpolation methods and logic. The second

way is again SMIL, a descriptive way to define animation parameters. SMIL animations can trigger script execution and vice versa. Both, script based and SMIL animations can be triggered by the events listed above.

SMIL offers five elements for descriptive animations: `<animate />`, the most general element for animating numeric, interpolateable attributes, `<set />` for setting non interpolateable attributes, such as string-based values, `<animateMotion />` for moving elements along a motion path, `<animateColor />` for animating color values and finally `<animateTransform />` for animating transform attributes. Common attributes of the five animation elements are “begin”, “end”, “dur” (duration), “from”, “to”, “by”, “repeatCount”, “repeatDur”, “fill”, “calcMode”, “keyTimes”, “values”, “keySplines”.

Of particular interest are the latter attributes: “calcMode” allows to specify the interpolation method (discrete, linear, paced and spline), “keyTimes” and “values” allow the setting of timestamps (in percentage of the full duration) and corresponding values, fixpoints that the interpolation has to respect, and “keySplines” define acceleration or deceleration effects. Two very useful tools for defining keySplines and keyTimes are available at (Hirtzler, 2005b) and (Hirtzler, 2005c). (Neumann, 2003) shows an example where keySplines and keyTimes are combined with progressive line drawing.

Following is an example, with source code and the corresponding graphics, where a text-string is animated along a bezier curve. First, a path is defined with a unique id. Next, a text-element is created with a `<textPath />` element as a child. The `<textPath />` references the path with the id “curve”. Nested within the `<textPath />` element are a `<tspan />` element, containing the actual text and a negative delta-y offset to place the text above the line, and an `<animate />` element that animates the “startOffset” attribute from 0 to 50%. The animation is started if the user clicks on the text with the id “go”. Finally, a text element needs to be placed with the id “go” which starts the animation.

```
<path id="curve" d="M100 200Q200,100 300,200
T500,200 M100 200Q200,100 300,200 T500,200"
style="stroke:blue;fill:none" />
<text style="font-size:25;fill:red;">
<textPath startOffset="0%" xlink:href="#curve">
<tspan dy="-10">Textpath on Bezier's curve
</tspan>
<animate begin="go.click" dur="5s"
repeatCount="1" attributeName="startOffset"
values="0%;50%" />
</textPath>
</text>
<text id="go" x="550" y="380" style="font-
size:25;">GO</text>
```

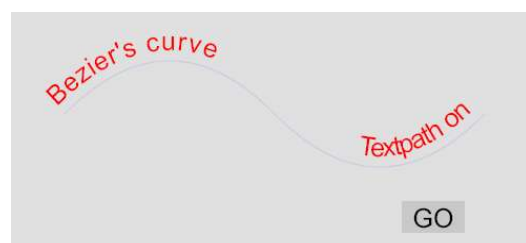


Figure 4: Animated Text along path – © M. Hirtzler, Source: [http://pilat.free.fr/english/animer/text\\_bezier.htm](http://pilat.free.fr/english/animer/text_bezier.htm)

## 2.10 Extensibility and Metadata

As a XML based language, SVG supports foreign namespaces. It is possible to define new elements or add new attributes to

existing SVG elements. Elements and attributes in a foreign namespace have a prefix and a colon before the element or attribute name. Elements and attributes in foreign namespaces that the SVG viewer does not know, are ignored. However, they can be read and written by script. Foreign namespaces are used to introduce new elements (e.g. GUI elements, scalebars) and for the attachment of non-graphical attributes to SVG graphic elements (e.g. GIS non-graphical attributes). Those attributes can be analyzed and used to create thematic maps or charts. Additionally, one can display those attributes upon mouse-over. This is not only useful for maps and drawings, but also for user-interfaces, technical drawings, charts, etc.

Following is an example that includes GIS attributes in map data. Within the doctype the attribute lists for the <svg /> and <path /> elements are extended:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN"
"http://www.w3.org/Graphics/SVG/1.1/DTD/
svg11.dtd" [
<!ATTLIST svg xmlns:attrib CDATA #IMPLIED>
<!ATTLIST path
      attrib:ctry_code CDATA #IMPLIED
      attrib:ctry_name CDATA #IMPLIED
>
]
<svg width="100%" height="100%"
viewBox="-2726130 -5330377 6272480 5460306"
xmlns="http://www.w3.org/2000/svg"
xmlns:attrib="http://www.carto.net/attrib/">
  <g id="countries" style="fill:none;">
    <g id="countries_AD">
      <path id="ctry_336" attrib:ctry_code="AD"
        attrib:ctry_name="Principality of Andorra"
        d="M-679572 -13980921-464 .... " />
      ...
    </g>
  </g>
</svg>
```

For the inclusion of metadata, the W3C consortium recommends the use of the RDF (resource description framework) or the Dublin core standard. The RDF fragments should be included in a <metadata /> tag and should be defined in a foreign namespace (e.g. Rdf). Hier Referenz auf RDF geben.

### 3. WHY USE SVG FOR E-LEARNING?

#### 3.1 Strengths of the SVG approach

SVG is well suited to play a major role in E-Learning environments. The visualization options available in SVG graphics go beyond competing file formats. Any attribute can be animated and the available interactivity options and script bindings allow the building of fully interactive applications that do not need to hide from stand-alone offline multimedia applications. It is important to note that SVG should be used as a complementary technology and in conjunction with other established web-technologies, such as XML, XHTML, static raster graphics and movies. SVG is primarily a presentation and exchange format that can and should be generated out of other storage formats, databases and XML sources. Specifically, it is recommended that one uses SVG in connection with other XML based e-learning markup languages, such as ELML (Bleisch, Fisler, 2005). SVG should be used for static illustrations, animations and interactive applications.

It is a fact that interactive applications can motivate students. Interactivity can involve and immerse students compared to a dry verbal and static presentation. Benjamin Franklin said *"Tell me and I forget. Teach me and I remember. Involve me and I*

*learn"*. One can let the student solve the problem himself, directly with an interactive SVG application. Specific learning goals can be isolated and students can concentrate on the essential tasks rather than first having to learn complex GIS applications.

When using SVG to teach or illustrate phenomena, one can involve students in different levels of integration. In a first level one can introduce and explain the subject in movie-like animations with a low level of interactivity. The student could still determine the speed of the progress by letting him choose the speed of the animations or by letting him step forward and backwards whenever he wants. In a next level one could guide the student through a workflow and support him with wizard-like interfaces where the student is confronted only with simple decisions within the current context of the workflow. In the highest level of interactivity and complexity, one could leave all decisions open to the student without forcing him into certain chronologic sequences. Finally, after a student worked through an e-learning lesson, he can take self assessments or exams, to test whether the student understood the topic and can correctly use and apply the newly acquired knowledge, both in theory and practice.

The extensibility features of SVG allow to introduce domain specific extensions and share components with other SVG content developers. Metadata can be included in a text-based format that can be equally well read and/or understood by humans and machines. Its text-based nature and the option to embed semantics and context directly in the file format make SVG substantially more accessible than any other graphics format. Search engines can easily analyze the context and semantics of SVG files and applications. They can index title and description tags.

A feature that made HTML successful in the early days of the web is the ability to view the source code of webpages. This way, web developers can learn from other websites and "look under the hood" of Javascript and DHTML applications. Learning (D)HTML and Javascript does not require expensive courses or certifications but can be learnt by anybody who is willing to invest some time for "learning by coding" and is open to learning from other developer's source codes. Unlike many proprietary technologies, such as Flash or already compiled Java applets, which are usually like black boxes, the source code of SVG applications can always be analyzed. Additionally, discussion boards and mailinglists exist where developers can share ideas, code and support new developers. These mailinglists are available for almost any open webstandard and are often faster and better than commercial support. Many examples, tutorial and demo sites exist for SVG where people can learn from each other. Good starting points are (Meinike, 2005), (Hirtzler, 2005d), (Lindsey, 2005) and (Held/Neumann/Williams/Winter, 2005).

The "learning by coding" approach is especially interesting with SVG, since students can directly manipulate graphics and visualizations by changing elements and attributes in the source code. That way, students can learn complex subjects, such as geometry, mathematics and programming in a fun and intuitive way. Teaching experience has shown that students are usually highly motivated if they can immediately see feedback of their programming efforts, even if the courses are more difficult and time-consuming than the average course in their curriculum. Good SVG editing environments allow simultaneous work in the source-code or document tree and graphically in the SVG canvas, with the support of GUI based drawing tools. Updating the canvas graphically, automatically adjusts the source code and vice versa.

One significant advantage of SVG is its XML base. Web developers that are already familiar with (X)HTML, Javascript, XML, CSS and XSLT can immediately use their existing knowledge when learning SVG. The XML base means that SVG content can be created by any text or XML-editor. While it is generally useful to use graphics software or specialized SVG editors for creating or editing SVG content, it is possible to edit content with free text-editors. That means that one can also quickly adopt existing SVG files over low-bandwidth terminal sessions, directly on a webserver.

SVG is also particularly useful for data driven visualization of business data, charts, maps and technical drawings, as it can be generated using XSLT conversion or any scripting or programming language the developer is familiar with. Developers are therefore not limited to a specific serverside framework and there aren't any vendor lock-ins. Furthermore, many GIS or spatial databases already support SVG generation. Having defined conversion rules, updating the SVG presentation is easy and can be automated.

For deploying SVG files and applications, there is usually no license fee necessary. Last but not least, it is important to mention that the development of the SVG specification is open to everyone. Everyone is invited to give feedback on the public W3C SVG mailinglist (W3C, 2005). Members of the SVG working groups, however, need to be either W3C members or "invited experts" due to their valuable contributions. The current members of the W3C SVG working group represent a good average of the graphics and mobile hard and software industry as well as private persons and research institutions. In contrast, proprietary graphics formats, although sometimes documented, are usually under complete control of one company and are often patented. Quite often, if a company goes bankrupt, continuous support is not guaranteed.

### 3.2 Weaknesses of the SVG approach

Apart from all the positive aspects of SVG there are unfortunately also weak aspects. One issue is that it takes longer for SVG to penetrate the web developer market than initially expected, mainly because important software companies, such as Microsoft and former Macromedia did not actively support SVG. So far, the Adobe SVG viewer plugin is needed to view SVG content. Currently, that viewer has around 30% market penetration. It was only recently, that Opera and Mozilla announced native SVG support for their browsers. Even Adobe had temporarily slowed down SVG support for a while, because some Adobe managers saw it as a threat to PDF, the current number one money maker of Adobe. Luckily, that attitude changed and Adobe is again more actively supporting SVG. SVG meanwhile also enjoys widespread support in the Open Source scene. The SVG file format is supported by the two major Unix desktops (KDE and Gnome). Many OS vector graphics or layout software projects support SVG for import and export. Some of them even use it as their native file format.

The situation is much better with mobile phones. SVG was from the beginning part of the 3GPP standard, and mobile SVG viewers are already widespread available in many 3<sup>rd</sup> generation mobile phones. SVG is now also natively supported by the Opera and Mozilla mobile versions. Finally, most of the mobile phone vendors, such as Nokia, Motorola, etc. actively support SVG.

One major drawback of the SVG approach is that good tools for content creation are still in their infancy. While it is trivial to create static and animated SVG graphics, tools for scripting

development are not yet mature. Hence, the content creation of highly interactive content is still reserved to the more computer literate developers who are used to directly working in the source code. However, that situation is going to change in the long run, esp. with the native integration of SVG in the Mozilla browsers. Several existing ECMAScript debugging tools support professional ECMAScript and SVG development. Debuggers are currently integrated in the Apache Batik project, the eSVG product and the Mozilla and Firefox webbrowsers.

Finally, there is the problem of not being able to hide the source code effectively. This can be a positive feature, but quite a few content creators are hesitant to use open standards where they cannot use code protection. While methods exist to obfuscate Javascript or disable the "View Source" function in the Adobe SVG viewer, it is usually trivial for computer literate people to still have access to the source code. This is also possible for documented binary formats, such as Flash. Quite a few programs exist to decompose swf files and extract the individual media elements, such as graphics, movies and text. To be able to hide the source code in the future, Adobe is looking into the so-called digital rights management.

## 4. USAGE SCENARIOS AND EXAMPLES FOR SVG IN E-LEARNING ENVIRONMENTS

As already mentioned in section 3.1 it is recommended to not use SVG exclusively, but in collaboration with other webstandards such as XHTML, CSS, XML and XSLT. XML should be used to store the content, while XHTML and SVG can be used for presentation. This strict separation of content and presentation ensures that one can easily generate various versions or deliver content for several output devices by simply applying different stylesheets or conversion rules. The following list of usage scenarios and examples is only exemplary and by no means complete – good starting points for finding additional SVG examples are <http://www.svgx.org/>, <http://www.svg.org/> and <http://www.carto.net/papers/svg/links/>

### 4.1 Geometry, Mathematics and Computer Graphics

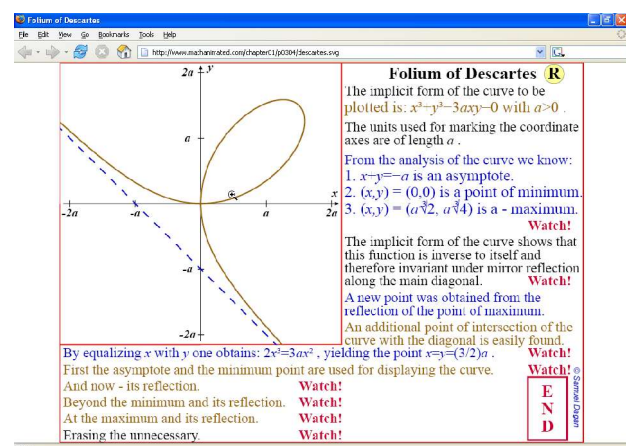


Figure 5: Animated visualization of the "Folium of Descartes" curve, © Samuel Dagan

SVG offers all the basic shapes needed to visualize geometric and mathematical problems. Animation and interactivity can be used to show solutions. Interactivity can also be used to let students demonstrate solutions in self assessments and exams. Examples for SVG in mathematics and geometry can be seen in (Hirtzler, 2005d), (Dagan, 2005) and (Crocodile Software, 2005). The latter citation points to an offline commercial e-learning software that uses the Mozilla webbrowser with SVG

support for the rendering part. Kevin Lindsey (Lindsey, 2003a) provides a good tutorial on how to recursively draw bezier curves with SVG illustrations.

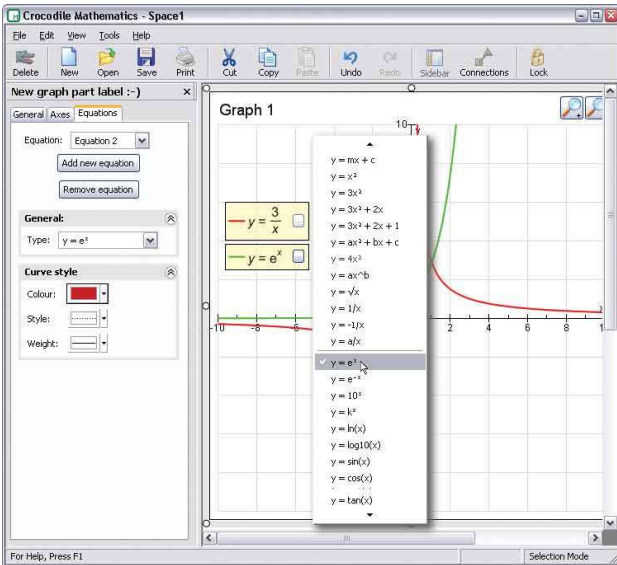


Figure 6: Crocodile Mathematics - a Mozilla and SVG based offline e-learning application, © Crocodile Software

#### 4.2 Engineering, Simulations and Technical Documentation

SVG is well suited for teaching engineering subjects, presenting technical drawings and explaining, visualizing or simulating instruments. Animations can visualize the operation of machines, technical devices or circuit diagrams. In technical drawings one can display non-graphical attributes (such as article numbers or part names) on mouse-over. Tooltips or infopanels can be used for that purpose. In simulations, the user can interactively manage control panels, control flows or change environmental parameters.

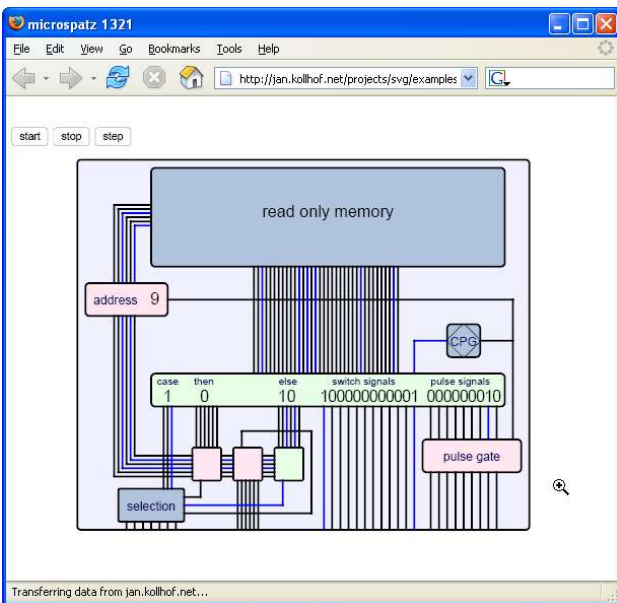


Figure 7: Animated visualization of a microcontroller layout, © Jan Kollhof, Source: (Kollhof, 2004a)

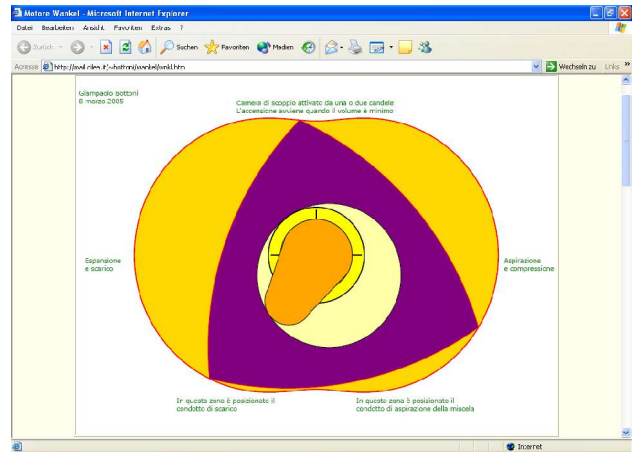


Figure 8: Animated visualization of the Wankel engine, © G. Bottoni, Source: (Bottoni, 2005)

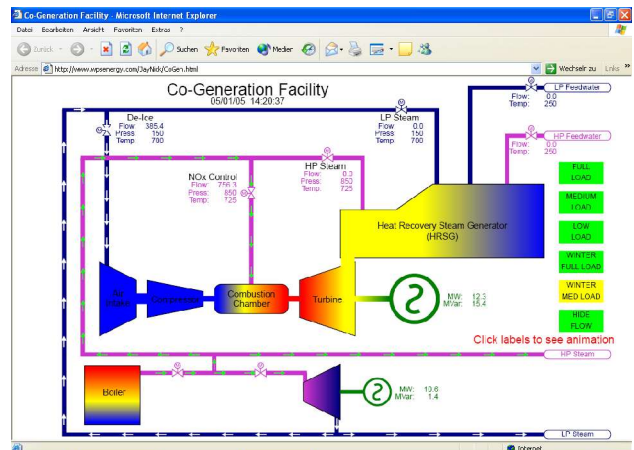


Figure 9: Interactive and animated visualization of a co-generation facility, © Jay Nick, Source: (Nick, 2005)

Examples include electrical troubleshooting diagrams from Hyundai (Hyundai, 2003), an animation of the principle of the Wankel engine (Bottoni, 2005), an animation of the functionality of a micro controller (Kollhof, 2005a), animations and graphics on control systems and real-time metering (Nick, 2005) and SVG-based instruments visualization (Wade Johnson, 2005).

#### 4.3 GIS and Cartography

The rich visualization and interactivity options of SVG make it particularly useful for mapping and GIS. The available fill and stroke options, symbols and markers enable higher quality map graphics and complex symbolizations. Interactivity helps display additional non-graphical data and enables analysis functions. Basic GIS functionality can be directly implemented in SVG, while more complex GIS analysis functions can be delegated to serverside GIS or spatial databases. In the latter case, SVG is only used as a presentation tool. Data acquisition and analysis functions can be directly practiced in interactive SVG applications. Complex workflows can be explained and split up into smaller exercises.

An example for using SVG in mapping applications is the Tirolatlas (Förster/Winter, 2005 – currently requires Internet-Explorer on Windows), an innovative online atlas containing maps, charts, text and tables. An online digitizing tool (Neumann, 2004) demonstrates GIS data acquisition through digitizing where the output can be directly saved into a spatial

database. Additional examples include an illustration of a line simplification algorithm (Lindsey, 2003) and a demonstration of the Dijkstra shortest path algorithm (McCormack, 2004).

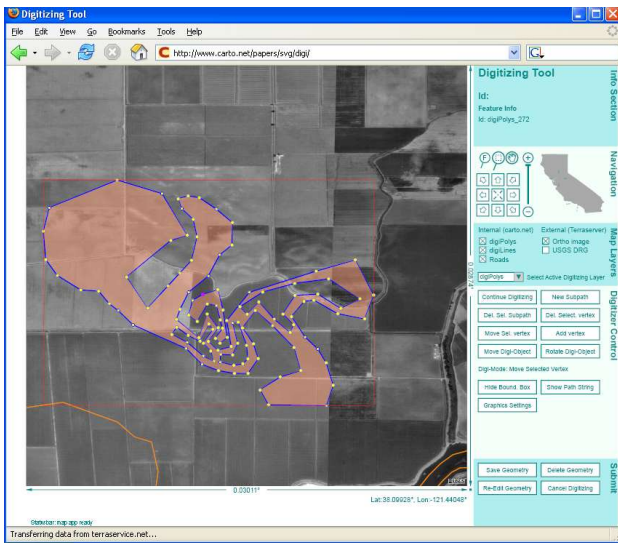


Figure 10: SVG based interactive digitizing tool, © A. Neumann, Source: (Neumann, 2004)

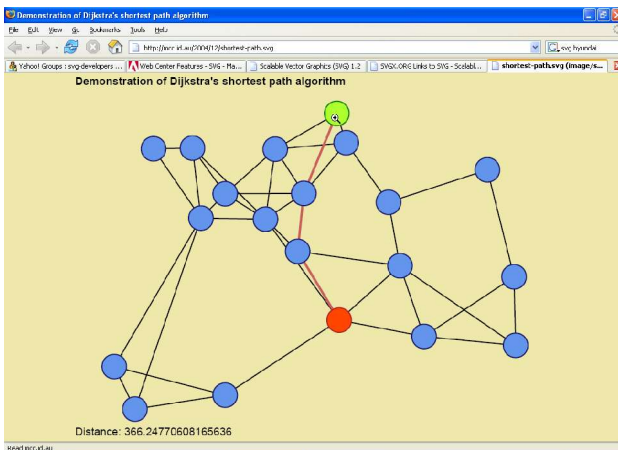


Figure 11: Interactive visualization of the Dijkstra shortest path algorithm, © C. McCormack, Source: (McCormack, 2004)

#### 4.4 Programming and Visualization of Algorithms

Students are usually highly motivated if they can program graphical applications, because they can immediately see feedback and the results are less abstract than with other programming exercises. SVG can also be used for illustrating the functionality of algorithms. The algorithm source code or pseudo code can be displayed next to the graphical result and the program code can be stepped through. This way, the relation between a line in the source code and the influence on the graphical representation is made obvious.

Examples include Jan Kollhofs demonstration of a sorting algorithm (Kollhof, 2004b) and Thomas Meinikes SVG demonstrations "SVG - Learning by Coding" (Meinike, 2005), an extensive collection of SVG code examples.

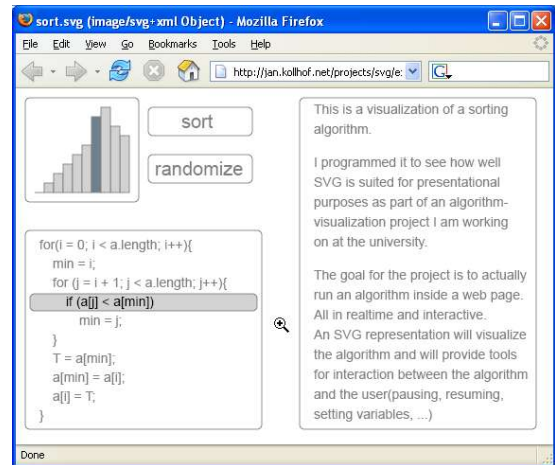


Figure 12: Animated visualization of a sorting algorithm, © Jan Kollhof, Source: (Kollhof, 2004b)

#### 4.5 Games and Kids

Many examples show the usefulness of SVG for smaller games and animations. Games can have a high pedagogical value if they are carefully authored and transport learning subjects adequate to the age of the intended audience. Useful games are crossword puzzles, quizzes in any subjects, finding locations in maps, ordering and structuring geographic phenomena or solving geometrical or mathematical problems.

Examples include the "Tirol for Kids" section in the Tirolatlas, containing various geography or cartography related animations and games for learning and testing the geography knowledge of kids and students (Förster/Winter, 2004). A website dedicated to SVG and gaming (Ellis, 2005) lists a number of SVG based games.

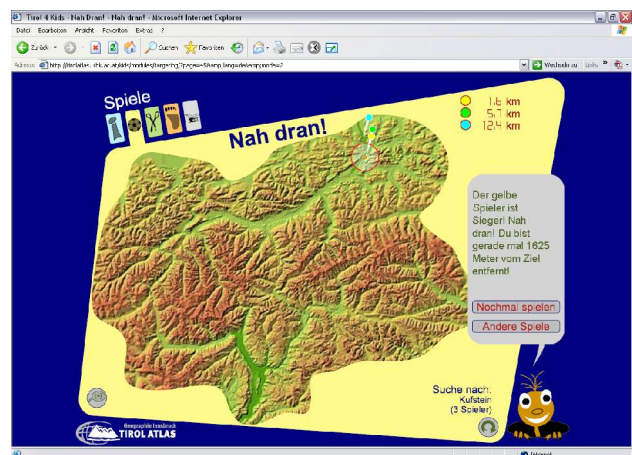


Figure 13: "Nah dran", an SVG game for testing geographic knowledge, © Tirolatlas, Source: (Winter/Förster, 2004)

#### 5. SVG CONTENT GENERATION

Although easy and user friendly SVG development tools are still in their infancy, there are already more options to generate SVG content than for any other graphics format. Following is a non-exhaustive list of SVG generation options. In many cases a combination of different generation or conversion options lead to a satisfying result.

### 5.1 Text Editors and XML Editors

The text or XML base of SVG is probably one of the largest advantages. It allows the creation of content in any simple text editor, even across small bandwidth network connections. XML editors are more comfortable and allow validation of SVG syntax. Many XML editors also support code folding and typing support. Some editors feature an internal preview of the graphical rendering of the SVG content.

### 5.2 Graphics Format Converters

Many general purpose graphic converters nowadays support SVG for reading and writing. Specific converters, such as the Docsoft QuickSVG CGM to SVG converter (Docsoft, 2005), even support the conversion of interactivity functions or the inclusion of non-graphical data.

### 5.3 Graphics Software

Most companies developing graphics or CAD software also support SVG, among them Adobe (with Illustrator) and Corel (with CorelDRAW). Almost all open source graphics software supports SVG for import and/or export.

### 5.4 Specialized SVG Editors

Specialized SVG editors usually use SVG as their native file format. They are specifically tailored towards the features of SVG. While the creation of SVG static geometry and simple animations is currently covered well enough, most editors still lack professional scripting and interactivity support. Creating complex interactive SVG applications still requires good programming skills. In this category there are SVG editors such as the Open Source Inkscape (Inkscape, 2005) project, an animation editor from Ikivo and Adobe (Ikivo, 2005), and RapidSVG (Xstream, 2005), a tool specifically tailored towards e-learning, with support for simple GUI widgets.

### 5.5 SVG printer drivers

SVGMaker provides a SVG printer driver for the Windows platform, which enables SVG printing support for any Windows application. The program works similar to the Adobe Distiller software and also provides a control for page navigation in multipage documents.

### 5.6 XSLT Conversion

SVG developers can benefit from the fact that SVG is XML based and can easily convert SVG content from any XML data utilizing XSLT conversion. This method is particularly useful for data-driven applications and documents that need automated conversion workflows.

### 5.7 Scripting and Programming Languages

Again, developers can benefit from the text-base of SVG. Any programming language provides text file output. Many programming or scripting languages even provide libraries for reading and/or writing SVG content.

### 5.8 Export from Databases

Many (spatial) databases already provide SVG export support for maps and charts. Examples include Postgis/PostgreSQL and Oracle. Given the fact that most DBMS provide procedural language extensions and APIs to most popular programming

languages it is relatively easy to extend other DBMS for that purpose.

### 5.9 Export from GIS or Mapping Servers

Most of the current GIS software vendors already support SVG either as an export format or as part of their webmapping server products. Companies that support SVG include ESRI, Intergraph, Microimages, Smallworld, Safe Software (FME) and many third party vendors that enhance existing GIS with more sophisticated SVG export functions. Examples of third party products are MapViewSVG (UISMedia, 2005) for ESRI and SVGMapMaker from DBXGeomatics (DBXGeomatics, 2005) for Mapinfo.

## 6. NEW DEVELOPMENTS IN THE UPCOMING SVG 1.2 SPECIFICATION

Compared to the SVG 1.1 specification, in which the W3C introduced sub profiles, the SVG 1.2 specification is a major upgrade. Numerous new features potentially enhance the multimedia experience, add new graphics, visualization and networking options, and improve and facilitate interactivity and application development. The new features listed below are only a very brief summary of the upcoming SVG 1.2 additions and improvements. For a full list of new features, please consult (W3C, 2005). The introduction of the SVG 1.2 specification is not without controversy, as it partially overlaps with the scope of other webstandards and is becoming increasingly complex.

### 6.1 XBL Support (XML Binding Language)

sXBL will allow custom markup extensibility via pre-packaged components. Developers can create re-usable higher level components in a custom XML vocabulary. It builds on the concept of a shadow tree containing lower level SVG elements that will be rendered instead of the original custom markup. The shadow tree will be generated using templates and scripting. Applications for XBL are widgets, visual effects and domain specific extensions with common markup. Cartographers could e.g. define a XBL version of north arrows or scalebars. It is beyond the scope of this article to explain the functionality of the XBL technology.

### 6.2 Text Wrapping

SVG 1.2 finally adds text wrapping support. Text can flow in arbitrary shapes and is constantly updated if the connected shape changes size and shape. Exclude shapes can define obstacles a text has to wrap around. FlowText can have a different coordinate system than the linked flowRegion. This means if a flowRegion is rotated, the text lines can stay horizontally aligned. Hourglass example, Pilat Example.

### 6.3 Editable Text and Text Selection Events

Implementing editable text (e.g. text input form elements) in SVG up to version 1.1 was complicated. One had to write relatively complex script constructs to simulate text input boxes or implement simple text editors. SVG 1.2 will add an "editable" attribute that allows the editing of single text elements or flowtext. A text selection interface will allow script access to the text selection mechanism and add events that fire if a text was selected.

## 6.4 Official Audio and Video Support

While the Adobe SVG viewer supports audio with a proprietary extension since version 3, SVG 1.2 now officially adds support for audio and video media. At the time of writing it has not officially been decided what video formats and codecs are mandatory and which are optional. The SVG viewer should, however, at least support the royalty free ogg vorbis audio format. Next to the usual SMIL attributes and synchronization options, the `<audio />` and `<video />` elements support an "audio-level" (volume) attribute. Video content can be transformed, clipped and masked and may be overlaid by transparent elements or can be transparent by itself. SMIL elements or script interfaces can control the playback of the media.

## 6.5 Transition Effects

SVG 1.2 supports the transition effects (e.g. checkerboard, dissolve, blending, etc.) defined in SMIL 2.0. These effects are useful for multipage documents, presentations or slideshows. The effects are already implemented in the Adobe SVG viewer version 6.

## 6.6 Multipage Support

New `<pageset />` and `<page />` elements will enable multipage support. This feature should be useful for presentations, multipage publications, books, cartoons, etc. Until now, one had to simulate this feature by changing the visibility or display attribute on groups simultaneously. Page navigation should be possible by SMIL, script or page keys.

## 6.7 Streaming Support and Progressive Rendering

Streaming support allows viewers to start displaying content or start animations while the file is still downloading. For that purpose, authors can specify that the timeline starts "onStart", after an elements opening tag is fully parsed, or "onLoad" (the default) which is fired after a tag is fully processed. Authors can also define whether content can be discarded after using it, or if the viewer needs to keep it because other elements still need to reference it. The new specification also defines how progressive rendering should be implemented. A "prefetch" attribute controls when external resources need to be loaded.

## 6.8 Better Time Control

In SVG 1.2 it will be possible to control the playback speed of animations. Values are relative to the parent time container. Negative values cause elements to play backwards. In SVG 1.2 the author can introduce multiple independent time containers. Additional time containers may be nested. In that case, the "speed" attribute accumulates. Until now, animation playback could only be controlled globally. It will also be possible to "jump" directly to a snapshot in time. In the future, animations and media elements can also be started using access keys.

## 6.9 Multiresolution Images

SVG 1.2 will support multiresolution images. Threshold values ("min-pixel" size and "max-pixel" size) control what content ("subImage") will be displayed. SubImages can contain both raster and vector graphics and have the usual "x", "y", "width" and "height" attributes that can be used to determine which parts of the subImages need to be displayed.

## 6.10 Vector Effects

Vector Effects are particularly interesting for GIS and cartography, but also for interactive drawing applications. They serve several purposes: multistroking and multifilling allow the combination of various fill and stroke options, e.g. a gradient can be applied in combination with a pattern or uniform color to the same geometry, or a multistroke freeway line signature can be made up of several stroking options. A setBack effect can interrupt stroking before and after a vertex. Reverse allows to reverse a path, thus affecting animations and markers. Join and "vePathRef" allow the buildin of a new path out of other paths. This method can be used to build simple topological structures by building polygons out of edges. Union, intersect and exclude allow the combining, intersection and subtraction of paths.

## 6.11 Additions to the Rendering Model and Enhanced Compositing

SVG 1.2 introduces a background element and new options for alpha compositing, such as clip-to-self, knock-out and "comp-op". Comp-op specifies composition operators, such as "xor", "multiply", "difference", "exclusion", "lighten", "darken".

## 6.12 Extended Links

Extended links allow links to multiple targets where the user is presented with a choice (e.g. menu or popup list). This is useful for many interactive applications, e.g. technical drawings. A switch may even provide text in different languages.

## 6.13 Application Development, Scripting and DOM enhancements

One goal of this specification section is to finally standardize existing proprietary extensions, such as the network interfaces ".getURL()" and ".postURL()" or the "window" object. Furthermore, there will be support for focus and navigation and tooltips. DOM enhancements will introduce better support for coordinate system translations and a new "wheel" event for mouse wheels or "jog dials". There will also be better network interfaces (e.g. URL Request or sockets, including the option to abort a request), a progress event that allows the monitoring of download progress, and a better timer interface. A file upload dialog and the possibility for persistent client side storage support (similar to cookies) further facilitate SVG application development.

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### **7.3 Acknowledgements**

I'd like to thank the SVG community and W3C SVG working group for providing numerous examples and their continuous support with SVG and programming problems. The open source community provides various SVG authoring and viewing software for free. Specifically, I'd like to thank the Batik, Inkscape, KSVG, librSVG and Mozilla team. Furthermore, I'd like to thank the Adobe SVG team for their feedback and fruitful discussions which helped solving SVG development problems or introducing new features in the SVG specification. My girlfriend Juliana Williams helped correcting my typos and disentangling complicated sentences.

## DEVELOPMENT OF SUSTAINABLE E-LEARNING CONTENT WITH THE OPEN SOURCE eLESSON MARKUP LANGUAGE eLML

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**KEY WORDS:** Internet/Web, Education, Learning, Teaching, Open Systems, Content-based, Standardization, Sustainable Structure

### ABSTRACT:

eLML, the open source “eLesson Markup Language” has been developed out of the proven XML-based content structure of the Swiss Virtual Campus (SVC) Project GITTA (Geographic Information Technology Training Alliance). This paper presents the eLML structure and how sustainable e-Learning content can be developed, exchanged and employed using eLML.

eLML is based on the didactical concept ECLASS (adapted from Gerson, 2000), standing for entry, clarify, look, act, self-assessment and summary. Every self-contained lesson is subdivided into one or more units that are structured according to the didactical concept. To allow different teaching and learning scenarios most of the structure elements are optional or can be repeated several times. The development of a lesson starts with the definition of learning objectives and the planning of content for each part of the didactical structure. This ensures that didactical aspects are considered foremost, in a field where technical problems can sometimes become too prominent otherwise. Storing the content in an XML-based structure provides many advantages, ranging from the sustainable management of a pool of lessons to different presentations of the content according to varying requirements. Out of a pool of eLML-based lessons, where each lesson also contains a glossary, bibliography and metadata section in addition to the actual content, different courses can be assembled. eLML is not a new learning management system (LMS) but eLML-based e-learning lessons can, for example, be transformed into XHTML and be used in combination with a LMS. eLML-based content can also be imported directly into a modern commercial or open source LMS using the IMS Content Packaging Format (CP).

The paper presents experiences from the development of eLML itself, the design of e-learning content based on this structure, and the use of eLML-based content in conjunction with a LMS. The current use of eLML in several SVC projects ensures that eLML will be enhanced and kept up to date for future e-learning projects.

### 1. INTRODUCTION

Since eLML is based on the technical framework of the Swiss e-learning project GITTA (Geographic Information Technology Training Alliance), this paper begins with a short overview about the GITTA project.

#### 1.1 GITTA – The history behind eLML

The GITTA project is one of around fifty e-learning projects funded by the Swiss Virtual Campus (SVC, 2001). Between 2001 and 2004 a consortium of 10 interdisciplinary Geographic Information Science and Technology (GIST) teaching institutions, from Swiss universities, federal institutes of technology and universities of applied sciences – together covering around 75% of the Swiss GIST offerings in higher education – built up a modular online course in GIST. The main motivation was to exploit synergies, increase the teaching capacity and improve the quality of GIST courses. Nearly 40 authors, from three language regions, created a pool of 50 lessons, divided into basic and intermediate levels, and 10 case studies that can be used on a modular basis for GIST teaching (Fisler, 2004).

This heterogeneous consortium needed some strict didactical and technical structures to create consistent and similar looking lessons and case studies. After an extensive evaluation of both the lessons and the case studies, a didactical model was chosen using XML as the technical backbone. Using Document Type Definitions (DTDs), XML documents conforming to the didactical model could be created and validated. Thus XML offered the sustainability and interoperability needed for GITTA

that no Learning Management System (LMS) offered in 2001. Choosing the didactical guidelines first and then the technology that could cope with these guidelines made GITTA a problem driven and not a technology driven e-learning project.

The first to discover the potential of GITTA’s XML structure was SVC’s technical board Edutech. They both financially and philosophically supported GITTA to publish their XML framework and make it available to other SVC projects. Since the GITTA XML structure, based on outdated DTDs and depending on specific server technologies (e.g. Apache Cocoon, 1998), was undocumented and hard to learn for authors, a consolidated, server-independent and documented XML framework based on XML Schema was developed in spring 2004.

#### 1.2 eLML – Yet another markup language?

This new XML framework was called eLML, the “eLesson Markup Language” (Fisler & Bleisch, 2004) and was published under the General Public License (GPL) as an open source project (OSI, 1998) on Sourceforge.net. eLML is, in contrast to the old GITTA structure, free of any GIST-specific terms or technologies and therefore usable for any e-learning project choosing XML as their main base for creating and storing content. Furthermore, eLML as an open source project is free of charge and welcomes new contributors in the development process to enhance the framework.



eLML should be understood as the result of three years experience in working with an XML structure and the wish make this knowledge accessible and help authors creating structured e-learning content. eLML can be compared to other markup languages that were developed to describe e-learning content (e.g. LMML in Süß et al., 2001 or EML in Koper, 2002). The main reason for creating a new markup language was that when the GITTA project started, none of these XML markup languages satisfied its needs.

## 2. eLML – E-LESSON MARKUP LANGUAGE

### 2.1 ECLASS – the didactical concept behind eLML

The aim of eLML was to offer the GITTA authors a tool that ensured conformity to certain didactic guidelines. These guidelines were adapted from the ECLASS model developed by Gerson (2000). ECLASS is an acronym for the terms entry, clarify, look, act, self-assessment and summary. Enriching these elements with elements like glossary, bibliography or metadata led to the XML framework that is now called eLML.

As shown in Figure 1, GITTA lessons were organized into different modules that again were part of either the basic or the intermediate level. Both level and module are purely organizational entities with no technical relation within eLML. The eLesson Markup Language uses lessons as the smallest interchangeable entity. A lesson is built up of units (conforming to the ECLASS model) and of additional elements like learning objectives, bibliography, glossary and metadata.

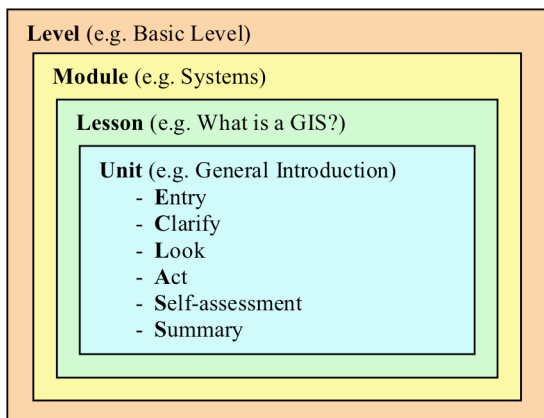


Figure 1: The ECLASS model

eLML is not as rigid as it may look. Since some elements are optional or can be used in reverse order, it is flexible enough to allow the representation of entities such as the following:

- **Lessons:** Standard e-learning lessons begin with an entry element that describes the content of the lesson. Then they could continue with a clarify element describing some theory and one or more look elements to show examples. Usually lessons end with a self-assessment (to check if learning objectives are reached) and a summary.
- **Case studies:** As described in Niederhuber (2005), GITTA case studies use their own didactical model. They usually start with an entry element followed by two units (using clarify elements), whereby the clarify elements are used to describe the instructions.
- **Others:** Even documentations could use eLML to generate structured reports. In this case both act and self-assessment elements would be left out.

### 2.2 Structure of an eLML lesson

Figure 2 shows how the described didactical model ECLASS is represented within the XML framework eLML:

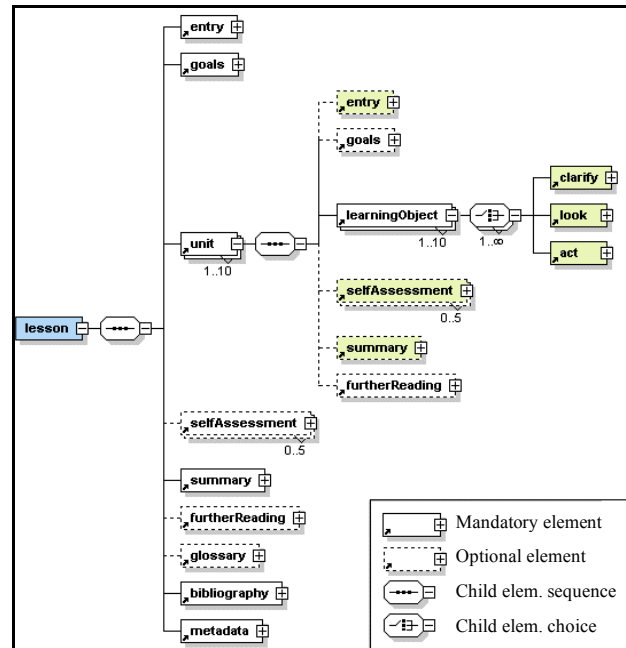


Figure 2: Structure of an eLML lesson

An eLML lesson always starts with the mandatory introduction (entry) followed by a concise listing of the lesson's learning objectives (goals). The unit elements, described in the next paragraph, contain the actual content of a lesson. After the units a lesson can have one or more self-assessments followed by a mandatory summary and an optional further reading section. Also optional is the glossary to describe terms used within the lesson – the XML Schema ensures that all glossary terms used in a lesson are defined in the glossary. The Harvard Citing System (Holland, 2004) is used for the mandatory bibliography that is also validated. All citations, references, further readings etc., have to be listed within the bibliography section, otherwise the XML parser issues an error and thus a lesson will not be valid. Not many authors like to fill out metadata, but eLML ensures that at least the minimal metadata elements are filled out. This subset of the IMS Learning Resource Metadata Specification (2002) can be used to store data about the length of the lessons, the author(s), copyrights, the required knowledge to solve this lesson and the basic technical requirements. Both bibliography and metadata are defined separately and thus can be replaced by other citing references or metadata standards.

With two exceptions, the unit element itself is built up exactly as the lesson root element described above:

1. The glossary, bibliography and metadata elements are only available at the lesson and not the unit level.
2. At the unit level all elements, except the "learning object" (described below), are optional.

Within units, eLML defines so-called "learning objects" (not to be confused with the learning objectives – called "goals" within eLML). Each learning object describes a certain model, concept, term or process using the three elements clarify (theory), look (example) and act (the student has to "do" something). These three elements have no visual representation and are solely used as guiding elements for authors. This way, the author has to think about how a certain concept should be

presented to the student. Whether a learning object starts with some theory (clarify element) and continues with one or more examples (look elements) or, alternatively, the student first has to do something (act element) and then reads the theory behind it (clarify element) is left to the author.

A learning object should fit on about one screen page and take the student about 5 minutes to understand. Units are typically made of 4 to 6 learning objects, typically requiring about 30 minutes of working time. In the case of GITTA, lessons were built of 4 to 6 units, meaning that GITTA lessons take the students normally around two to three hours to work through. But this is just one approach since the total required working time for a lesson is not defined within eLML. Other projects use eLML lessons to represent a whole semester course, thus one unit represents one lecture (one or two hour).

### 2.3 Content elements

The last section covered the basic structure of an eLML lesson. The afore mentioned structural elements, entry, unit, learning object, self-assessment, summary etc., could be represented as lesson chapter titles. Within these chapters, there are content elements that contain the actual subject matter.

The old GITTA structure worked with semantic elements using e.g. explanation, remark or motivation paragraphs. This approach was rejected because for the authors it was too complicated to grasp and because the elements did not have a visual representation (or if they had, the authors chose the elements according to their representation in the final layout and not according to their semantic meaning). In theory a total separation between content and representation (layout) would be desirable but – as the GITTA project showed within its three years – this is not realistic. Therefore certain structural elements (column, formatted, newLine etc.) are offered within eLML but their use is not recommended.

A short overview of the eLML content elements:

- column: Defines a two- or three-column layout.
- table: Used for tables and not as a layout element.
- list: Numbered or bulleted lists.
- box: Content of this element is represented in a box. The exact layout of boxes is defined separately.
- term: When a glossary term is used the definition is either available as “mouse over” link or as a separate paragraph with a link to the glossary.
- newLine: A line break (not recommended).
- multimedia: Pictures, Flashes, Applets, Movies or even plain HTML code (e.g. JavaScript).
- formatted: Possibility to format text as bold, italic, underlined, subscript etc. Not recommended.
- popup: Clicking on the title (e.g. a question) opens a box (e.g. the answer). Always open in print version!
- link: Link to external or internal resources including other units, learning objects etc.
- citation: Citations can be inline or as a paragraph with many options described in the manual. A resource has to be defined in the bibliography before being used.
- paragraph: A regular paragraph that offers attributes to be visible only to tutors or to be shown only in the print or the online version of a lesson.
- indexItem: Marking words to be listed in the index.

All of these elements have additional attributes. For instance, the “icon” attribute allows certain elements to be emphasised with a special icon: “attention” by an exclamation mark icon or

“help” by an interrogation mark icon. Furthermore, this attribute allows a list (e.g. in the appendix) of all elements with the same icon attribute to be extracted. A scenario where this might be used is in a math course where the important formulae were marked with the attention icon. The appendix could then list only the important formulae as a summary without text.

eLML also defines rules for nesting of elements. For instance, to include a column within a list element would not make sense, neither would a table within a multimedia element. Therefore the eLML XML Schema exactly defines which element can be used where. An example of how these elements are used and how such an XML document looks can be seen in Figure 3.

```
<?xml version="1.0" encoding="UTF-8"?>
<lesson xmlns:xsi="http://www.w3.org/2001/XMLSchema-instc
title="What is a GIS?">
  <entry label="LEntryLesson" title="Introduction">
    <paragraph> Living in what we call ‘the age of ir
      storage capacities, high resolution sensors c
      to be acquired, stored, organised and structu
      only to manage data, but also for the interpr
    <paragraph icon="remark" role="student">In inform
      style="italic">unprocessed, uninterpretec
    >information</formatted> can be extracted. Hc
    source, depending on factors like perspective
  <paragraph>Thus, an information system is a tool
    is usually capable of integrating and combini
    transformed into useful information by a user
    a whole suite of software packages and hardw
  <paragraph>
    <multimedia mimeType="gif" src="../../image/less
  </paragraph>
```

Figure 3: An extract of an eLML XML document.

### 2.4 Developing of an eLML lesson

Creating an eLML lesson typically starts with defining the learning objectives of a particular lesson (the “goals” element within eLML). When the author has defined what the student should learn within this lesson, he/she decides on the units that are needed to present the subject matter and from there each learning object that presents a certain aspect of the topic. The actual writing of the lesson is done with an XML editor. Multimedia elements like movies or flash animations etc. are made using appropriate tools.

For authoring a lesson’s XML document, common editors that support XML Schema validation can be used. This implies that an author has a basic knowledge of XML. A web front end, as used for other e-learning projects, could not be realised due to the complexity of the XML Schema. Another solution is to use tools that can render a Graphical User Interface (GUI) based on an XML Schema. JAXFront (2001), see Figure 4, is such a tool. It was tested with eLML and might be used by GITTA and other project authors in future.

UNNAMED1	
contributionInBook	
bibID	b1
author	DITTRICH, K.
publicationYear	1999
titleOfContribution	Datenbanksysteme
editor	RECHENBERG, P., POMBERGER, G.
title	Informatik-Handbuch
publicationPlace	Wien

Figure 4: JAXFront Screenshot of eLML bibliography reference

## 2.5 Presentation and layout

eLML includes XSLT and XSL-FO files for transformation into both an online (XHTML) and a print (PDF) version of a lesson. The standards used are described in detail in Section 3.3.

**Online version:** The online version uses templates to generate the final XHTML version of a lesson. eLML includes a plain layout, two GITTA layouts (Figure 5) and another projects template. Three means of creating a new template are provided:

- Using the plain layout and adapting the included CSS file is the simplest way to create a customised layout.
- XHTML: Creating an XHTML template using a web design tool is also fairly easy. Adding two XSL statements transforms it into an eLML template.
- XSLT: Using XSLT statements it is possible to build a new template with new functions or elements.



Figure 5: GITTA lesson transformed using the GITTA layout

Thanks to the new XSLT 2.0 standard, eLML since 2005 offers a multiple output document option. The page breaks can either be at the lesson level (one single page generated), at the unit level (each unit on a single page) or at the learning objects level (each learning object on a single page). Also since 2005, eLML output can be zipped into an IMS Content Package and imported into any existing LMS, such as WebCT or OLAT (1999; see Figure 6).



Figure 6: Same lesson as shown in Figure 5 imported into the LMS OLAT using IMS Content Package standard.

**Print version:** The print version uses the Apache Formatting Object Processor (Apache FOP, 2001) to generate a PDF document, like the one shown in Figure 7. This engine does not support all the latest XSL-FO elements, as can be seen on the Apache FOP compliance page. Nevertheless we chose to use it because:

- Open source products should be based on other open source products and not require commercial software.
- The Apache FOP is the most widely used engine.
- All elements used in eLML were supported by Apaches FOP either directly or using a workaround.

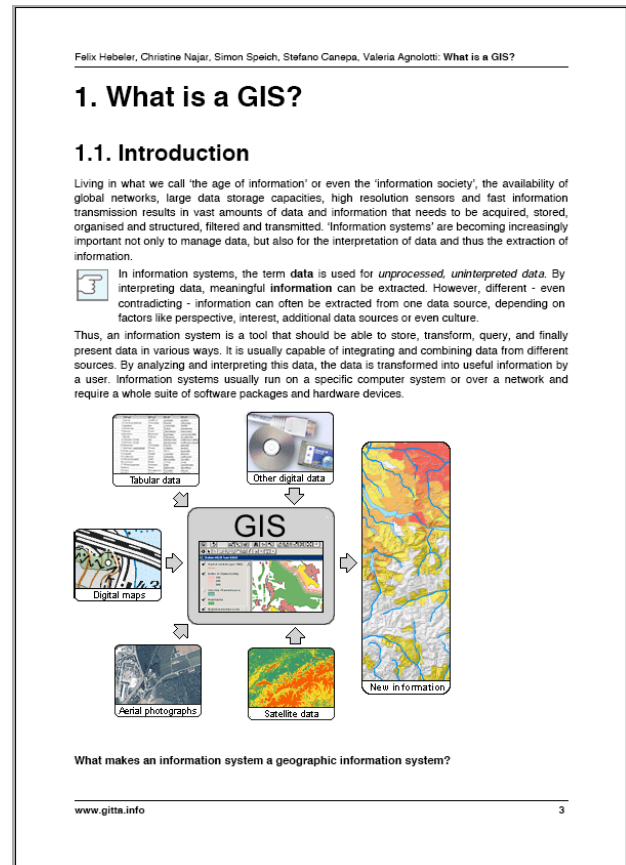


Figure 7: Again the same GITTA lesson, this time as a PDF using the Apache Formatting Object Processor.

There are additional parameters that can be adjusted, having impact on the online or print version. These include a specific contact email address used in contact links, disabling the chapter numbering, language settings, project URL for home links, defining value lists, etc. These options are described in detail in the eLML manual (Bleisch & Fisler, 2004).

## 3. TOWARDS AN OPEN SOLUTION

When the GITTA project started in 2001 nobody talked about open source or open content. The consortium agreed to produce content for internal use only, like most SVC projects at that time. As funding ended, a solution for sustainable low cost maintenance had to be found. That is when open source and open content came into play.

### 3.1 Releasing eLML under an open source license

Keeping the GITTA technical infrastructure up to date required a lot of resources. When Edutech came up with the idea of opening the XML framework to others, the consortium agreed that open source might be the key for sustainable GITTA maintenance. Thus the technical “backbone” eLML was released under the open source license GPL on Sourceforge.net (see Figure 8). If it could be possible to motivate other e-learning projects to use eLML and to participate in developing and updating eLML, the maintenance cost for GITTA would be lowered. By opening eLML for the e-learning community via open source, GITTA saved other projects a lot of time required to building up a technical infrastructure. This time can be invested by these projects into the enhancement of eLML and keeping it compatible to the latest e-learning standards. GITTA benefits from these developments since there is no need to finance its own technical development team.

Figure 8: The Sourceforge.net eLML project page

### 3.2 Releasing content under the Creative Commons license

The open source philosophy should not only cover the technical part of an e-learning project but could also be applied to its content. Benefits of sharing knowledge and content include the opportunity of improved content due to the feedback from external authors. Therefore, in April 2005 the GITTA consortium decided to release all its material under the Creative Commons license (CC, 2001). As the open source licenses mainly address software projects, the Creative Commons license was developed for publishing music, movies, photos, and other content such as electronic books, educational material and e-learning courses. Via the CC website it is possible to assemble a personal license that either includes or excludes commercial use, altering of content, feeding back updates to the project, etc. CC offers the whole spectrum of possibilities from full copyright (all rights reserved) to public use. The license founded in 2001 seems to have become a standard not only in the USA and Europe but also throughout the world (e.g. in Brazil as described in Ermert, 2004).

### 3.3 Using common standards

eLML uses common (open source) standards wherever possible. Each lesson is stored in a single XML file, conforming to the eLML XML Schema. This file is then transformed either using XSL-FO into PDF or using XSLT 2.0 in one or more XHTML output documents. Also exported is the imsmanifest.xml file

used for the IMS Content Package format. The versions and references to these standards are shown in Figure 9.

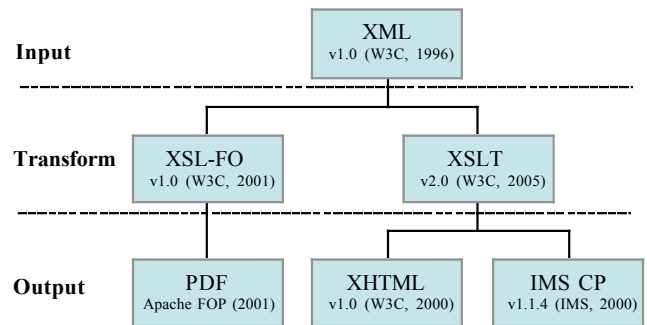


Figure 9: Standards used by eLML

## 4. CONCLUSIONS

After an introduction about the origins and motivation behind the eLesson Markup Language (eLML) this paper presented eLML in detail. The didactical model behind eLML is an extension of an existing model. This has to be kept in mind when using eLML. Loosening this tight eLML structure is one of the most common requests by new users. While this has already been done to a certain degree, too many changes could dilute the structure in such a way that the didactical concept behind would no longer be visible and stringent.

An eLML lesson is stored as an XML document that has to be validated by an XML Schema. This technique assures that all lessons are built up in a common way. Thus to create a lesson, an author has to be acquainted with the basics of XML and use an appropriate editor to create a lesson. The lack of tools with simple front-ends (GUIs) is one of the most severe drawbacks of eLML at the moment. A Java GUI is presented in this paper, but it is not yet fully tested and would still not offer the same ease-of-use as a standard word processing or web design tool.

The transformation into both an online and a print layout is based on common standards and is accomplished by using open source processors. The benefits are the low costs and the high compatibility with browsers and other tools. Drawbacks of open source can be that updates of tools (like Apache FOP) sometimes require more time to be accomplished in comparison to commercial tools.

Finally, the reasons for releasing eLML under the open source license GPL were discussed. The motivation for this step being that a growing community of eLML users may reduce maintenance costs for a project. As the list of developers started growing in the months after the release of eLML on Sourceforge.net, the benefits were obvious: more updates due to a larger community finding (and repairing) inconsistencies and bugs and a growing list of new implemented features. For example the implementation of the IMS Content Package standard, a major benefit for all projects using eLML, is a feature that was implemented with the help of such a new developer.

The GITTA consortium decided that also the content itself should be released as “open content” under the Creative Commons license. Before doing so, all copyright issues have to be resolved and the lessons have to be updated according to the latest eLML release. The CC license can request that changes to a source have to be sent back to the authors. Thus the hope is that by building up a GITTA user community it will be possible

to gain external authors to feed back corrections and updates of existing lessons or even enlarge the pool of GITTA lessons. Obviously the injection of errors into existing lessons (deliberately or not) could become a problem. Possible solutions would be to release strict rules for gaining write access and/or to set up a review committee that has to approve updates.

To stay informed about eLML, visit [www.elml.ch](http://www.elml.ch) or subscribe to the eLML Newsletter by sending an email with the subject "subscribe" to [ELML-news-request@lists.sourceforge.net](mailto:ELML-news-request@lists.sourceforge.net).

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## 6. ACKNOWLEDGEMENTS

The authors would like to thank Sandra Demarels, Alistair Edwardes, Seraina Rohrer and Robert Weibel for reviewing this paper and for their valuable input. Thanks also to the eLML developers, especially Michael Ziege, for the constant feedback and updates of the XML framework. For clarifying legal issues we would like to thank [openlaw.ch](http://openlaw.ch) and CC Switzerland.

## DEVELOPING AUTHENTIC AND VIRTUAL E-LEARNING ENVIRONMENTS

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**KEY WORDS:** Online learning, E-learning, Authentic learning, Virtual learning, Spatial sciences

### ABSTRACT:

As part of their learning process, students often need to understand and interact with real world processes. Traditional learning activities such as field trips, site visits, videos, visiting speakers and live interviews have been used to achieve this. Because of various practical, legal and political issues, such activities can be difficult or even impossible to organise.

E-learning can play a vital role in providing suitable and effective learning environments to enhance the knowledge and skills of students. Such an environment can provide a virtual interface to a real-world scenario or process. Students need to make decisions and receive responses in a highly interactive exchange. An e-learning environment must also be authentic, providing the student with meaningful and realistic information and scenarios that represent real world processes in a practical manner.

The work being presented in this paper describes the virtual e-learning developments, experiences and evaluations that have been undertaken by the Department of Spatial Sciences at Curtin University across a number of projects. The Virtual Online Learning (VOL) project outcomes included a range of online and virtual modules in the spatial sciences – geographic information science (GISc), global positioning systems (GPS), cartography and surveying. The Virtual Industry Link Learning Environment (VILLE) project is developing interactive virtual site visits that interact with industry practitioners and emulate tours of processing facilities. The aim is to provide stimulating and interactive learning environments that adequately prepare a student for real world conditions.

## 1. INTRODUCTION

### 1.1 Introduction to e-learning

The world wide web is increasingly being used as a resource in the learning and teaching of students in higher education. The e-learning revolution has been largely technology driven with the Web enabling greater flexibility and access by students to learning resources (NBEET, 1996; Veenendaal, 2000; Koohang and du Plessis, 2004). The importance and potential of the web for e-learning has been recognised for providing education in the spatial sciences (Kemp and Unwin, 1997; Carver et al., 2004). However, e-learning is much more than simply a technological means of placing existing learning resources online and reaching a wider body of students; rather, it must be seen as a pedagogical means of enhancing the learning environment.

### 1.2 Beyond the classroom

E-learning is not just a replacement for classroom instruction and a means to facilitate distance learning. Instead, it can be seen as both a means to replace classroom activities for distance learners, as well as complementing face-to-face learning in classroom situations (Veenendaal et al., 2002b; Carver et al., 2004).

In fact, e-learning can go beyond the traditional means of instruction and learning by bringing student interaction and real-world scenarios directly into the learning environment. Authentic learning occurs where students can understand, relate to and interact with real-world situations and problems. Real-world scenarios can be brought into the classroom via virtual online environments where students can visualise and interact

with the environment in a manner similar to real-world conditions.

E-learning is being utilised by both distance and on-campus educational programs in geographic information science (GIScience), cartography and surveying within the Department of Spatial Sciences at Curtin University of Technology. A number of projects have contributed to the development of e-learning resources. The Virtual Online Learning (VOL) project resulted in a number of highly interactive e-learning modules that involve learners in topics within GIScience, global positioning systems, cartography and surveying. The Virtual Industry Link Learning Environment (VILLE) project is developing interactive virtual field trips and site visits that simulate field work or emulate tours of industry sites and workplaces. Examples from these projects will be used in this paper to demonstrate the effectiveness of learner engagement in e-learning.

### 1.3 Dimensions of e-learning

In order for e-learning to be effective, three dimensions need to be considered: pedagogical, technological and organisational (Jochems et al., 2004). Although often driving the e-learning agenda, technology is but one consideration and provides the infrastructure to enable e-learning to take place. The more important aspect is pedagogical where the focus is on the learning process and how e-learning can be used to enhance that process and its outcomes. The organisational aspect concerns the roles and interactions among learners, educators and learning resources. All three dimensions need to be considered for authentic and virtual e-learning environments.

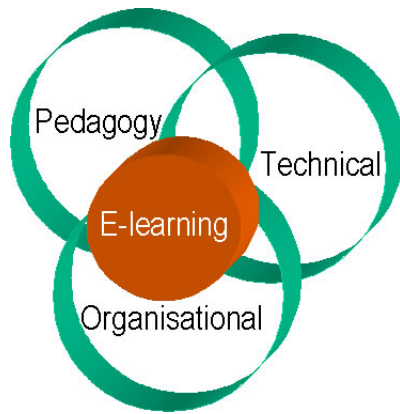


Figure 1. The three dimensions of e-learning

This paper focuses, in particular, on the pedagogical and organisational aspects as it relates to learner-content interaction.

## 2. THE ROLE OF AUTHENTIC AND VIRTUAL LEARNING

### 2.1 Improving learning by interaction

Many e-learning applications are of low pedagogical quality (Chou, 2004; van Merriënboer et al., 2004). In many cases, they simply use the technology as a repository of learning resources and as a facilitator of electronic communication between students.

Student learning needs to involve constructive activity (Jonassen et al., 1995; Chung et al., 2003; van Merriënboer et al., 2004). Just simply reading material from an online resource, interacting with classmates either directly or via email, or reading/copying other students' work is insufficient for learning. The frequency of interaction is not a good indicator of learning. Rather, the more students are directly engaged in their learning activities, the better they will learn.

In addition to asking questions and seeking help, students need to spend some time and effort in other constructive activities, such as interacting with the learning problem, seeking further explanations from different perspectives, and obtaining appropriate feedback and responses along the learning path. According to Chou (2004), learners achieve intellectual growth and changes in perspectives as a result of effective learner-content interaction.

E-learning provides a means to support such constructive activity. A study by Chung et al. (2003) showed that students who used online learning support tools reflected more on their learning than students who did not use such tools, resulting in improved interactions with classmates, better knowledge building and hence improved learning.

A small study was conducted by one of the authors (Gulland) in an introductory computer programming course. Three interactive online learning tools were developed for assisting students with control structures (FOR, WHILE and DO-WHILE loops). All students were subjected to a common face-to-face lecture, after which they were tested regarding their understanding of these concepts. The students were randomly divided into two groups, one group was given access to the interactive tools, and the other simply used their lecture notes. The group that used the tools scored 27% higher than the group

without, and the standard deviation was 21% lower. The student feedback included the following comments:

- “This would be VERY useful for each of the concepts that we learn in this unit. Not only does it explain the method behind the command but it gives the student the syntax, which is often what goes wrong in my programs (having a comma or whatever in the wrong place).”
- “It can be a good help, the last clip was very helpful and understandable, should use them in the lectures”
- “These little programs illustrate the concept well”
- “Easy to understand, useful”

### 2.2 Utilising authentic learning experiences

Learners can become independent contributors by gaining first-hand knowledge and experiences from real-world situations (Carver et al., 2004; Jansen et al., 2004; Stein et al., 2004). Often, students are being taught concepts and applications in either a classroom or an online environment, where they cannot directly relate to the practical application or experience in the real-world setting. Such learning experiences are not authentic.

Authentic learning activities are designed to give students a sense of reality, of how the concepts and skills being taught are actually being used and applied in a real-world situation. Authentic learning needs to link classroom practices to industry practises that go beyond the classroom. Students need to experience the real world context within their learning environment by carrying out learning tasks as close as possible to the real world (Jonassen et al., 1995; Chou, 2004). Such authenticity can be gained by exposing students to real-world situations via field trips and site visits, to practitioners who can relate their experiences and practices in a real-world application, to concepts and processes that resemble real-world scenarios, to working collaboratively on industry projects and problem-solving situations, etc.

Virtual environments contribute to all such activities, placing the learning activity in a real-world context, providing further explanation evoking student responses, and enabling student discussion from a deeper learning perspective. For example, Jansen et al. (2004) describes a virtual business e-learning environment where students adopt roles and perform tasks in a simulated “real” business setting. The goal is to bridge the gap between the learning and working environments.

## 3. IMPLEMENTING AUTHENTIC AND VIRTUAL LEARNING

Within the context of a number of learning projects, a range of online learning resources have been developed at Curtin University for programs of study in the spatial sciences. Many of these resources involve a high level of interaction with learners and aim to provide authentic learning activities. This section will outline some of them, including a virtual field trip for vegetation sampling, a virtual industry learning link involving interviews with practitioners in live real-world industry settings, and virtual assembly of industry-based GPS equipment.

### 3.1 Virtual field trips

Field trips and excursions are learning activities that expose the student to real-world settings. Students are able to visualise the environment, understand the relationships, utilise their

knowledge and skills in a real setting, interact with the environment, make “real” mistakes, and obtain responses and feedback to guide them in the correct direction.

One of the outcomes of the GIScience program at Curtin University is that students are able to perform spatial sampling. In addition to learning the principles and methods of sampling, students embark on an excursion to apply these principles and methods on, for instance, vegetation cover. In this example, students need to make decisions on how best to set up a sampling regime to cover the study area, to obtain the sample readings, to record the readings and to analyse them within a geographic information system (GIS) software package. The learning process is greatly enhanced by students viewing actual vegetation coverage, making decisions regarding sampling methods, observing the effects of their decisions, and working with the results obtained by their own efforts. The excursion helps students to more fully understand the concepts, take ownership of “live” data, and have a deeper understanding of the analysis process, knowing how the data relates to a real-world situation.

Such excursions, although very effective and crucial to the learning process, are often difficult if not impossible to organise and carry out. For example, the vegetation sampling activity is dependent on vegetation conditions, weather, etc., not to mention some of the organisational aspects including timetabling, transportation, liability and insurance risks. Inclement weather, the wrong season where vegetation coverage is inadequate, or timetabling clashes could constrain or prevent such an excursion from occurring, disrupting the entire learning program. In addition, such an activity is usually impossible for distance students.

The solution developed through the VOL project at Curtin University of Technology was to build a virtual field trip that provided a student with, as close as possible, the same experience by performing vegetation sampling via online and highly interactive learning activities (Veenendaal et al., 2002a). Figures 2 through 4 illustrate some screen shots of the vegetation sampling fieldwork module that was developed. Further information on the design and implementation of the virtual field trip is provided by Veenendaal and Corner (2001).

Some of the features of the virtual field trip learning resource involving a high degree of learner interaction include:

- a) Panoramic view of the study region linked to an interactive map (Figure 2). Students can pan through the study area and view panoramic photographs of vegetation cover and topography. They can navigate from either the 2D map or the panoramic image which are linked and synchronised (that is, each image reflects mouse movements made in the other). The virtual study area, within the Canning River Regional Park, is also the place where the real field trip is held.
- b) Choice of sampling methods and parameters (Figure 2). Students choose a site and set out the sampling frame utilising an appropriate sampling method of their choice (by determining origin, orientation, size, etc. of a sampling grid).
- c) Measurement and recording of samples (Figure 4). Students utilise an appropriate measurement scale to observe and record vegetation coverage for each

sampling unit. An interactive tool allows students to “practise” taking measurements and provides them with feedback regarding how well they fared. For example, in Figure 3, a green entry in the table of measurements indicates a correct value and red an incorrect one. When students have gained sufficient confidence in their ability to take measurements, they perform the “real” sampling. The results can then be recorded and uploaded via a spreadsheet directly into a GIS software package for analysis. In fact, since the results are obtained digitally, students performing the virtual sampling are spared the additional mundane effort of manually keying in the results onto computer.



Figure 2. Panoramic view linked to an interactive map



Figure 3. Choosing the sampling method and parameters

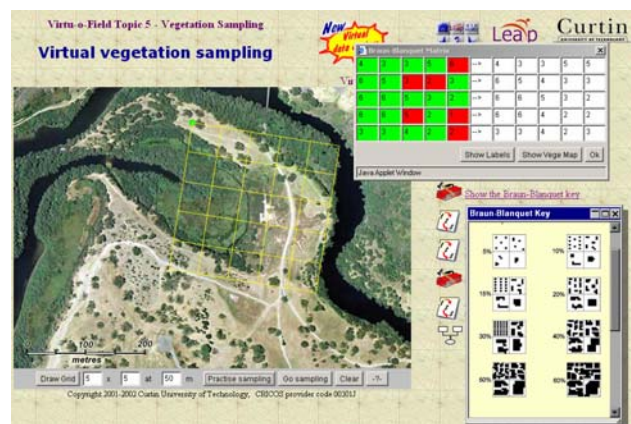


Figure 4. Feedback obtained from practise sampling

In fact, the virtual sampling field trip has additional benefits for the student. In addition to performing the sampling at any time and from any place, they can repeat the activity at a later stage if they so wish, and they can take as much time as is required to understand each step in the process without being constrained by the time limits imposed by an actual excursion. Further, the virtual field trip is used by on-campus students to prepare themselves for the actual excursion by orienting them to the study area and ensuring they understand the processes and procedures required to complete the vegetation sampling.

The students were evaluated on the basis of an assessment focussed on utilising the outcomes of the field trip. The same instructor, assessment and grading criteria were used across three years. In the first year, the virtual field trip was not yet utilised. In the second year, some components of the virtual field trip with some limited interaction were utilised. In the third year, the students were exposed to the full virtual field trip. The results are listed in Table 1. Note that the results include a combination of on-campus and distance students in the second and third years.

Year	Available to students	Student cohort	Assessment grade %	Change from Year 1
1	• No access to virtual field trip	40	60.6	--
2	Some virtual field trip components	43	64.6	6.6%
3	Complete virtual field trip	50	76.5	26.2%

Table 1. Results of virtual field trip implementation

There was a modest increase in assessment grades with the implementation of some components, but with the full implementation of the virtual field trip there was a substantial increase of 26.2% in grades compared to students who did not utilise it at all. Student comments included:

- *“for me, the virtual field trips were the only way to really understand and comprehend just what it takes to implement a complete GDA solution”*,
- *“It felt like I was there”* (from a distance student),
- *“...added a strong element of reality to the unit that is often forgotten in lectures. The virtual field trip was good preparation for the real field trip”*,
- *“it allows me to try and practice how to sample data of real world”*

Overall, student attitudes to field trips were very positive. Real trips were found to be more stimulating and virtual field trips were found to be more useful.

### 3.2 Virtual industry learning link

Students, toward the end of their study program, need to be prepared for a career in the real world of industry. Exposure to industry, perhaps by undertaking site visits or by listening to visiting lecturers from industry can be very helpful in this process. Both of these methods have been employed for many years and have been keenly sought after by students.

With the development of more flexible learning programs for both on-campus and distance students, new challenges have been presented to the educator. Students are often constrained to a specific time and place where the site visit or guest lecture is to be held. If they are unable to attend, which is most certainly the case for distance students, then they are not able to benefit from that particular learning activity. Even if present, they only have one chance to take in what is being said. Especially for site visits, students at the back of the group may not always follow what is being said, either because the speaker is somewhat soft-spoken or because of additional noise and interference in the on-site environment. A solution often utilised is to video the site tour or the visiting lecturer, and to stream it onto the Web for later access by learners. This is a very effective solution for making the learning activity accessible and reproducible beyond the constraints of the physical activity.

A further difficulty lies in the integration of such learning activities with the existing content and activities of the learning program. Adding the content of the visiting lectures into the study material can often appear as an add-on to the existing study materials and may not contextualise them well. Often, there are multiple learning outcomes that need to be addressed by site visits or guest lecturers, and they are then covered all at once when that activity takes place, rather than occurring at appropriate intervals within the study period as individual topics are covered and each learning outcome is achieved.

The GIS Management course within the Department of Spatial Sciences is a senior year unit delivered in both face-to-face and distance modes. There is a requirement in this course for students to understand and engage in business processes and procedures relevant to managing GIS projects. In the past, this course has relied on site visits and guest lecturers. However, the number of such activities needs to be minimised because of time and logistical constraints. Student feedback has indicated a greater desire to have more practical and real-life activities spread throughout the course, rather than focussing all on a limited number of such activities.

- “More examples of real-projects would be good. Examples from real-projects...”
- “...different case study each week would be better still, with different solutions to similar problems”

Curtin University has undertaken a novel approach to meeting this demand. Case studies from industry are embedded within the online learning resources. The case studies are presented in pop-up windows and are hyperlinked to appropriate locations in the e-learning resources (eg. study guide, work guide, etc.). The case studies are identified with an “industry interface” icon and include video clips, descriptions, examples, maps, images, documents, etc. as appropriate (Figure 5).

The videos are delivered by industry-based GIS practitioners and are recorded within the industrial workplace. Video footage including interviews and workplace scenes (and commentary) are segmented into short, easily-downloadable and manageable portions that are associated with particular learning topics and outcomes. These segments are then linked into the existing learning resources at contextualised and appropriate locations. Any supporting material, whether it be textual, graphic or other, are presented together with the video segment in the pop-up window.

The student, therefore, has access to the virtual industry link in the context of any supporting material, and at the point within the study program that is appropriate to that topic or discussion. The student is also able to progress through the e-learning resources in a flexible and self-paced manner, without being constrained by the time at which a physical site visit or guest lecture occurs. Further, because each individual “industry interface” is aligned to one specific topic or thought, and is contextualised, students are more focussed and can engage themselves more directly. The result is a deeper understanding and appreciation in working towards the learning outcomes.

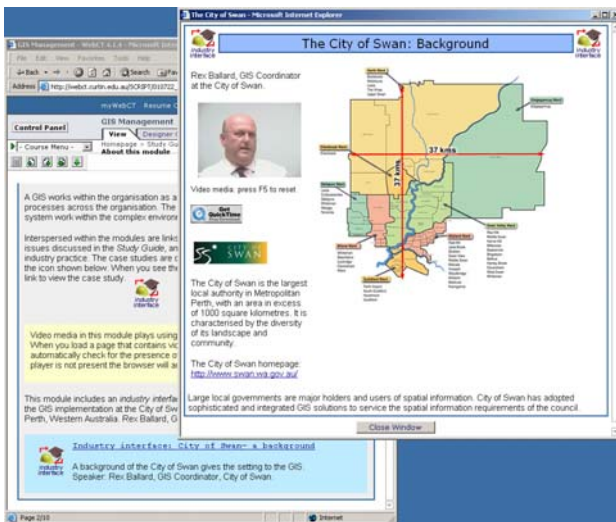


Figure 5. Let the practitioners give the real world view

A further benefit of this approach is that multiple industry links involving different organisations and case studies can be reached in a single study period, without encountering time constraints and logistical difficulties. This particular work, undertaken within the VILLE project, is ongoing. Although no formal evaluation results have yet been obtained, informal feedback suggests that students are very enthusiastic with the e-learning tools provided thus far, and that the video footage of the industry interviews and workplace add a sense of “realism” to their learning.

### 3.3 Virtual assembly of equipment

Frequently, students need to be familiar with equipment used in industry in order to get the maximum benefit from field trips and practical activities or applications. Usually such familiarisation takes place in a practical session with some hands-on experience preceded by a demonstration. Depending on the amount and availability of equipment as well as the duration of the practical session, students have a limited time to develop their knowledge and skills in using the equipment. Distance students don't even have this luxury. Further, there is the danger that learning how to set up equipment absorbs such a significant portion of a practical exercise that the underlying concepts and skills to be learned (for example, the use of the equipment in a field survey) are overlooked.

To overcome these problems, an interactive tool was developed to demonstrate how to assemble equipment for a GPS survey. On-campus students work with this tool in labs before operating the real equipment, leaving them with more time to understand how to assemble and operate the equipment. Distance students

also use the online tool to become familiar with equipment commonly-used by industry.

An example of such a tool is the virtual assembly of Trimble Geodetic GPS equipment. Figure 6 illustrates the interactive tool where students need to identify appropriate components, and assemble them in the correct order by using the mouse pointer to move the component to its appropriate location. Red crosses immediately indicate incorrect locations and/or sequencing of components in the assembly. Pop-up messages indicating the type of error appear when rolling the mouse over a cross, and extra helpful tips are displayed after several unsuccessful attempts. When a correct decision is made, the tool immediately moves on to the next step. If students really get stuck, they can obtain hints that point them in the right direction.

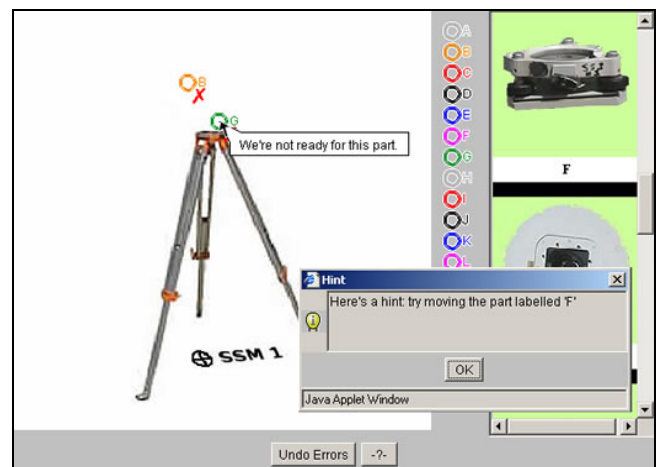


Figure 6. Virtual assembly of GPS equipment

The high interactivity engages the student directly in the activity of assembling equipment, and familiarises them with the individual components and order of assembly even before they ever touch the actual equipment itself.

Feedback from the instructors indicate that this particular e-learning resource saves up to 25% of valuable time in a 4-hour practical session. From the point of view of the tutors, there is less pressure on them, during the course of the practical session, to individually explain the assembly and operation process. In fact, they can focus more on the utility and application of the instrument which is directly related to the learning outcomes. Student feedback has indicated less frustration in seeking help from tutors and waiting for “their turn” when multiple groups of students simultaneously require attention.

## 4. CONCLUSIONS

An e-learning environment needs to extend beyond technical drivers to pedagogical and organisational dimensions that focus on the interaction between the learner and the learning environment. In fact, effective e-learning resources can not only be used to complement face-to-face education or replace the classroom for distance education, but can facilitate the integration of student interaction and real-world scenarios into the learning process. The use of highly interactive and virtual resources can support authentic learning where students can relate to and experience real world contexts in their learning.

A number of examples demonstrating the use of such virtual and authentic learning resources were outlined, in particular, a virtual field trip for vegetation sampling, a virtual industry learning link for introducing GIS management processes and decision-making via practitioners in industry, and the virtual assembly and handling of industry-based equipment.

By engaging with the knowledge, skills and real-world processes provided through the use of these highly interactive and virtual resources, students were able to gain a better understanding of the concepts, applications and relevance in relation to the real-world context. This was reflected in the student performance and feedback comments. They found their learning experiences to be useful and stimulating. The most effective tools tend to have a direct link to real-world applications. As interactive online tools allow students to proceed at their own pace, and repeat the process as necessary, more knowledge is gained from real-world applications that are preceded by use of related interactive tools.

The research and developments within the projects referred to in this paper are ongoing. For example, the authors are currently developing virtual and authentic learning resources for site visits or simulations involving processing plants, mining operations and geological processes.

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## 6. ACKNOWLEDGEMENTS

The authors would like to acknowledge the support and encouragement of colleagues who assisted in the design, development, implementation and evaluation of many of the learning resources referred to in this paper. In particular we are thankful for the invaluable contributions of Tony Snow, Graciela Metternicht, Robert Corner, Derek Lichti and Mike Stewart. This research was funded by the Learning Effective Alliance Program (LEAP), the Online Learning Development (OLLD) project and the Department of Spatial Sciences at Curtin University of Technology.

# VIRTUAL LANDSCAPES AND EXCURSIONS - INNOVATIVE TOOLS AS A MEANS OF TRAINING IN GEOGRAPHY

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**KEYWORDS:** interactive web-based e-learning, virtual excursion, animation and visualisation of landscapes, real geodata

## ABSTRACT:

In addition to real field trips and education virtual field trips are an excellent tool to convey scientific knowledge concerning geography. This paper describes the scientific, technical and didactical approaches of the web-based virtual excursion in the real world of a former mining area. Numerous interactive functions and knowledge tests support the students' thinking and learning in a 3D and 4D world. The developed tools are highly interdisciplinary and contain geoscientific as well as remote sensing, cartographic and GIS knowledge. Multiple use, integration in widespread types of lectures, and self learning are possible and necessary. The procedure is an example of innovative knowledge transfer from theoretical topics to real landscape processes.

Qualified staff are needed to create and improve such virtual excursions and for supervision of students. The long-term sustainability of web-based teaching tools remains a challenge.

## 1. INTRODUCTION

In the last few years there a heavily increase and importance of well designed of importance of web-based e-learning tools in remote sensing, GIS, geomorphology ([www.geoinformation.net](http://www.geoinformation.net), URL 1, [www.gisteam.de](http://www.gisteam.de), URL 2). Often the existing teaching material has been completely transformed to the web and includes the full content of this lesson. In some cases there is a huge number of screen text pages or poorly designed interactivity. From the special view point in geography we realise that the teaching material used for study lessons is mostly with separated image examples and is not related to a specific landscape. One of the most important and most difficult stepping stones in geosciences education is the understanding of landscape processes on different spatial and temporal scales. Field excursions are very useful and essential, but also cost money and are time consuming in education in geography. It is well known that students get a higher input through learning activities in real world applications and situations. For this reason there exist concepts for the combination of web-based multimedia e-learning tools and field-trip experiences in real landscapes using the virtual excursion method. The basic concept was developed by Gläßer and Thürkow (2004) for the highly dynamic coastal zone area "Darß" at the Baltic Sea within the project WEBGEO ([www.webgeo.de](http://www.webgeo.de), URL 3, Goßmann et al. 2003) and is used by members of the webgeo-network for other landscapes too.

## 2. OBJECTIVES

The good experiences with the developed techniques of virtual excursion in e-learning tools form the basis for the project Geovlex-geovisualisation, virtual excursion and virtual landscapes ([www.geovlex.de](http://www.geovlex.de), URL 4). The transformations of concepts, together with associated tools structures from the coastal zone area offers brand recognition. In contrast to the natural landscape of coastal zone areas with large nature protected areas and intense coastal processes, the new test site is a complete anthropogenic landscape, strongly influenced by heavy active mining and reclamation activities.

Using a very good scientific data base, visualization of historical and future processes is based on 4D realtime applications, networking of modules, applications, objects, and geoscientific themes

## 3. SCIENTIFIC, TECHNICAL AND DIDACTICAL APPROACHES

### 3.1 Scientific Approach

The test site is the abandoned lignite mining area "Goitzsche" near Bitterfeld, Central Germany. The strongly anthropogenic influenced area is close to the university and easy accessible during field trips. The selection of the area is appropriate for the following reasons:

- ✓ A highly dynamic area due to reclamation activities and natural processes;
- ✓ Very well suited for demonstration of anthropogenic determined landscape with different goals for the future (nature protection, tourism, fishery...);
- ✓ Large amounts of geoscientific data acquired by our own research projects;
- ✓ Very good data base of multi- and hyperspectral airborne scanner data;
- ✓ High resolution laser scanner terrain model exists.

The main goal is the better understanding of natural and man-made features of landscapes and their development over time and space as a part of a particular ecosystem based on real geospatial databases and (WEB) GIS-methods concerning a real landscape. Figure 1 shows the geoscientific content and the geoscientific methods for the 3D and 4D visualizations and animations. The design and programming of web-based teaching and learning tools to convey scientific knowledge in geography is realised within the virtual excursion in a real landscape (Fig. 1). The numerous interactive functions and examinations support the student's three-dimensional understanding and learning by doing. Visualization of three-dimensional topics (using real x, y, z-coordinates in virtual landscape models from the field trip area and visualization of four-dimensional processes for spatial analysis based on GIS animations ) increases the understanding and the motivation of the users enormously.

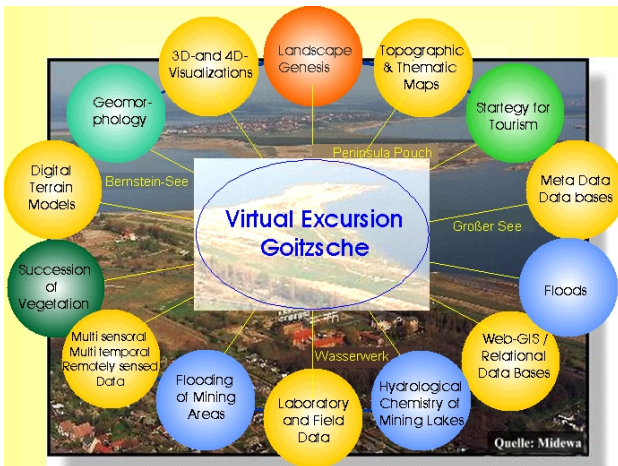


Figure 1: Interdisciplinary Themes in the Virtual Field Trip Goitzsche-Bitterfeld

The virtual excursion can be employed with various choices:

- ✓ Guided tour of all excursion points with general information on each subject;
- ✓ Guided tour to:
  - Succession processes in the mining area;
  - Hydrochemical and and hydrobiological properties and development of the residual lakes during the flooding process;
  - Exteme flood in August 2002 of the Elbe and Mulde rivers and there influence on the mining area;
  - Touristic routes at the present and for the future ( Fig. 2, 7);
- ✓ Free selection of the tour points or particular modules.

All tours were supplemented with interactive usable maps, multitemporal multispectral and hyperspectral remote sensing data, high resolution digital laser scanner model (Fig. 3,7,8) and analytical data from field work. Basic digital image processing of remote sensing data is integrated for the specific contents of the excursion goals. So there is a link between the geoscientific and the different spatial models as well as methods of spatial analytical methods in a landscape and all components complement one another. These new concept guarantees a real interdisciplinary education.



Figure 2: Start Site – Virtual Field Trip Portal (URL 5)

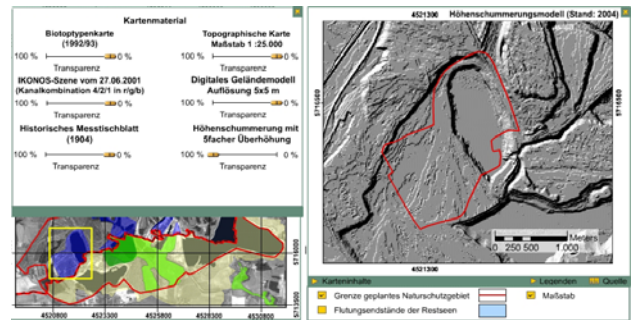


Figure 3: GIS based Field Trip Material with High Interactivity (URL 6)

### 3.2. Technical Approach

The web information system is based on freely available up to date open source software and GIS products for a global use. The GIS-Product ArcGIS and image classification program, Erdas/Imagine and Envi are used to process the basic spatial raster and vector data of the field trip areas. Landscape models and real time applications are based on the software products World Construction Set and Virtual Nature Studio. No commercial learner platform is used in the project. To enhance the success of learning by doing, we programmed our own learning environment based on the open source data base MySQL in use with PHP and the Apache Webserver. Figure 4 shows the networking of the programmed database applications to manage glossary entries, spatial maps and data, metadata, photos, animations, videos, learning modules, virtual field trip navigation, and so on as a learning environment.

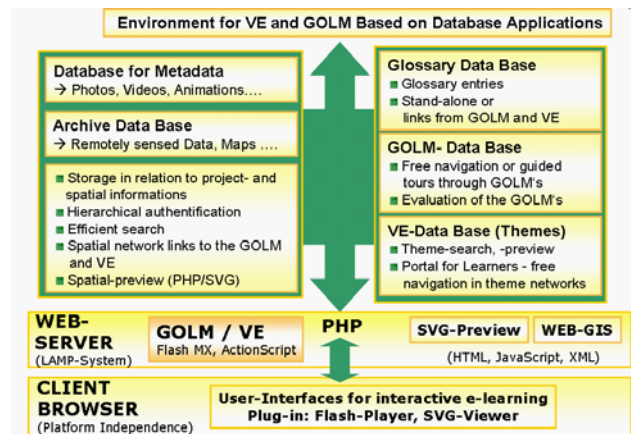


Figure 4: Environment for Virtual Field Trip and GOLF based on Database Applications

### 3.3 Didactical approach

The developed tools belong to the “Blended Learning Model“. One should be wart that the personal and financial efforts for realisation of the subjects and instruction into the virtual environments and the programming of animations and interactions are often seriously underestimated. A multiple use and integration of the tools in widespread types of lectures, seminars or other courses is essential. One can than reduce extensive text pages on the screen and low animated figures.

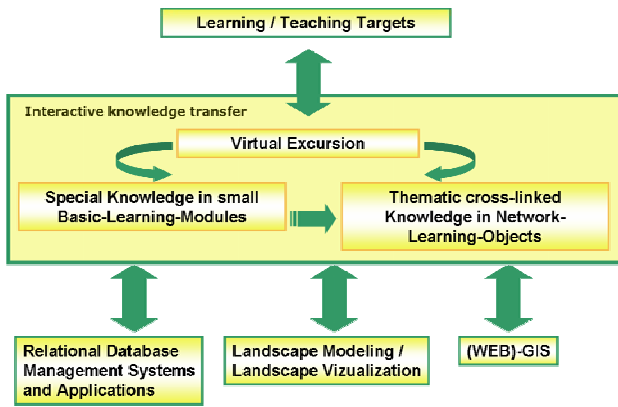


Figure 5: Basic Concept of Interactive Knowledge Transfer

All contents of education are summarized to modules, we call geovlex-online-learning module (GOLM). Each GOLM contains basic knowledges, welcome pages, content pages, exercises and final pages (Fig. 6).

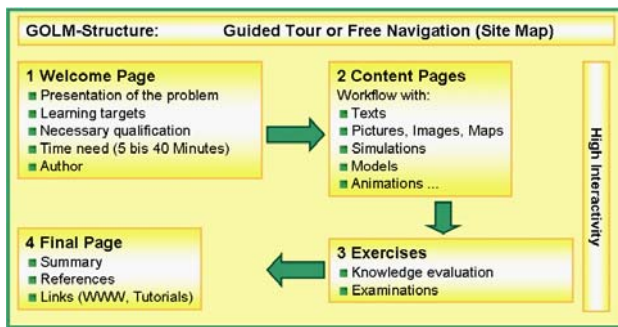


Figure 6: Structure and Content of the Geovlex-Online-Learning - Module (GOLM)

A prerequisite for successful use of the system is an intensive study of literature for the basic theoretical background. Each GOLM contains the condition for use and references. In addition a glossary explains essential terms. A large variety of self - evaluation tools and tests, like drag and drop, multiple choice, fill in given text using the interactivity and animation, enable the self-pacing of learners as well as the supervision by teacher (Braun et al., 2003).



Figure 7: Interactive Map for Tourism and Tourism Concepts in the Goitzsche Area (URL 7, Kratsch 2005)

The modules can be used for enhancement of theoretical knowledge based on facts for teachers and learners in Earth

sciences education. They are applicable in face-to-face-learning as well as for distant online learning:

- ✓ Integration in lectures, seminars or other courses by teachers;
- ✓ Multiple use in preparation and wrap-up of field trips and lectures;
- ✓ High flexibility and individuality depending on pre-existing user knowledge;
- ✓ Improved individual navigation and selection of GOLMs by use of modular structure,

All modules are characterized by high interactivity and integration of numerous animations and the implementation from a large variety of interactive and interdisciplinary exercises and tests (Fig. 5, 8).

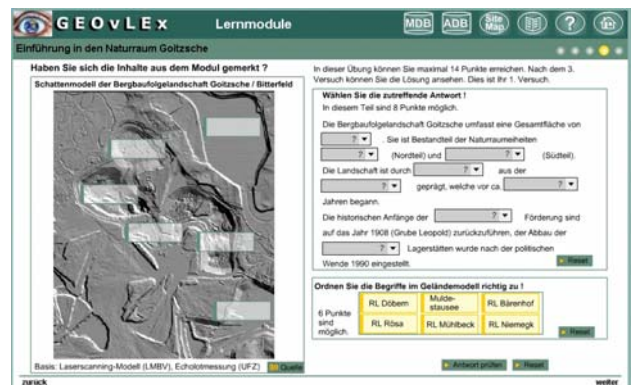


Figure 8: Interactive Test in the Landscape Environment (URL 8)

#### 4. CONCLUSIONS

Virtual landscapes are innovative tools for geoscientific education and interdisciplinary knowledge transfer from theoretical topics to a real landscape. Design of virtual landscapes requires complex knowledge of geoscientific processes and data processing techniques, applied informatics, digital cartography, geographic information system, image processing, and science of cognition.

The realization of the virtual excursion is an effective way for interdisciplinary knowledge transfer from geoscientific topics of a real landscape to contextualize with basics of remote sensing, cartography and GIS and enables trans-sectoral teaching and learning. More over promotes the use of IT systems and GIS systems. The high degree of interactivity using real geo data in a virtual environment and the 4D real-time application improve the students' understanding of historical and future processes. The modular structured tools are developed as "Blended-Learning-Scenarios" for various lectures, not only in geography. A multiple use of modules, applications and objects can be included in other courses of study like multimedia, landscape planning, and geobotany. Moreover the integration of the tools in education in higher classes in schools, for long term study for teachers themselves and environmental communication and education, is both possible and necessary. The virtual excursion "Darß" is now implemented in the environmental education center "Darßer Arche" ([www.darsser.arche.de](http://www.darsser.arche.de)), plans for the region "Goitzsche" will be similarly implemented

There exists a large variety of new solutions in e-learning and e-teaching; we are at the beginning of this development, which requires intensive and multidisciplinary research for technical realisation, and new didactical concepts (Lindau, 2004). Often

underestimated is the personal expense for the permanent evaluation of modules, supervision of students and actualisation of the data used. The rapid technical development of multimedia software products requires a continuing updating of existing tools. If we are not able to manage this process, we will convert the positive effect of modern e-learning and e-teaching tools into negative experiences. To set the technical and personal requirements for this development is an unsolved problem in many universities. The long term learning is a challenge for the future and for which we have to develop excellent concepts.

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URL2: <http://www.gisteam.de/support/tutorial/>, GIS-Team, Ingenieurbüro für Geoinformatik

URL3: <http://www.webgeo.de>, Webbing von Geoprozessen für die Grundausbildung Physische Geographie, Univ. Freiburg et al.

URL 4: <http://www.geovlex.de>, Webbasierte Geovisualisierungen, virtuelle Landschaften und Exkursionen, Uni. Halle

URL 5: [http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r\\_003;1](http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r_003;1)

URL 6: [http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r\\_007;2](http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r_007;2)

URL 7: [http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r\\_005;4](http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r_005;4)

URL 8: [http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r\\_004;4](http://mars.geographie.uni-halle.de/geovlex/module/rahmen.php?string=1;r_004;4)

## 6. ACKNOWLEDGEMENTS

The project is funded by the multimedia program of Saxony-Anhalt and in addition by the EU- EFRE- fund. We thank our partners from the webgeo-network for cooperation.

## DEVELOPMENT OF AN EDUCATIONAL SOFTWARE SYSTEM FOR THE DIGITAL MONOPLOTTING

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Commission VI, WG VI/1 – VI/2

**KEY WORDS:** E-Learning, Educational Software, Photogrammetry, Digital Monoplotting

### ABSTRACT:

This paper presents a user-friendly Windows-based educational software system for explanation and demonstration of the procedure of digital monoplotting. The software system named Digital Monoplotting Teaching Program (DiMoTeP) is primarily designed to be used by teaching personnel in lectures to bring over this particular topic of photogrammetry to master students in an attractive way. The program consists of two parts: an HTML-based animated tutorial presenting the theoretical background of the method and a practical part demonstrating the procedure with the real data. The theoretical part of the program is a web-based tutorial covering explanation of the topic, i.e. definition and background of monoplotting, required data, methods used in the process and application areas. The demonstration tool is a Windows® software implemented in C/C++ programming language that performs the basic functions of the procedure, i.e. import the DTM and image data, recording the point or line features as well as visualization. The students' feedback showed that the overall structure provides an easy and didactic tool for teaching.

### 1. INTRODUCTION

Learning and teaching by means of modern digital tools is of growing interest in the geomatics community. In the past few years, diverse e-learning environments such as

- <http://www.fpk.tu-berlin.de/wbt/fernerkundung/>: Introduction to Remote Sensing of TU Berlin,
- [http://www.ipi.uni-hannover.de/elan/index\\_main.htm](http://www.ipi.uni-hannover.de/elan/index_main.htm): Course on integrated sensor orientation of Hannover University,
- <http://www.fzg.uni-vechta.de/airlaser/>: Tutorial on airborne laser scanning by University Osnabrück,
- <http://learning.intermaptechnologies.com/>: Tutorial for interferometric SAR by Intermap,
- <http://www.geoinformation.net/>: Multimedia environment for various geomatics topics by several German high schools,
- <http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/RS-fun/>: Introduction to Remote Sensing by Tokai University,
- <http://www.gitta.info/>: Geographic Information Technology Training Alliance, a program of Swiss Virtual Campus

and some others have been set up. These tools are mostly designed as extensive interactive environments to be used for a self-study in addition to traditional geomatics courses. The software presented in this paper follows a different goal. We aimed at developing a *demonstration tool*, which could be used by teaching personnel to explain particular topics of digital photogrammetry in a comprehensive and attractive way. In this paper we show the first results dealing with one of the procedures of the single image photogrammetry, the digital

monoplotting. We plan to extend this work to other topics (model orientation, bundle adjustment, DTM generation etc.) that would represent modules of an “educational digital photogrammetric workstation” focused on the demonstration with real data.

Similar efforts have been presented in Coelho (2004). In this work a comprehensive tool, called E-FOTO, which covers most of the basic steps of the photogrammetric workflow, is given. The tool is basically developed for “self-teaching”, which means that the target user group are the students rather than the teaching personnel. Perez-Garcia et al. (2004) have presented two software applications for demonstration of the Hough transformation. Although the tool is designed to assist the educators, there is no explanation material provided in order to teach the theory of the topic.

The project presented in this paper was conducted as a diploma thesis of the first author (Fluehler, 2004) supervised by the second and third authors. As it was the first work of this kind at our chair, all the procedures were developed “from the scratch”. The total time available for the literature study, software development, thesis writing and its presentation were 4 months. The result is an easy-to-use Windows-based tool (Figure 1) including the explanation of the method, demonstration using the real data and the software documentation. It is a freeware that can be downloaded from the webpage of the Chair of Photogrammetry and Remote Sensing of the Institute of Geodesy and Photogrammetry, ETH Zurich: <http://www.photogrammetry.ethz.ch/research/student/monoplott ing.html>.

The data comes as an integrated part of the installation file. We use a data set of Ayers Rock in Australia, as this is an impressive object with distinct height differences suitable for

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the purpose of our project. For the demonstration of the digital monoplotting we include an aerial image, an orthoimage and the digital elevation model (DEM). The original resolution of both image files as well as of the DEM was significantly reduced in order to fasten the processing time.

The tool has already been used for a lecture within the post-graduate course at our Institute (next lectures are planned for the running semester). The participants of this course have

various background and mostly do not come from the field of geomatics. Their reactions were overall positive. It was much easier for them to understand this particular photogrammetric topic as the whole procedure was not only theoretically explained but also practically demonstrated. In Section 2 of this paper we describe both the explanation and demonstration tool in detail, followed by the conclusions in Section 3.

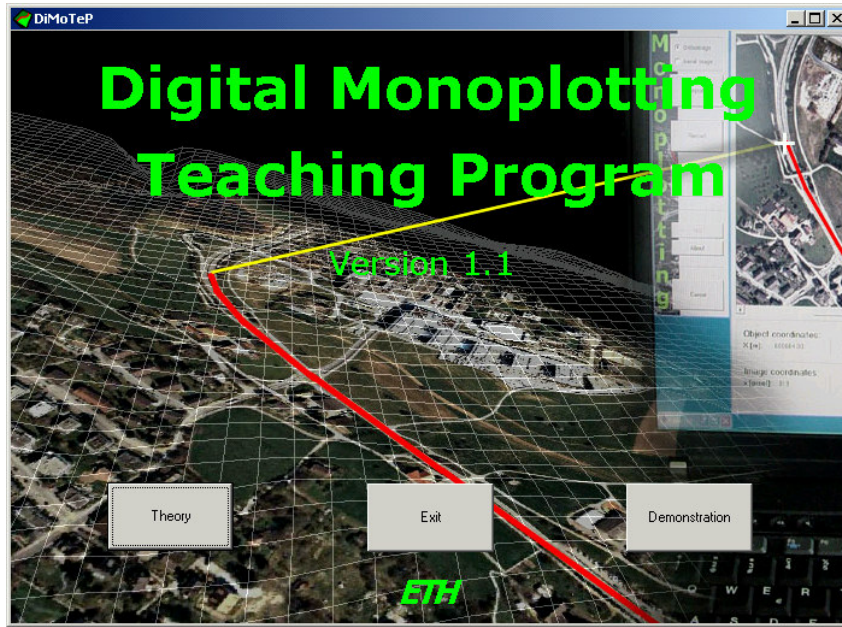


Figure 1. Digital Monoplotting Teaching Program (DiMoTeP).

## 2. DIGITAL MONO PLOTTING

### 2.1 The Explanation Tool

Monoplotting is a procedure of single image photogrammetry for obtaining real-time 3D coordinates from the measurements in image space (Figure 2). The required datasets are a Digital Terrain Model (DTM) and an aerial image with its orientation parameters or a geo-referenced orthoimage respectively. The relevant image features are interactively digitized in the original or orthorectified image. Due to the underlying DTM the 3D coordinates of these features can be computed in real time.

The explanation tool is a web-based tutorial, which is prepared as hyperlinked HTML pages. It has been optimized for Internet Explorer and Netscape Navigator with the resolution of 1024 x 768 pixels. It covers all of the necessary explanation aspects of the topic under the two main titles:

1. Required Data
  - DTM
  - Aerial Image
  - Orthoimage
2. Monoplotting
  - Background
  - Methods
  - Applications

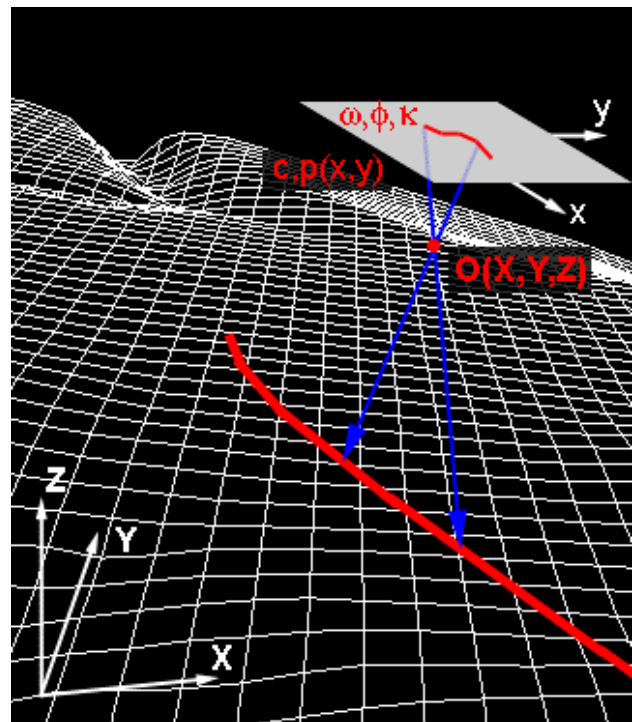


Figure 2. The principle of monoplotting.

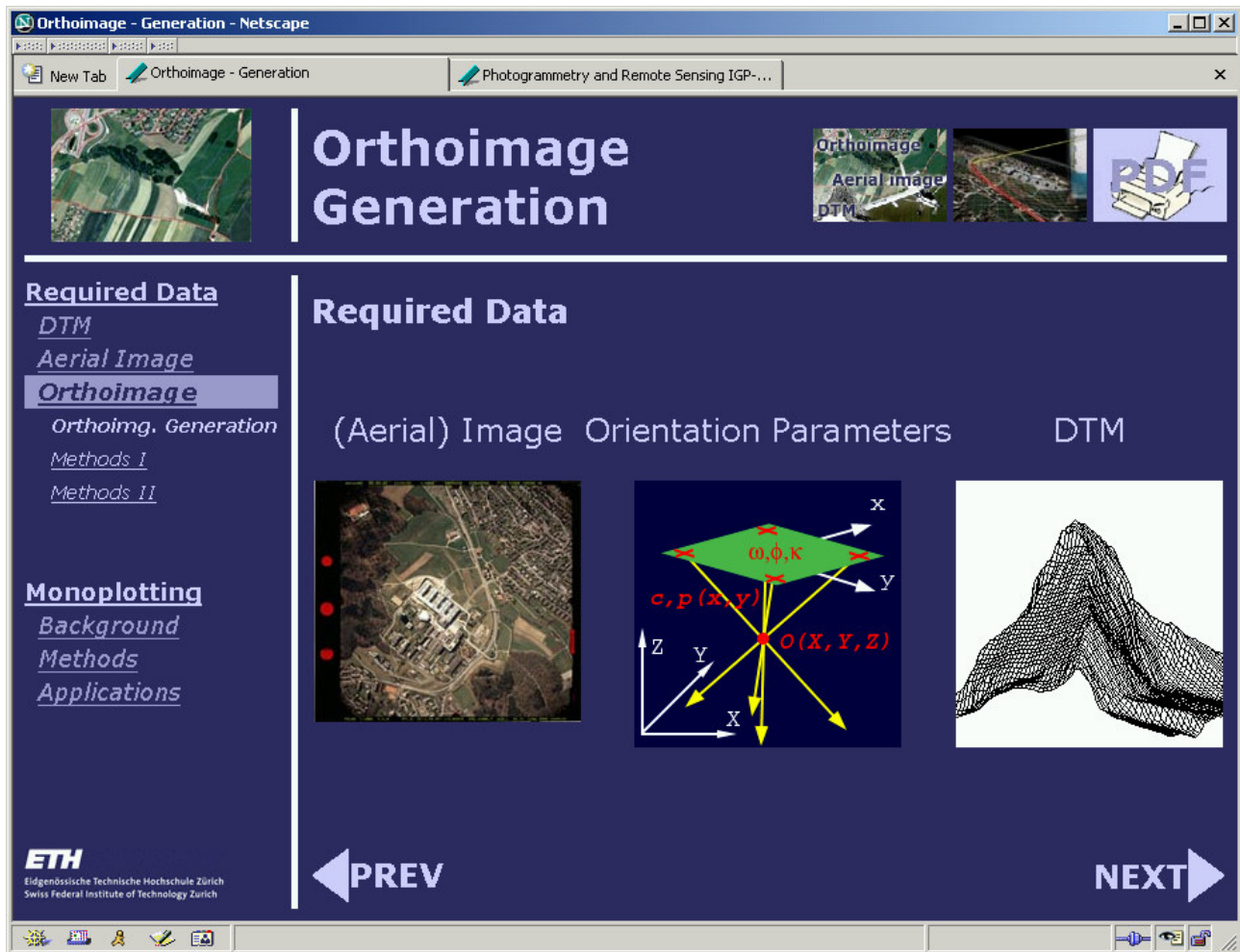


Figure 3. The explanation tool.

### Required Data

Two kinds of data are needed for the monoplotting procedure: a DTM and an overlaying image with its orientation parameters or optionally an orthorectified image. This DiMoTeP part gives an overview information about the input data.

The text content is enhanced by informative images and animations. Particular topics are covered in detail, e.g. DTM file formats, interior and exterior orientation of aerial images, difference between the aerial and orthoimage, and orthoimage generation (Figure 3).

### Monoplotting

This software part starts with the background of the monoplotting procedure and ends up with the possible application areas. The processing methods and implementation aspects are explained in detail.

In case that an orthoimage is available for monoplotting, the procedure is straightforward. The X and Y coordinate values in the object space can be directly derived from the point measurements in the georeferenced orthoimage. In the subsequent step the Z coordinate is interpolated from the underlying DTM for the given XY coordinate pair.

When the image is given in a raw (aerial or terrestrial) form without being resampled to a map projection, an iterative monoplotting procedure is applied. After measurement of image coordinates  $x, y$ , the  $X, Y$  and  $Z$  coordinate values are derived by intersecting the image ray with the DTM. The relation between the image and object space is established via collinearity equations (Figure 4). Starting from maximum elevation ( $Z_0$ ) of the DTM, the backprojected position ( $X_1, Y_1$ ) is calculated. Using this position value, a new elevation value ( $Z_1$ ) is interpolated from the DTM. In the next step a new backprojected position ( $X_2, Y_2$ ) is computed using the latest elevation value, and so on. The iterations are done until the change of coordinate values are negligible. This procedure is called single-ray backprojection (Mikhail et al., 2001).

### 2.2 The Demonstration Tool

The demonstration tool is a Windows® software implemented in C/C++ programming language using C++ Builder™ 5 as the Integrated Development Environment (IDE). When the user clicks the “Demonstration” button in the main menu (Figure 1), the window of the demonstration software is called (leftmost menu in Figure 5). It performs the basic functions of the procedure, i.e. importing the DTM and image data, digitizing the point or line features as well as visualization.

**Orthoimage/Aerial Image**

**Required Data**  
[DTM](#)  
[Aerial Image](#)  
[Orthoimage](#)

**Monoplotting**  
[Background](#)  
**Methods**  
[Principle](#)  
[Orthoimage/Aerial I.](#)  
[Applications](#)

**Orthoimage**  
 $X, Y$ : orthoimage  
 $Z$ : interpolated from DTM

**Aerial Image**  
 $X, Y, Z$ : intersection of image ray with DTM  
 Image space to object space by collinearity equation

**Diagrams:**  
 - **orthoimage:** Shows a horizontal line representing the image plane with points  $p1'$  and  $p2'$ . Below it is a green wavy line representing the DTM with points  $p1$  and  $p2$ . Vertical red lines connect  $p1'$  to  $p1$  and  $p2'$  to  $p2$ .  
 - **aerial image:** Shows a perspective view of the image plane at height  $Z_0$  with points  $p1'$  and  $p2'$ . Below it is the DTM with points  $p1$  and  $p2$ . Red lines represent the image rays from the image plane through the DTM to the ground points. The ground coordinates are labeled  $X_n, Y_n, Z_n$ .

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Figure 4. Single-ray backprojection.

**DiMoTeP - Import Aerial Image**

**Aerial Image**  
 Aerial Image [.jpg]: aerial\_image.jpg  
 DTM (Raster Grid): DTM Import

**Interior Orientation**  
 Camera Constant [mm]: c: 152.023  
 Image Focal Point [mm]: x: 0.00, y: 0.00

**Fiducial Marks [mm]:**

	x	y
1:	0.000	111.378
2:	111.351	0.000
3:	0.000	-111.378
4:	-111.351	0.000

Marks in corner

**Exterior Orientation**  
 Position [m]: X: 5438.54, Y: 6910.84, Z: 6024.48  
 Rotations:  rad  deg  gon  
 $\omega$ : -0.0227765,  $\phi$ : 0.0107757,  $\kappa$ : -0.3169867

**DiMoTeP - Fiducial Measurement**

**Residuals of Fiducial Marks [microns]:**

	x	y
1:	9	205
2:	-9	-206
3:	9	207
4:	-9	-206

$\sigma(0)$ : 292

Figure 5. Interior orientation of the aerial images.

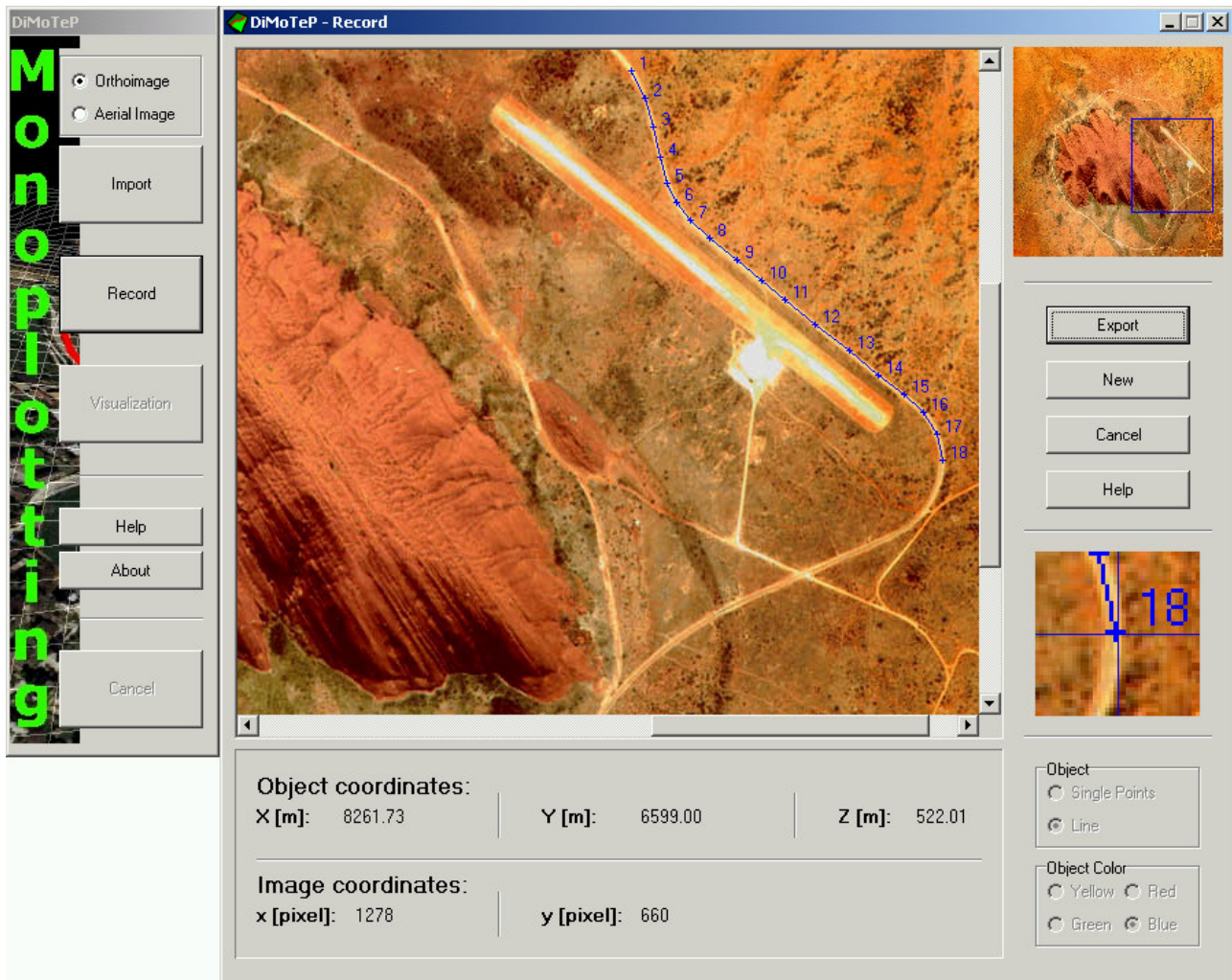


Figure 6. The record module allows digitizing the point and line features.

The first step of the workflow is the import module. It accepts the DTM data in Arc ASCII Raster format (ESRI DTM definition consisting of a header and elevation values). The image files are accepted in JPG format. When the orthoimage is used, JPG file must come with a complementary JGW file, which contains the georeferencing information, i.e. ground resolution of a pixel along the X and Y directions, rotation angles along the X and Y axes, and X and Y object coordinates of the midpoint of the upper-left pixel.

When the aerial image is used instead of the orthoimage, interior and exterior orientation parameters of the image must be known in advance. These parameters are set to the program. Then, the interior orientation is performed in order to establish the geometric relation between the pixel coordinate system and image coordinate system (Figure 5).

In the record modus, single points or lines can be measured in the image while the 3D object coordinates are displayed in real time. User can select appropriate color for the drawings (Figure 6). Three windows (overview, main and magnifier windows) in different zoom levels allow roaming inside the image quickly.

The DTM with the image data as well as the measured features can be exported in VRML format for the visualization (Figure

7). Elevation values can be exaggerated by a user-defined factor for better visualization. In case of using an aerial image, a corresponding orthoimage is calculated for the overlay with the DTM. The VRML file can be visualized by Internet Explorer, Netscape Navigator or another web browser with an appropriate VRML viewer plug-in, or by a 3D modeling and visualization software, e.g. Geomagic Studio or Deep Exploration.

In any step of the procedure user can access the help file by simply clicking the Help button.

### 3. CONCLUSIONS

In this paper we have shown a user friendly system for the demonstration of the digital monoplotting. Although the software only covers a very small part of photogrammetric procedures, another topics can be implemented in a similar way. As our main focus was the demonstration by teaching personnel, the program contains only fundamental textual information. To support the self-study as well, more detailed explanations would be of advantage.

The used programming environment (C++ Builder™ 5 as IDE) proved to be a suitable tool for the straightforward development

of educational software. The programming as well as the generation of a graphical interface can be done in a user-friendly way. Based on a solid knowledge of the object oriented programming the given task could be fulfilled in time, even though the developer was not yet familiar with this programming environment.

The presented software DiMoTeP was awarded by a silver medal of a CATCON 2004 contest during the XXth ISPRS Congress in Istanbul (Computer Assisted Teaching CONtest, <http://www.isprs.org/catcon/index.htm>). The software is free of charge and can be downloaded from the web page <http://www.photogrammetry.ethz.ch/research/student/monoplott ing.html>.

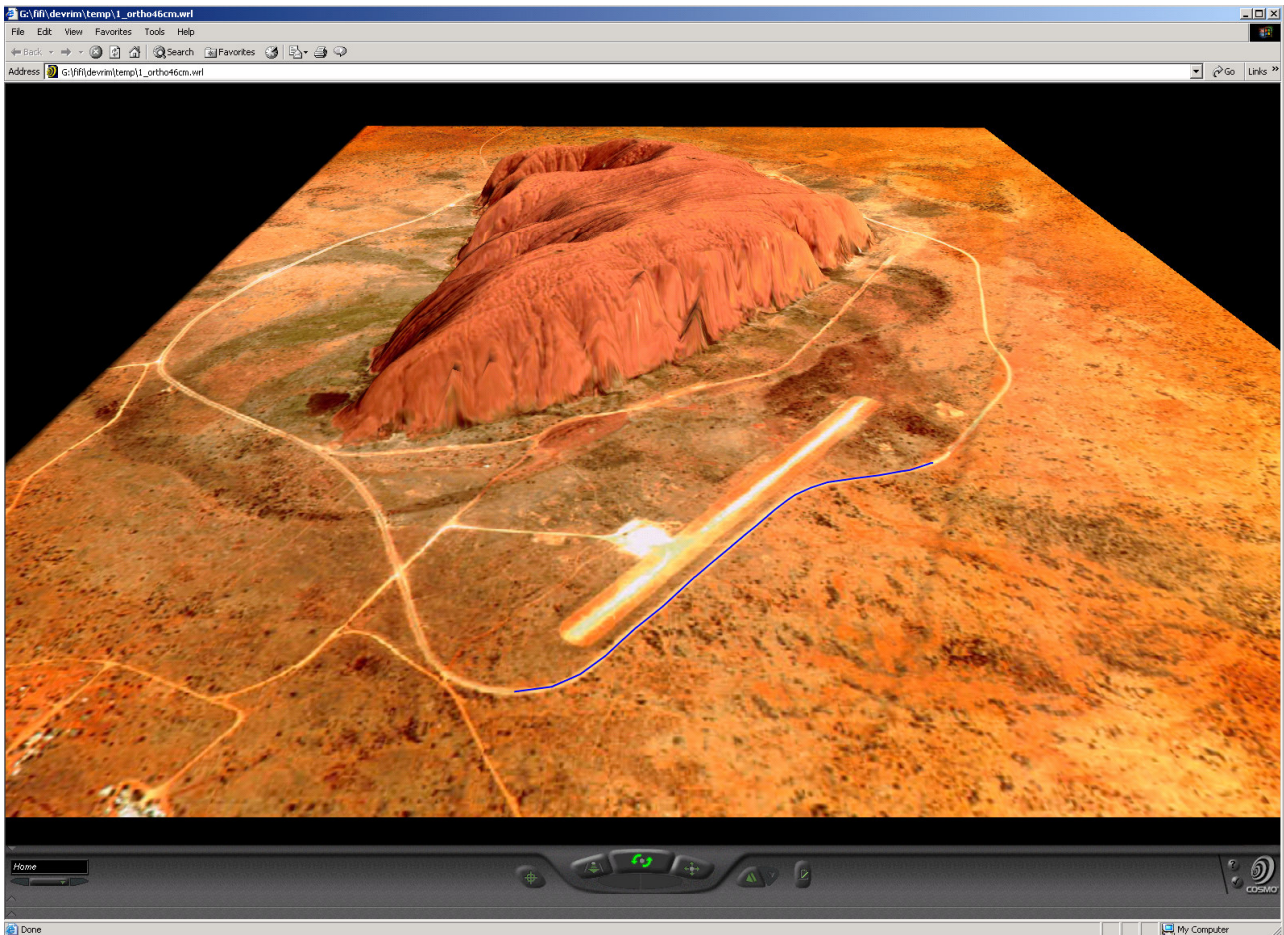


Figure 7. Visualization of the model in VRML format.

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# APPLYING TRANSFER IN GOAL-BASED INTERDISCIPLINARY LEARNING ENVIRONMENTS

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**KEY WORDS:** Case-based Reasoning, Goal-based Scenarios, Learning by Design, Interdisciplinary Teaching, Blended Learning

## ABSTRACT:

Case- and problem based learning environments support learners both, in the active process of self-directed learning as well as in the consolidation of new knowledge. Especially case-based learning fosters the usage of transfer by providing appropriate stimuli to recall previous knowledge. The present contribution discusses the suitability of instructional design principles as suggested by the Goal-based Scenario approach by Roger Schank and the Learning-By-Design<sup>TM</sup> approach by Janet Kolodner to develop blended-learning modules in the context of a new interdisciplinary Master curriculum (*Master of Mind and Brain Sciences*) at Potsdam University. From this perspective, the potential of case-based reasoning and collaborative reflection will be evaluated.

## 1. THE PROBLEM OF INERT KNOWLEDGE

It is widely acknowledged in the present, constructivist community of the learning sciences that the acquisition of knowledge and skills can successfully evolve when it is embedded in learning environments that motivate learners to actively engage with problem-solving.

Yet, as measurements of results in problem-based learning environments demonstrated, learners that are good at solving real-world problems often have difficulties to reflect on their experiences and fail to transfer what they have learned to new tasks.

Already Salomon & Perkins (1989) have called attention to this fact with the telling formulation "rocky roads to transfer". Thus, one of the main goals of new approaches to constructivist learning is to address the classical problems of knowledge-transfer with the help of *Goal Based Scenarios*, orchestrated learning rituals and hands-on practice.

Since the beginning of the 1990s the former AI-theoretician Roger Schank at the Institute for Learning Sciences (ILS), Northwestern University has been advocating the application of *Goal Based Scenarios*, in the following abbreviated as GBS (Schank, Berman, & Macpherson, 1999). In the context of his company CognitiveArts, real-world as well as computer based learning environments, designed according to the GBS pattern, have been developed for business administration and other purposes.

Schank criticizes that a lot of traditional learning procedures rarely support the transfer of newly acquired knowledge to vocational situations and do not foster the intrinsic motivation of learners. On the basis of his former approaches to knowledge representation, Schank developed an alternative instruction method: *learning by doing*. This approach centers on the acquisition of skills (procedural knowledge) and relevant content related knowledge that is necessary to reach a certain goal in a GBS.

According to Zumbach (2002) this process of learning is hardly ever linear, which means that for a certain problem the best strategy is not always found at once. If one fails by making a wrong decision, even this realization contributes to the process of learning, because wrong or ineffective actions can be avoided in future situations. Nevertheless, the information that can be derived from such failed expectations has to be memorized in such a way that it can be used in similar future situations. In the terminology of case-based reasoning, this means that experiences have to be correctly indexed in a case library.

Intrinsic motivation can be effectively sustained by activating learners with self-set goals in a certain task-scenario. With that, learners pay more attention to relevant knowledge than in a traditional exam.

The *Learning by Design*<sup>TM</sup> approach (LBD<sup>TM</sup>), developed by Janet Kolodner et al., is based on the same principles of case based reasoning (CBR) derived from cognitive theories of memory, Artificial Intelligence and analogical learning. With the support of several software tools, this approach tries to undergird learning-transfer by hands-on design and exploration activities that are augmented by several stages of reflection.

In order to administer the interdisciplinary teaching practice in Cognitive Science at Potsdam University in a more coherent way, we have decided to evaluate the suitability of the Goal-based Scenario approach and LBD<sup>TM</sup> for a forthcoming Master-Curriculum.

## 2. CASE-BASED LEARNING

### 2.1. Theoretical sources: Case-based and analogical Reasoning

#### 2.1.1. What is transfer?

Transfer can be defined as the capability to reuse knowledge and skills in a context that differs from the one in which they

have been acquired. We speak of *near transfer* when the features of the new context differ only slightly from the original learning situation. *Far transfer* on the other hand, is necessary when a learner has to use his/her prior knowledge in a completely unusual and unpractised situation.

The ability to gradually transfer knowledge and skills from the academic context to applied and professional scenarios is one of the most important goals of higher education (cf. Zimmermann, 2000). Teaching students this key competence is time consuming and does not develop automatically. The *Learning by Design<sup>TM</sup>*–approach takes up the two theoretical concepts of case-based and analogical reasoning, in order foster the aptitude of knowledge-transfer.

### 2.1.2. Case-based reasoning as a Strategy for Artificial Intelligence (AI)

Case-based Learning was inspired by AI-programs of case-based reasoning (CBR). CBR-Expert systems, such as MEDIATOR, JULIA or IMPROVISOR learn on the basis of single case-examples that are actively encoded in regard to possible, future scenarios. Errors in the application of an older case lead to a recoding, re-evaluation and interpretation of that case (cf. Kolodner, 1993). Janet Kolodner and colleagues extracted a number of principles of optimization and terminologies (case library, case indexes, case processor) to interpret and advance human learning processes. A central point of the philosophy of learning that derived from that is to confront learners with diverse contexts of usage: "...one cannot always fully interpret one's experiences well and extract the lessons learned and their applicability at the time they are experienced – because one is missing information about the situation or because one does not know enough yet. We can get around the deficiency with an iterative cycle in which a learner has multiple opportunities to revisit old experiences, attempting to apply them in a variety of situations, and each time, refining its interpretation of them based on new explanations it can derive." (Kolodner, Gray, & Frasse, 2003, p. 194).

### 2.1.3. Analogical Reasoning as a cognitive Process in human Learning

It has been proven in cognitive psychological theories of analogical reasoning that learning-transfer can only happen when an appropriate degree of deep understanding concerning knowledge and skills is already existing. Pure memorization of facts does not lead to knowledge-transfer. Deep understanding takes time, repeated application in different contexts, feedback and reflection of unsuccessful transfers. Students, who combine a deep understanding of concrete and single problems with underlying abstract principles in order to solve a problem, are able to think more flexible and can solve a larger amount of analogical problems (cf. Kolodner, Gray, & Fasse, 2003).

## 2.2. Schank's Goal-based Scenarios

### 2.2.1. Components of GBS-Design

The Goal-based Scenario-approach by Roger Schank and colleagues continues former theoretical work on case-based reasoning and narrative forms of learning. The primary objective of Goal-Based Scenarios is to impart skills that are relevant for a certain situation. Students shall to learn "how to" rather than "know that". Procedural knowledge is knowledge about how certain skills are used in order to reach a goal, whereas content knowledge includes the actual information,

even though the acquisition of some declarative knowledge is, of course, a necessary precondition to learn skills.

To provide an example from Cognitive Science we could imagine the following situation: A student can have read a lot about statistical methods but never have calculated a set of experimental data with a software-package for statistics. Superficial knowledge of facts does not automatically grant the ability to transfer knowledge to vocational situations.

Schank and colleagues have gradually designed and elaborated a component model of GBS that interweaves and combines cognitive, emotional and motivational factors of learning. Following Schank, & Cleary (1995) a GBS consists of the following components:

- *Learning Goals, Target Skills*: Target Skills constitute the main educational objectives of a GBS. Factual knowledge is only important in as much as it is necessary to acquire skills.
- *Mission*: The mission of a GBS shapes the challenge that students engage in. The mission has to be precise, understandable and stimulating.
- *Cover Story*: The cover story sets the context of the GBS. It serves to nourish the motivation of the learner by conveying the relevance of the learning goals.
- *Focus*: The focus defines the general class of task students have to learn. Schank emphasises four basic categories:
  - a. *Design*: create or simulate sth.
  - b. *Diagnosis*: analyse and explain problems
  - c. *Discovery*: compare and find out problems
  - d. *Control*: run and control a complex mechanism
- *Operation*: specifies the concrete tasks and activities students have to do.

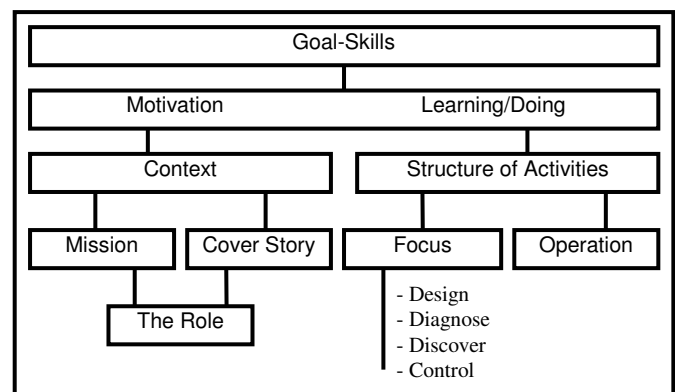


Figure. 1 : Structure of GBS, adapted from Zumbach (2002).

At the current stage of our preparations, learning content from the field of Cognitive Science is restructured to fit the needs of a GBS. This is done in order to create a stepping stone for future introductory lectures (see 3.1.1.).

### 2.2.2. Computer-based GBSs

In computer based GBSs these components are realized by cover stories with video clips of simulated clients or interviews with experts. In some GBSs, the learner also plays the role of a

journalist who interviews experts and has to research into given sources.

According to Zumbach (2002) GBSs allow a highly interactive training that offers an appropriate compromise between challenge and support. How can that be realized? In a GBS actions of learners alternate with reactions of the GBS, regardless whether the feedback is provided by a living expert or a virtual software environment. Goal-based Scenarios enable students to solve a certain “mission” in an authentic cover story. This way, learners are challenged to learn independently and encouraged to apply their knowledge to solve the given task.

Since the motivating nature of a goal-based *learning by doing* prevents inert knowledge, it would be desirable to apply this form of learning to suitable study situations. Yet, as a critical factor, the economic efficiency may not be neglected. According to Zumbach (2002), the development of GBSs would only be profitable at the minimum of 200 users.

### 2.3. Learning by Design™ according to Kolodner

#### 2.3.1. Rituals

The *Learning by Design™* -concept has been developed and elaborated since 1997 by Janet Kolodner and colleagues at the Georgia Institute of Technology. Influenced by constructivist theories of learning, findings of case-based and analogical reasoning have been systematically applied in problem based learning scenarios. The approach aims at larger groups of students such as in university courses and high school classes. It combines case- and problem based learning with the advantages of collaborative learning scenarios. The basic idea of LBD is to involve learners into a pre-structured, active and scientific working process in order to link knowledge with cases that are easy to recall. Hands-on experiences that are gained this way are orchestrated by iterative practices and rituals in so called *cycles of activities*. These *cycles of activities* arrange experiences of learners in such a way that acquired knowledge can easily be recalled and, by means of analogical transfer, be reused in a new but similar situation.

Furthermore, LBD is enriching direct, explorative learning and experimenting with guided reflection. During the LBD cycles, stages of active experimenting and designing alternate with venues for investigation and reflection.

During the design cycle students have to (1<sup>st</sup>.) understand the design challenge and realize what they have to learn. (2<sup>nd</sup>.) They have to plan, (3<sup>rd</sup>.) develop and (4<sup>th</sup>.) conduct an experiment as well as to analyze, explain and interpret their results in front of their fellow students. The cycle of investigation is intended to clarify in collaboration with the students (1<sup>st</sup>.) what they still have to learn, (2<sup>nd</sup>.) how this knowledge can be acquired and eventually (3<sup>rd</sup>.) to help and support students to reflect on and discuss the results of their findings.

Embedded into the alternation of these cycles, are regular rituals of presentation that iteratively practise the reuse of acquired knowledge and provide the students with a constant feedback from teachers and fellow students. These rituals include in detail:

- *Pin-up sessions (Design: Present & Share)*: gives students the opportunity to present first plans for a design of experiments and to justify their decisions in front of other groups. This is intended to grant a deep understanding of the design challenge.

- *Gallery Walk (Design: Present & Share)*: here, first design experiences after first constructions, tests and an explorative collection of data are shared and discussed within each group.
- *Poster session (Investigation: Present & Share)*: here, the results, analysis and the interpretation of conducted experiments are presented. This helps to practice poster sessions at scientific conferences.
- *Messing about (Design: Understand challenge)*: in small groups, suggestions and examples from real-world situations are integrated into the present tasks.
- *Whiteboarding (Design: Understand challenge / Investigate: Clarify questions)*: In order to encourage communication between the groups, the whiteboarding session is intended to be a forum for an exchange of ideas that were gathered during the *messing about*.
- *Gathering examples (Design: Understand challenge)*: here, examples are gathered individually in order to connect what one has learned with authentic cases. Afterwards these examples are exchanged by *Whiteboarding*.
- *Creating and refining design rules of thumb (Design and Investigation)*: This activity allows to extract general rules of thumb from the design experiences that also fellow students can use. False, weak or speculative rules can be modified or rejected by the other groups. The formulation of *rules of thumb* helps students to extract abstract rules from concrete design experiences (transfer).

LBD™- rituals are gradually practiced and established in so called *mini-cycles* within one group. Several of studies of evaluation, conducted by independent evaluators, report about excellent results on all seven rating scales in favour of LBD-Learners in direct longitudinal comparison to control groups (Kolodner, Gray, & Fasse, 2003).

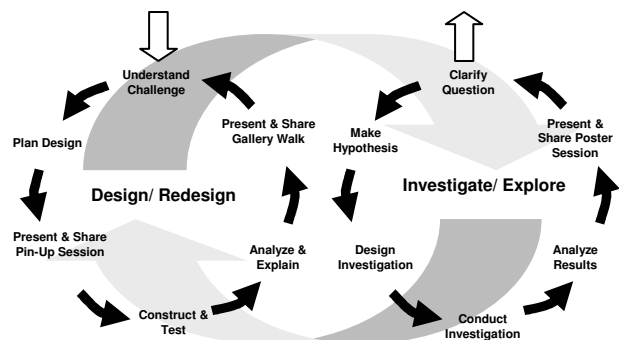


Figure. 2: LBD-cycles, Kolodner; Gray, & Fasse (2003)

#### 2.3.2. Software: SMILE

Electronic case-based learning aids support learners to actively reflect on, interpret and explain their project experiences. Kolodner, Owensby & Guzdial (2004) demonstrate that since the late 1980's the reflection supporting merit of case-based learning aids is well known. At the beginning, it were simple electronic learning diaries, as the Instructional Software Design Project (1991) or systems that, during discussions (CSILE) or tasks (KIE), provided helping prompts. Later learning aids that were influenced by CBR took that functions up again. The electronic DDA- tool (Design Discussion Area), developed by Kolodner and colleagues, for instance, was designed as an

electronic supplement and extension of the *Poster sessions*, *Pin-up sessions* and *Gallery walks*, of the LBD cycles. It helped students to present and discuss their design ideas and results in a coherent form. When the DDA-tool turned out to be inadequate in a practical test, the Kolodner group developed the software tool SMILE (Supportive Multi-User Integrated Learning Environment). SMILE amalgamates several tools for each LBD ritual. An *Experiment Result Tool* for instance, offers learners a scaffold to structure the results of their experiments, a *Pin-Up Tool* provides templates to articulate design decisions and a *Gallery Walk Tool* helps to document the current progress.

Even though these templates and scaffolds may help to reflect on new knowledge at early stages of learning, it would be desirable to have an adaptive scaffolding that gradually withdraws according to the progress of the learner.

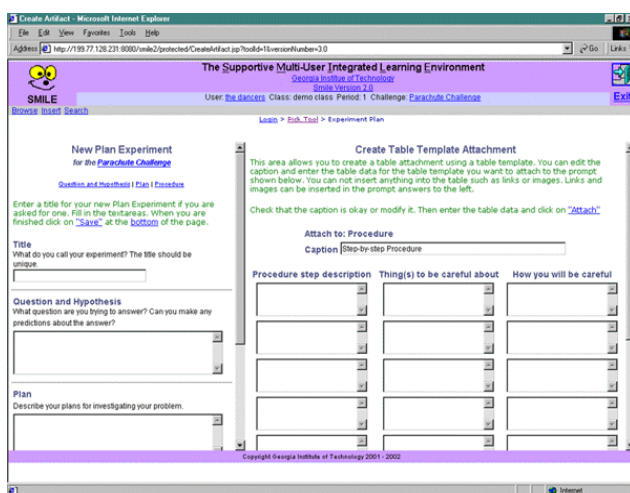
### 3. GOAL-BASED SCENARIOS AND CASE-BASED LEARNING IN COGNITIVE SCIENCE CURRICULA

#### 3.1. Challenges of interdisciplinary teaching

How can an extensive and heterogeneous field of knowledge ranging from biology, computer science, linguistics, psychology and theoretical physics, to skills in experimental design, data analysis and computational cognitive modeling be imparted in an effective and motivating way? The founding faculty of the master program *Master of Mind and Brain Sciences* at Potsdam University is facing the task to develop and sequence curricular modules that are appropriate for students coming from diverse disciplines and facilitate knowledge transfer in order to equip students for future vocational demands.

Beside special bridging courses, such as courses on *Non-linear Dynamics of complex systems* for non-physics and other preparative courses on mathematics, it is planned to develop an integrating module as an *Introduction to Cognitive Science* according to instructional methods of case- or goal based approaches in a blended learning scenario.

The necessary preparations have to be arranged in correspondence with the responsible teaching staff.



**Figure 3:** SMILE – Verson 2.0 Tool for Experimental Design (<http://www.cc.gatech.edu/projects/lbd/software.html>)

#### 3.2. Blended Learning-Modules

##### 3.2.1. Introductory module: Series of lectures and Case-based training courses.

In a first stage of expansion, a lecture series and a parallel seminar with E-learning support will be conjoined at a usual learning content management system. Lecturers of the participating cognitive science disciplines will provide a brief overview of the state-of-the-art of their subject and will then introduce a current prototypical research project (experiment, simulation, formal analysis). In a weekly, parallel seminar content related details of this project will be taught and analysed as case studies. This way case-based and goal-based instructional methods can be realized. In a final web-based project, students will work on a similar case-task in small groups. At this time the LMS serves as a platform for the electronic distribution of learning objects, for reflection in and between learning groups and supports collaborative work on case-libraries (cf. Weinberger, Fischer & Mandl, 2001).

##### 3.2.2. GBS and LBD Modules

In a second stage of expansion, suitable components of LBD™ or of GBSs will be integrated into a prototypical seminal-model. Especially suitable for this plan are lectures that impart knowledge and skills in cognitive modelling and the design of dialogue strategies for human computer interaction.

#### 4. SUMMARY AND OUTLOOK

Case-based learning, integrated in problem based learning environments, fosters by means of analogical reasoning and collaborative reflection processes of deep understanding and facilitates knowledge transfer to new contexts of application.

For the design of the interdisciplinary program *Master of Mind and Brain Sciences* at Potsdam University, we currently examine the applicability of both approaches in regard to the following criteria:

- Promotion of learning transfer
- Stimulation of motivation
- Suitability for interdisciplinary teaching
- Necessary effort to train lecturers
- Economic efficiency concerning the production of learning - software

In our context, especially the design principles for electronic Goal-based Scenarios, as illustrated by Schank (2005), will be considered and applied.

Furthermore, for the practical application of LBD or GBSs, it will be necessary to be mindful of Zimmermann's (2000) distinction between domain specific content knowledge and general scientific research skills. General skills of learners can only develop, when they are repeated, tested and reflected in diverse contexts. Lecturers and E-Learning authors from the heterogeneous disciplines of the *Mind and Brain Sciences* will have to be trained to develop suitable modes of case- and goal-based presentations from their own disciplines and to build scaffolds that foster interdisciplinary knowledge transfer.

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## USING THE INTERNET TO ENHANCE INDEPENDENT LEARNING.

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### Commission VI, WG VI/1 – VI/2

**KEY WORDS:** On-line collaborative learning, threaded discussion, action learning.

### ABSTRACT:

The Internet has provided a facility to support flexible delivery for teaching and learning. This has encouraged the development of student-focussed independent learning. This paper reviews two case studies that explore new approaches to teaching and learning that do not rely on a teacher-focussed or teacher-centred style, but rather utilise the Internet as a means of communicating between, and with, students.

The first case study involves the use of the Internet to enhance the field experience obtained by geospatial science students in their undergraduate studies. Learning through “Action Learning and Action Research” this study uses a Virtual Field Trip (VFT) to prepare second year students for a week-long field excursion to a popular national park in western Victoria, Australia. Initial findings are that whilst students found the VFT useful and would prepare them for fieldwork, they would not like to see it replace actual fieldwork.

The second case study was part of an international collaborative learning project developed by The Online Center for Global Geography Education under the auspices of the Association of American Geographers. RMIT undergraduate students participated in on-line learning with a group of undergraduate students from Utrecht University in the Netherlands. Whilst research has shown that collaborative learning allows students to attain a higher level of cognitive thinking and interest, this remains unclear with regards to on-line collaborative learning. The module evaluated by the students dealt with population geography. The module consisted of four lessons, each with a series of pages of textual and graphical material and a series of questions and activities. Students were divided into 16 groups of six students, three from RMIT and three from Utrecht. Overall student feedback was positive, but a number of students experienced difficulty in organising themselves and getting work completed on time. Questionnaires were issued to students prior to and after the module had been completed. Evaluation is still underway.

### 1. INTRODUCTION

Action learning and action research has been defined by Kimber (1999) as learning that results from active experience. Rather than students passively learning via the traditional “teacher-focussed” lecturing approach, action learning and action research actively engage students in building, testing and refining mental models (Michael and Modell, 2003).

The School of Mathematical and Geospatial Sciences runs three spatial science programs in geomatics, surveying and multimedia cartography. Practice-based geospatial science professions like surveying and cartography are reliant upon the application of knowledge in practice. It is therefore imperative that theory is integrated into practice through action learning (Chien *et al.*, 2002).

RMIT has moved towards a student-focussed learning environment where students are able to access learning materials outside the traditional lecture theatre. This has been facilitated through the implementation of the distributed learning system (DLS) at a university-wide level. Based on the Blackboard software, the DLS provides the facility for academic teaching staff to monitor student progress, upload courseware including assignments, on-line tutorials and other supporting documentation. This facility has also enabled the two case studies discussed in this paper to be implemented and tested for their effectiveness in imparting knowledge to

undergraduate geospatial science students. The aim of this paper is to present two case studies that demonstrate the application of the Internet to facilitate independent learning.

### 2. CASE STUDY 1: VIRTUAL FIELD TRIP

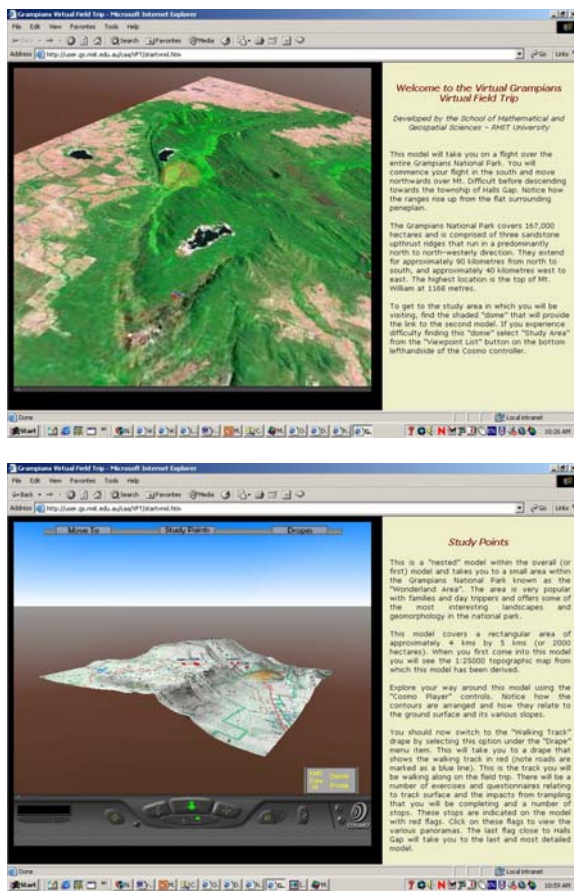
Virtual field trips vary in what is presented and the quality and approach of what is presented (Qiu and Hubble, 2002). These include VFTs that use a series of maps, text and photographs that read like a diary of activities on a field trip, for example the five day tour of the Grand Canyon developed by Bob Ribokas (2002), through to the Virtual Field Course hosted by the Geography Department at the University of Leicester ([www.geog.le.ac.uk/vfc/index.html](http://www.geog.le.ac.uk/vfc/index.html)). The Virtual Field Course is comprised of a number of exercises, including one based on a geo-referenced database, focussing on computer-based support for fieldwork. Likewise, the Department of Spatial Sciences at Curtin University of Technology in Western Australia, has developed the “Virtual Online Learning” ([www.cage.curtin.edu.au/vlearning/](http://www.cage.curtin.edu.au/vlearning/)) that can be used to facilitate geographic concept learning using a number of spatial activities ranging from survey principles to thematic classification.

As part of the second year, students are required to participate in a field camp of four days. Surveying students undertake a number of surveying exercises, whilst Cartography and some Geomatics students (not pursuing a major in surveying) are required to undertake a series of “mapping” activities. This

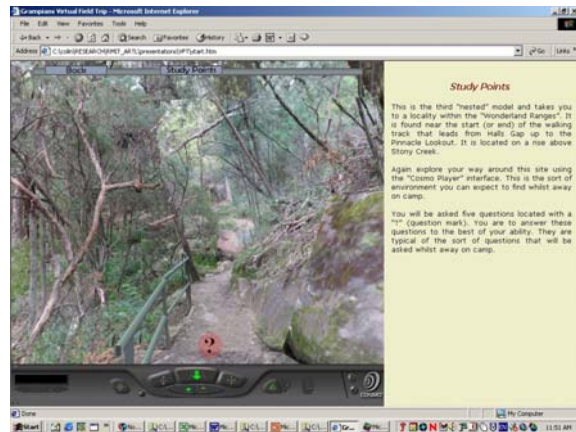
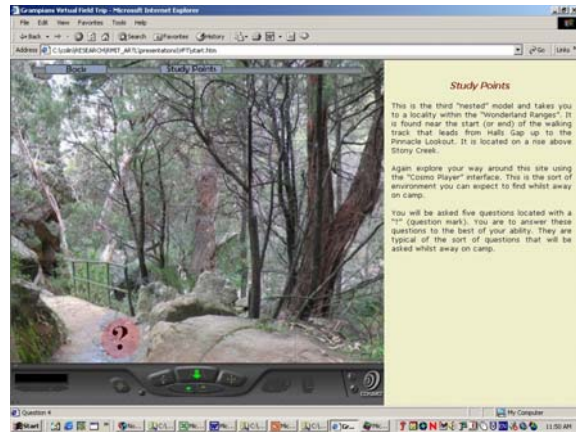
second group of students undertake fieldwork assessing hiker impact along walking trails in the Grampians National Park in western Victoria, Australia.

Previous research by Counihan (2005) has demonstrated that enhanced appreciation for a locality can be gained with increased prior knowledge about that locality. Given the limited time students are away, it is imperative that their learning experience is maximised during the field camp. It was decided to embark on the development of the virtual field trip to not replace, but rather augment, fieldwork to be encountered by students whilst away. Development of a series of nested virtual environment (VE) models is discussed extensively in Arrowsmith *et al.* (in press). The model is available at <http://user.gs.rmit.edu.au/caa/VFT/start.htm>.

Figures 1 to 4 show examples of the three scales of models used in the VFT.



Figures 1 and 2: *The large and medium scale shows the virtual field trip locality in context.*



Figures 3 and 4: *Site specific models give the students an appreciation for the type of environment through which they will be traversing. Question bubbles enable interactive feedback to students.*

An initial evaluation of the VFT using a questionnaire administered to 17 participants revealed the following general observations:

- all students like field trips and camps;
- all students generally got good marks for geography related courses;
- all students are able to work well with computers;
- all students believe that field excursions are a valuable learning resource; and
- disagree that VFTs should replace fieldwork.

Specific observations relating to the VFT included:

- the majority of participants found it useful and would prepare them adequately for fieldwork;
- about half the participants experienced difficulty navigating their way around the VFT and became disoriented;
- most participants could anticipate that a range of biophysical factors would result in variable impacts; and
- all, with the exception of one participant, would feel more comfortable about going on a field trip to the Grampians. This participant also expressed some

concern regarding gaining understanding of the variability of impact along walking tracks.

The key benefits identified from this initial development include:

- the ability to portray information at a variety of scales;
- the ability for students to gain a three dimensional visualisation of the environment into which they would be visiting; and,
- the ability for students to work at their own pace.

Whilst the ultimate objective with fieldwork is for students to be exposed to the real environment about which they have been learning in the classroom, the VFT enables each student to explore the region independently and at their own pace. They can independently evaluate information relating to the environment given in the VFT and reflect using the formative assessment provided as part of the VFT. This will prepare them for what will eventually become a group activity. Given that fieldwork is essentially a group activity focussing on action learning, where students are asked to work in groups of two or three, extension into group work can be achieved on-line using the VFT through threaded discussion groups using the facilities provided within the RMIT DLS and Blackboard. Debate, peer opinion and collective report writing, with input from the fieldwork co-ordinator can all be achieved on-line.

### 3. CASE STUDY 2: EVALUATION OF A MODULE DEVELOPED FOR INTERNATIONAL COLLABORATIVE GEOGRAPHY EDUCATION

In mid 2004 an expression of interest was made by the Association for American Geographers (AAG) for interested academic staff to participate in an international collaborative project for the teaching and learning of geography. The project titled "The Online Center for Global Geography Education" is part of the IGU Commission on Geographical Education, and the project leaders have stated its primary objective as being to "...internationalize the undergraduate geography curriculum" (The Online Center for Geography Education, 2005). . Using the Internet it is anticipated that the learning and appreciation of geography can be enhanced by using the Internet to link students in different countries for collaborative learning and discussions about contemporary global issues (*ibid* 2005). We responded to that request on the basis that we believed our students would benefit from the opportunity to interact with peers from overseas, and that the students were already familiar with the distributed learning environment (using Blackboard) on which the project was based. We were selected to participate in the evaluation of one of a series of developed modules. A meeting of collaborators was held at a workshop at the International Geographical Congress held in Glasgow in 2004. The module we elected to evaluate dealt with topics relating to global population. The content of this module fitted well with a course taught in second semester (July to October) called "Changing Global Environments". This course deals with environmental change focussing on the Quaternary period. As part of this course we investigate climate change and its evidence, Pleistocene extinctions, human migration and civilization, culminating in human population growth and its environmental implications. As part of the course we investigate population and its dynamics including the geographic variability in growth. Students enrolled in the course are from a range of backgrounds, primarily from applied sciences. The majority would be "geospatial science students"

(Geomatics, Surveying and Cartography) who do this as an elective course. The course is offered as an elective and therefore attracts students mainly from 2<sup>nd</sup> to 4<sup>th</sup> year where opportunities to enrol in electives are greater.

Initially, the AAG assigned students into 16 groups of 6 students. Three students from RMIT were paired with three students from Utrecht University. Because of the makeup of these groups, members were more than likely unknown to each other even from within RMIT where the course is offered over two geographically separated campuses. Students were then asked to introduce themselves via a student page where they could post information about themselves and put up a photograph.

The "Population" module was comprised of four separate tutorials and within each tutorial there were three to four pages of written background material that contained embedded tasks and discussion questions. Students were requested to post comments, answers or general discussion and opinions to the threaded discussion board. Because the module formed only one aspect of what we study there was little opportunity to spend much time on the details of population growth. Therefore students mainly worked and communicated independently of teaching staff with the on-line material. However students were required to participate in all the on-line discussions and were required to submit answers to questions. Part of the assessment for this course was evidence of active participation in the on-line discussions. Both due to time constraints and by design, teaching staff maintained a "hands off" approach. On-line threaded discussions were monitored from time-to-time and all group discussions were reviewed nearer the completion of the course for assessment.

Most students participated quite effectively. I don't believe all students participated equally and sometimes responses from overseas (and locally) were slow.

Out of a 12-week semester, the module accounted for approximately 2 of these. Most students spent longer than the allocated time in participating in the module work and this made up a more significant proportion of their practical work.

#### 3.1 Attitudinal evaluation

To evaluate the effectiveness of teaching and learning in each of the modules and in particular the effectiveness of doing this internationally, two questionnaires were administered before and after the module. The first of these dealt with attitudes of students to working in groups, and in particular international groups, and learning "on-line". The second questionnaire dealt with academic content, or knowledge, contained within the module. These questionnaires were designed by AAG project staff and administered locally. Surveys to determine changes in knowledge and attitude using pre and post-test surveys are widely used, for example Madle *et al.* (2003) who used a similar procedure to evaluate the changes in knowledge and attitudes of digital library users in the British National Electronic Library for Communicable Diseases.

The attitudinal questionnaire consisted of 22 independent questions where students were asked to respond by ticking a box, on a Likert Scale, from strongly agree to strongly disagree to a series of statements. Responses were sought prior to participation in the learning module and the same questions were given after participation. There were 45 responses

obtained in the pre-test and 40 responses obtained in the post-test. Of these 25% of the students were female. 70% of respondents were aged between 18 and 23, 20% aged from 24 to 29 and the balance, that is 10% of students (or 4) were over 30 years old. All students indicated they used email occasionally or frequently. 75% of participants had travelled overseas.

Responses to each of the statements were recorded by students ticking a box and for each of these a mean weight was calculated. For responses of "Strongly agree" a "1" was recorded, 2 for "Agree", 3 for "Neutral/No opinion", 4 for "Disagree" and 5 for "Strongly disagree". The appendix shows for each question, the number of responses given, the weighted mean and variance, and the difference in the weighted mean for the pre and post-tests. To determine whether an attitudinal change was statistically significant a paired T-test was undertaken at the 0.025 level of significance (critical value of  $t = 2.02$ ).

### 3.2 Observations from responses

If we first consider the weighted mean responses, it can be seen that question 13, 11, 17 and 2 all recorded strong agreement. Question 13 "The internet is a valuable tool for learning" indicates the positive attitude RMIT students have towards learning "on-line". At RMIT we have emphasised the need for on-line access to material in order to embrace the university's policy of "flexible learning" and "flexible delivery". Staff and students make frequent use of the distributed learning environment offered by RMIT and students see it as just another piece of equipment to aide their learning. Question 11 and 17 "Learning about global problems interests me" and "Understanding international perspectives is essential to solving world problems" had strong positive responses. Again this is not surprising given the nature of the course content and that students were selecting this course as an elective. Strong disagreement was felt in responses to questions 1 and 7. Question 1 "Geography is not a subject I enjoy studying" makes perfect sense. If the student didn't like studying geography then they would not have elected to do this course. Question 7 "The study of geography is not useful for understanding major world problems" demonstrates that students feel that geography will assist them to understand global problems.

In terms of attitudinal differences, between the pre and post surveys, from the appendix it can be seen that statistically significant changes in attitude from the pre to post surveys were found in responses to questions 6, 8, 9 and 22. Attitudes are "...general and enduring positive or negative feeling[s] about some person, object, or issue" (Worchel *et al.* 1991: page 175). Therefore any change in attitude from participating in a 12-week course requires further investigation. Whilst knowledge can be altered relatively easily, by definition, changes in attitudes are more difficult to attain.

Movement of attitudes in a "positive" direction (that is a move towards stronger agreement) were found for questions 6, 8 and 22. Question 6 asks students to respond to "Learning about other cultures is why I like geography". This change in attitude is likely to have arisen because of the students' increased exposure to working with people from another country. Actual contact with peers from an overseas university has allowed students to interact and appreciate views held by international students. Question 8 "I understand the causes of global problems such as over-population" is more a knowledge-based

question and that students are now feeling more confident with the knowledge they have acquired through the course. Consequently they now feel they have a better understanding of global problems. Question 22 "Collaborating with students from overseas is fun" may indicate an initial reticence to participate in the activity, not knowing exactly what was going to be required. After completing the set tasks participants have now possibly realised that collaboration is not such an onerous task, and one that resulted in a level of satisfaction and appreciation working with peers from overseas.

Movement of attitudes in a negative direction (that is a move towards a stronger disagreement with a statement) was found in only one instance, question 9, "I do not believe global problems such as overpopulation can be solved". This reinforces the change in attitudes to the statement in question 8 in that there is a slight shift in positive attitude that problems associated with overpopulation can be addressed. Knowing that peers from another country might have similar thoughts to our own students, may increase their level of optimism to that issue.

By contrast the least change (and statistically insignificant) was seen in responses to questions 16, 17 and 19. Question 16 "I dislike working in teams on class assignments" scored a mean of 3.59, indicating a low level of disagreement with the statement. This is somewhat of a surprise given the hearsay problems associated with students working in teams. However the response is also encouraging and shows a concerted effort by teaching staff to move towards collaborative learning and group assignment work, and the more positive attitude of students to this. However in terms of altering their attitudes to working in teams, this project had very little, if any, influence. Little change in response to question 19 "I like communicating by email" also demonstrates this project had little impact on student attitudes. With a response rate averaging 2, indicates a general acceptance that email is part of our daily lives and is an accepted form of communication. Question 17 "Understanding international perspectives is essential to solving world problems" could be considered to be a widely accepted attitude (receiving strong agreement responses) and therefore this project merely served to reinforce this.

### 3.3 Other issues noted

There was some difficulty in getting students to collaborate concurrently – often there were delays in getting responses from students both locally and internationally and this frustrated some of our "better" students. Posting something to the discussion board and getting no response (at least for one to two weeks) made it difficult to maintain focus. I do believe (hearsay) that the students enjoyed the opportunity to interact with students from another country and it was a valuable experience.

I also believe the experience was extremely valuable and would like to explore new opportunities to further our collaboration with other universities internationally. For a subject such as geography where the focus is on global environments and human interaction with those environments, it is essential to examine international perceptions and values. For our students to hear opinions and exchange ideas and knowledge with students from another university allows our students to put into context the work we study in the classroom or lecture theatre. It shows them that the problems we face as an individual country are not that different from other countries and we all face similar challenges.

#### 4. CONCLUSIONS

This paper has reviewed two case studies used to identify the problems and benefits in supporting student-centred, teacher-independent learning using the Internet. The first case study made use of a virtual field trip to enhance the field experience of undergraduate geospatial science students. It did this through the use of a series of nested virtual environment models. Evaluation showed that the models were of limited use in conveying concepts that would be implemented in the field. These virtual environment models enable the complexity of reality to be simplified so that the important environmental aspects that are the focus of the fieldwork can be highlighted. Students were able to explore their virtual environment without the restriction of time and spatial scale. They were observed working independently of teaching staff, and at their own pace, often revisiting sites to gain a further understanding of important biophysical environmental relationships. These attributes of independent working were seen in case study two. This second case study also showed that certain attitudes can be altered and that collaboration with international students is enjoyable.

Common findings from both case studies are that students are able to work independently not only as individuals but also in groups. They are able to work independently of teaching staff provided clear objectives, guidelines and tasks are made explicit. They are willing and able to use the Internet along with a range of Internet-dependent tools as a mechanism for working through learning material. Case study two demonstrated that attitudes to cultural differences may be altered in collaboration with international students. Finally as case study two showed, students enjoy collaboration with international students.

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#### ACKNOWLEDGEMENTS

There are a number of people and organisations I would like to acknowledge who assisted in these two projects. Firstly I would like to acknowledge the technical expertise provided by Andrew Counihan and Dane McGreevy who developed the virtual field trip models. Without their expertise the first case study would not have eventuated. Thanks are also extended to the RMIT Science, Engineering and Technology Portfolio who provided funds necessary to develop the virtual field trip. Thanks to Michael Solem from the Association of American Geographers and Robert van der Vaart from Utrecht University for providing the opportunity to participate in the collaborative international online project. Finally I would like to acknowledge the dozens of nameless students who participated and provided valuable input into the evaluation of these two case studies.

APPENDIX

Q	Pre-test								Post-test								Diff in mean	Calc t	Table T (at 0.025)	Significant	
	SA	MA	N	MD	SD	No of Responses	Mean	Var	SA	MA	N	MD	SD	No of Responses	Mean	Var					
	1	2	3	4	5				1	2	3	4	5				(d)	(d sq)			
1	1	3	3	24	14	45	4.04	0.84	0	3	4	18	16	41	4.15	0.76	0.10	0.01	0.53	2.02	N
2	18	19	7	1	0	45	1.80	0.60	18	20	3	0	0	41	1.63	0.38	-0.17	0.03	-1.10	2.02	N
3	0	4	11	18	12	45	3.84	0.84	1	2	9	17	12	41	3.90	0.92	0.06	0.00	0.29	2.02	N
4	2	13	7	14	10	46	3.37	1.49	2	7	4	18	11	42	3.69	1.36	0.32	0.10	1.26	2.02	N
5	7	27	7	4	0	45	2.18	0.64	9	25	6	2	0	42	2.02	0.55	-0.15	0.02	-0.93	2.02	N
6	5	19	9	9	2	44	2.64	1.14	5	25	6	4	0	40	2.23	0.62	-0.41	0.17	-2.02	2.02	Y
7	0	2	11	17	15	45	4.00	0.76	3	4	3	17	14	41	3.85	1.44	-0.15	0.02	-0.64	2.02	N
8	7	26	7	5	0	45	2.22	0.71	12	26	3	0	0	41	1.78	0.32	-0.44	0.20	-2.89	2.02	Y
9	1	12	12	17	3	45	3.20	0.96	0	8	5	22	6	41	3.63	0.91	0.43	0.19	2.08	2.02	Y
10	5	14	7	14	5	45	3.00	1.51	5	15	7	9	5	41	2.85	1.54	-0.15	0.02	-0.55	2.02	N
11	17	23	5	1	0	46	1.78	0.52	13	21	6	1	0	41	1.88	0.55	0.10	0.01	0.61	2.02	N
12	0	4	10	21	10	45	3.82	0.77	2	1	7	19	12	41	3.93	0.99	0.10	0.01	0.51	2.02	N
13	31	14	0	0	0	45	1.31	0.21	21	19	1	0	0	41	1.51	0.30	0.20	0.04	1.83	2.02	N
14	0	5	7	15	18	45	4.02	1.00	0	9	4	21	7	41	3.63	1.01	-0.39	0.15	-1.79	2.02	N
15	13	16	15	1	0	45	2.09	0.70	10	21	8	1	0	40	2.00	0.55	-0.09	0.01	-0.52	2.02	N
16	2	7	8	17	10	44	3.59	1.29	3	4	8	19	7	41	3.56	1.22	-0.03	0.00	-0.12	2.02	N
17	21	21	3	0	0	45	1.60	0.37	18	20	3	0	0	41	1.63	0.38	0.03	0.00	0.26	2.02	N
18	1	17	19	5	4	46	2.87	0.90	3	15	16	6	1	41	2.68	0.80	-0.19	0.03	-0.94	2.02	N
19	15	20	6	3	1	45	2.00	0.93	11	20	9	0	1	41	2.02	0.71	0.02	0.00	0.13	2.02	N
20	4	3	3	18	17	45	3.91	1.50	4	7	2	14	14	41	3.66	1.83	-0.25	0.06	-0.90	2.02	N
21	9	23	7	6	0	45	2.22	0.84	7	22	6	1	4	40	2.33	1.22	0.10	0.01	0.46	2.02	N
22	3	13	24	3	2	45	2.73	0.73	9	18	11	1	1	40	2.18	0.79	-0.56	0.31	-2.94	2.02	Y
																	-1.49	1.41			

## GIS LEARNING BY WEB-BASED COLLABORATION

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**KEY WORDS:** GIS, Hydro-Informatics, Water Management, E-Learning,

### ABSTRACT:

Geographical Information System (GIS) software is essential part of many courses in Hydro- and Geo-Science curricula. It is being used to analyse and present information from geographic and geo-socio-economic environment as well as from numerical simulations to which it frequently is interfaced. So it has become a key-tool for many engineering and geo-economic projects in planning and consultancy. Using software is frequently taught bottom-up. Firstly, students have to familiarise with the way of handling the software; secondly, they have to understand the features provided and thirdly, they have to learn how to creatively adapt and combine features to solve non-standard problems. Experience shows that just running through software-manual in classrooms is boring and de-motivating. The presentation of theoretical background of software features lead to loss of motivation too, though this part is of crucial importance to prevent students from using GIS as game-box. The third level is best taught through complex examples from geo-/engineering practice. In order to obtain better teaching and motivation results, a top-down approach has been investigated. Students are given a complex project from hydraulic engineering which needs GIS support on different levels. So first they learn to identify the problems and tasks for which GIS might be applied; then they learn whether the corresponding tools are contained within the software package given or – after inspecting the theoretical methods typically applied within GIS – how to creatively combine tools to fulfil requirements resulting from the problem. The practical elements of running software – input and data handling – are just picked up intuitively on the fly. This approach has been followed within the “Hydro-Europe” intensive programme within the Socrates/Erasmus framework together with eight European Universities. The objectives of Hydro-Europe is to promote, in a global European vision, the key concepts, the methodologies, the tools and the good practices which are today essential for a sustainable water management. As water management just by size of river basins demands for international collaboration, project works have been given to teams of students. The teams consisted from students from the different participating universities. The team composition thus represented a mixture of young people from different mother tongues, cultures, education and disciplines. So this approach implicitly covered the aspect of learning “intercultural collaboration”. The next aspect concerned support for collaboration. Also in this field new an approach has been taken by using Web-services and the Internet. So all team members could reside at their universities and work together in a “virtual environment” without knowing each other personally at the beginning of the project. Moreover, as collaboration in this environment demands for new skills and a new 'technical culture', this aspect became an additional learning objective. Experience from the teaching experiments with respect to the European dimension of education clearly shows, that it is possible to develop common high quality university teaching courses in this manner and to establish life-long Internet-links between students from the involved countries (“virtual alumni chapter”). These positive experiences have been implemented into the Erasmus-Mundus Master Courses “Hydro-Informatics and Water Management”.

## 1. EINFÜHRUNG

### 1.1 Ansatz

Die Kenntnisse von Geografischen Informationssystemen sind zunehmend in weiten Teilen der Hydro- und Geowissenschaften notwendig. Einerseits sind die Problemstellungen in diesem Bereich länderübergreifend andererseits betreffen sie viele Bereiche der Ingenieurarbeit. Beispielhaft sei ein Hochwasserereignis genannt, das ein gesamtes Flusseinzugsgebiet erfasst und für die Modellbildung Daten über Meteorologie, Niederschlag, Gelände, Bewuchs, Fließquerschnitte, Deiche, Infrastruktur, Bauwerke, Gefährdungspotential benötigt und Kenntnisse der Hydraulik voraussetzt. Für die Modellbildung gibt es in der Regel kommerzielle Softwareprodukte. Diese betreffen Geografische Informationssysteme, Niederschlags-/Abflussmodellierungen, Flussmodellierungen aber auch Präsentationssoftware und CAD. Wesentlicher Bestandteil für den Bearbeitungsprozess

selbst und der Beurteilung der Ergebnisse zwischen den Beteiligten sind die Präsentations- und Kommunikationsprozesse. Diese beziehen sich nicht nur auf den Austausch von Daten, Modellergebnissen, Plänen und Zeichnungen, sondern insbesondere auch auf die "kreative" Diskussion möglicher Lösungen, ihrer Machbarkeit, ihrer Zuverlässigkeit und ihrer Bedeutung für die Gesamtfragestellung.

Ein Ansatz zur Lösung bieten moderne Informations- und Kommunikationstechnologien die virtuelle Umgebungen schaffen und neue Arbeitsformen ermöglichen. Diese neue "Technik-Kultur" kann nur über praktische Erfahrungen gesammelt und trainiert werden.

### 1.2 Ausbildung

Die Ausbildung der Studenten erfolgt derzeit in verschiedenen einzelnen Fachdisziplinen mit anschließend teilweise fachübergreifenden Projekten.

In unserem Projekt haben sich 8 Europäische Partneruniversitäten im Rahmen des Socrates/Erasmus Projektes unter Führung der Sophia Antipolis Universität in Nizza, Frankreich zusammengeschlossen, um eine gemeinsame studentische Ausbildung auf der Basis eines Projektes zu ermöglichen ohne vorauszusetzen, dass sie in den entsprechenden Fachdisziplinen fundierte Kenntnisse besitzen. Die Aufgabe besteht in der Analyse einer Flut im Fluss Var und möglichen einzuleitenden Maßnahmen zur Schadensreduzierung bei einem ähnlichen Ereignis. Dieses Projekt beinhaltet sowohl die Modellierung von Daten mit GIS, von Niederschlags- Abflussmodellen, Hydraulikmodellen als auch die Präsentation der Ergebnisse. In dem Projekt wurde die GIS- Modellierung ausschließlich internetbasiert mit 6 Projektteams, die mit Studenten von unterschiedlichen Universitäten besetzt sind, durchgeführt. Anschließend trafen sich alle Projektteilnehmer an der Universität in Nizza zur weiteren Bearbeitung und Präsentation. Die Erfahrung hat gezeigt, dass diese gemeinsame Arbeitsphase unbedingt notwendig ist. Kreative Prozesse sind nur bedingt in einer komplett virtuellen Umgebung möglich. Diese Prozesse sind besonders geprägt vom Sehen des Partners, den direkten Gedankenaustausch, das Beobachten von Reaktionen, dem Abschweifen vom Thema, schlicht durch Atmosphäre und Muße.

Die beteiligten Studenten kommen von unterschiedlichen Universitäten und Fakultäten einerseits und aus verschiedenen europäischen, südamerikanischen und asiatischen Ländern andererseits. Sie haben dabei unterschiedliche Kenntnisse und Voraussetzungen. So gibt es Studenten im Bachelor-, Master- oder PhD- Studium.

## 2. ORGANISATION

### 2.1 Dokumenten-Plattform

Die Arbeitsplattform muss die benötigten Projektdaten, Werkzeuge und Ergebnisse verwalten, die Funktionalität zur multi-medial gestützten Bearbeitung bieten und den Arbeitsprozess an sich unterstützen. Sie muss mit einem Minimum an Personaleinsatz betreibbar sein. Diese Anforderungen führten zu einer eigenen Softwareentwicklung im Lehrstuhl Bauinformatik. Dieses System ist ein serverbasiertes Ressourcen Management System (DCMS). Weitere Informationen hierzu siehe auch unter [dcms.bauinf.tu-cottbus.de](http://dcms.bauinf.tu-cottbus.de). Ausgangspunkt ist, dass bei einer aufgabenteiligen Kooperation digital gespeicherte Informationen zwischen den Bearbeitern im Team ausgetauscht werden können. Diese Informationen können in Tabellen, Texten, Grafiken, Plänen, Video- oder Audioaufzeichnungen gespeichert sein. Damit ein Rechner diese Daten lesen und anzeigen kann, muss er das Format der Speicherung, den MIME-Typ kennen. Darüber hinaus muss eine Identifizierung der Dokumente nach dem Speicherort (URL) und durch einen Deskriptor (Metabeschreibung) erfolgen. Damit lassen sich Dokumente strukturiert verwalten. Dieser Server bildet aber auch die Basis, um Informationen über die Koordination und Kommunikation der Teams zu verwalten. ( Zeiten der Online Präsenz, Adressbuch der Teilnehmer, Chat-Protokolle, Arbeitspläne, u.a.)

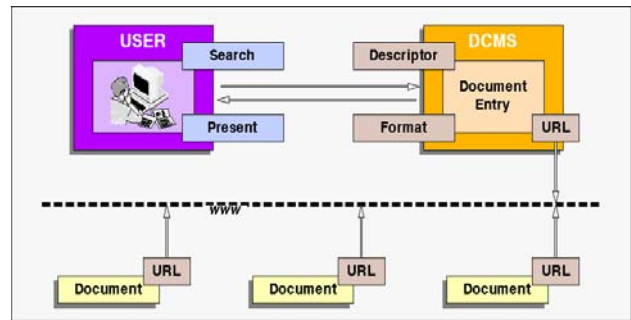


Abbildung 1: Dokumentenmanagementsystem

### 2.2 Team Organisation

Alle teilnehmenden Studenten der Hochschulen meldeten sich am DCMS-System als Nutzer an. Das bildete die Grundlage, um die Teamzusammenstellung zu ermöglichen. Alle Teams hatten per Internet ein Kickoff Meeting und erarbeiteten sich Pläne für die weiteren Arbeitsschritte als auch Termine für weitere "feste" Internetkommunikation. Diese Organisationsinformationen sind auch im DCMS integriert und abrufbar. Alle Teams haben zusätzlich eigene Internetseiten über die Projektbearbeitung erstellt.

### 2.3 Kommunikations-Plattform

Zentrales Element einer dezentralen Projektbearbeitung ist die Kommunikation und Abstimmung zwischen den beteiligten Teammitgliedern. Hierfür werden im Wesentlichen die Dienste E-Mail, Chat, White-Board und Videokonferenz genutzt. Dabei kommt das Tool Netmeeting von Microsoft zum Einsatz, da es an allen Orten zur Verfügung steht. An den Arbeitsplätzen stehen hierfür bei Bedarf Web-Cams und Headsets zur Verfügung. Lernziel ist es, den Studenten eine Benutzungs-"Kultur" in diesem Umfeld nahe zu bringen. So wird bei anfallenden großen Datenmengen schnell klar, dass die individuell versendete E-Mail mit Anhang nur Datenleitungen und Speicher füllt, jedoch zu keiner Transparenz der Projektarbeit beiträgt. Eine zentrale Speicherung der Anhänge als Dokumente mit Benachrichtigung an die Betroffenen und Abholung durch diese bei Bedarf ist wesentlich effizienter und wird vom DCMS unterstützt. Die Kommunikation in virtueller Umgebung in Teams, deren Mitglieder sich nie persönlich kennen gelernt haben, ist ein Novum in der Ausbildung. Ziel ist es, die Studenten auf diesen Arbeitsansatz aufmerksam zu machen, in einer multilingualen und multikulturellen Umgebung zu arbeiten und dessen Potenzial und Grenzen zu erfahren.

### 2.4 Software-Plattform

Um jedem Teilnehmer an dem Projekt gleiche Softwarevoraussetzungen von unterschiedlichen Hochschulen zu ermöglichen, wird die Technik von Remote-Desktop-Verbindungen angewandt. Lizenzrechte kommerzieller Software, aber auch Speicher und Prozessoren erlauben es nicht, entsprechende Fachsoftware auf allen Clients vorzuhalten. Auch unter Windows ist dieser Multiuser Betrieb mit einem Windows-Enterprise-Server verfügbar. Zur Verfügung steht die GIS-Software von ESRI, ArcView3.3 und ArcGIS8.3 sowohl am Server als auch an den einzelnen Arbeitsplätzen in einem Pool an der BTU Cottbus. Die Arbeitsverzeichnisse der Teams befinden sich auf extra Servern wobei diese über Netzwerkverbindungen von allen Arbeitsplätzen zugänglich sind.

### 3. PROJEKTBEARBEITUNG

Im folgenden soll der Inhalt des GIS-Teiles besondere Beachtung finden.

#### 3.1 Aufgabe

Basis für die Simulation der Flut ist zunächst eine Abfluss-Analyse basierend auf Messdaten der Niederschläge und dem digitalen Geländemodell. Die Teams hatten entsprechend den Kenntnissen und Voraussetzungen der Teilnehmer an den einzelnen Hochschulen die Arbeitsschwerpunkte festgelegt. So wurde beispielsweise im Team1 der GIS-Teil in Cottbus bearbeitet, wobei die anderen Teilnehmer über Remote-Desktop-Verbindungen direkten Zugang zur Software und den Ergebnissen hatten

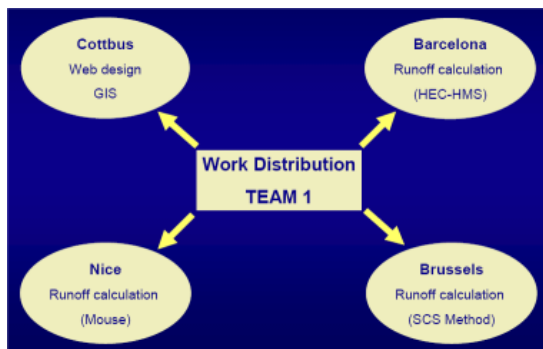


Abbildung 2: Arbeitsteilung im Team

Im GIS stehen Funktionen zur hydrologischen Modellierung des Geländes zur Verfügung. Diese Funktionen zu verstehen und zu nutzen war das Ziel des GIS-Teiles. Die Geländedaten wurden als ASCII-Tabelle mit X-,Y-,Z-Parametern zur Verfügung gestellt, um daraus ein digitales Geländemodell zu erzeugen. Die begleitenden Seminare waren nicht primär auf die Funktion der Software ausgerichtet, sondern beinhalteten die Datentypen, die Modellierung und die Methoden der Erzeugung von Geländemodellen und deren Analyse. Die Studenten waren sehr schnell in der Lage die entsprechenden Softwarefunktionen im GIS zu finden, anzuwenden und die Ergebnisse zu interpretieren.

#### 3.2 Digitales Geländemodell

Zur Erzeugung eines digitalen Geländemodelles aus ASCII-Tabellen wurden die logischen Schritte erarbeitet. Die Tabellen wurden konvertiert und ins GIS-System als Punktdaten importiert. Das Ziel war die Erzeugung eines digitalen Rastermodelles mit zwei verschiedenen Rasterweiten. Die Teilnehmer versuchten selbstständig diese Aufgabe durch probieren zu lösen und erarbeiteten sich dabei unterschiedliche Modellierungsmethoden. Einige Teams erzeugten direkt ein Grid, andere versuchten als Zwischenschritt die Methode der Triangulation, um ein Dreiecksnetz zu erhalten und dieses dann wieder in ein Grid zu konvertieren. Das die Methode der Triangulation weitere Randwerte benötigt, wurde aus dem Ergebnis sichtbar und in Chats mit anderen Teilnehmern verworfen.

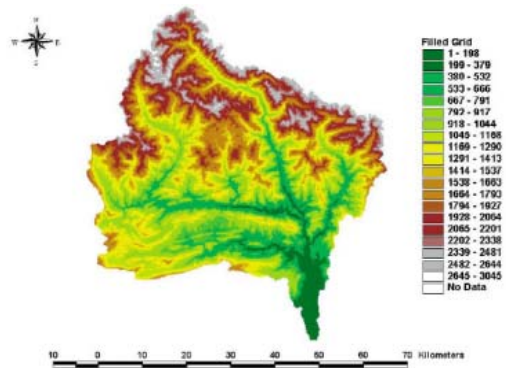


Abbildung 3: Digitales Geländemodell

Basierend auf dem Digitalen Geländemodell erfolgte die weitere hydrologische Modellierung.

#### 3.3 Hydrologische Funktionen

Die hydrologischen Funktionen Identifying Sinks, Fill Sinks, Flow Direction, Flow Accumulation, Stream Network und das Erzeugen der Watersheds nach festen Kriterien sind eine Abfolge von anzuwendenden Funktionen, die auf vorhergehenden Ergebnissen beruhen. Wichtig ist, dass die Ergebnisse der einzelnen Schritte richtig interpretiert und visualisiert werden.

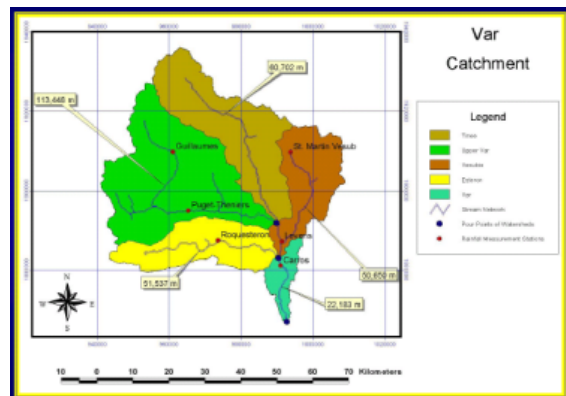


Abbildung 4: Berechnete Catchments

Das Team an der Uni in Warschau hatte durch Probieren verschiedene Ergebnisse für den Wert "Mean Slope" von Watersheds erhalten und stellte diese Frage per E-Mail an alle Teams, da sie innerhalb der Gruppe nicht beantwortet werden konnte.

*"Hello, Some problems during calculation in ArcView appear. We need help.so, short description of our doubts. We have got two different result of mean slope for each catchment. First result was obtained by using function (this function is given by HE authors): Hydro --->Hydrological Modeling.....( everybody can find it in instruction in page 6 point 14.) The results is in file slope.xls and slope.bmp We also calculated avarage slope using standard ArcView function: Analysis ----> Summarise zone... To obtain results we calculs slope of GRID ( topo\_075). The results is in file slope.xls and slope.bmp Now, we don't know how to interpret this differences. Please, sb provide us any information or contact with us.  
Greetings from Warsaw Joanna & Malgorzata (Team5)*

Es zeigt, dass Ergebnisse nicht einfach hingenommen werden, sondern im Team nach den Ursachen dieser Differenz gesucht wird. Letztendlich war als Ursache auszumachen, dass unterschiedliche Grids zur Berechnung zu Grunde lagen. Es wurde klar, dass die Ergebnisse gleich sein müssen und die Ursache ein Bedienungsfehler in der Softwarenutzung war! Chats wurden genutzt, um Probleme innerhalb der Teams zu diskutieren. Hier ein Beispiel zur Abfluss-Modellierung.

```

Hydro_Barcelona says:
the vegetation and landuse should interfere in the parameters of the runoff models?
Przemyslaw says:
but we can not make it because thae data we have are completely use less so far as w do not
have any clue as to read the values
Przemyslaw says:
I am not sure bur as far I found there is needed "CURVE NUMBER"
Przemyslaw says:
that is calculated from the vegetation, but I am not sure
amaud says:
the vegetation an landuse permit to know the infiltration in the soil, i
think
Przemyslaw says:
I found that last Year they used CN as 83
amaud says:
and for the scs parameter too
Hydro_Barcelona says:
we should have same infiltration methods and losses methods (SCS method) in order to
compare different models...Mouse, HEC and from Brussels
Przemyslaw says:
we could speculate on data we have, but it would not be very scientific
amaud says:
sure
    
```

Abbildung 5: Auszug aus einem Chat Protokoll

Diese Chats werden als Protokoll im DCMS gespeichert.

### 3.4 Projektbearbeitung in Nizza

Die anschließende einwöchige Projektbearbeitung in Nizza war geprägt vom Kennenlernen aller Teams aber auch intensiver Arbeit am Project von ca. 10 Stunden täglich. Basierend auf dem digitalen Geländemodell und dem Niederschlags-/Abflussmodell erfolgte hier die Erarbeitung eines hydraulischen Flussmodelles. Hierbei wurde die kommerzielle Mike-Software vom Danish Hydraulic Institute genutzt.



Abbildung 6: Projektbearbeitung

Begleitet war diese Phase von Seminaren, Diskussionen untereinander als auch mit Experten und Exkursionen ins Untersuchungsgebiet. Täglich wurden Zwischenberichte über die Arbeit auf den Internetseiten veröffentlicht. In einer Abschlusspräsentation stellten alle Gruppen ihre Arbeit und ihre Ergebnisse zur Diskussion.

## 4. SCHLUSSFOLGERUNGEN

Ausgehend von global zu lösenden Problemen werden in dem Kurs Studenten auf zukünftige Aufgabenstellungen vorbereitet. Sie lernen die Möglichkeiten der Informations- und Kommunikationstechnik kennen aber auch deren Grenzen. Sie

erfahren an einem Projekt die Softwarenutzung im top-down Verfahren wobei hier nicht die Software sondern die Modellierung und Problemlösung im Mittelpunkt steht. Das "Collaborative engineering in virtual environment" hat aber auch bei den beteiligten Mitarbeitern Einblick in Ausbildungstraditionen und Leistungsstände an den Hochschulen anderer Länder gegeben. Indirekt führte dies auch unter dem Aspekt des Potenzials moderner multimedialer Lehrformen zur Harmonisierung der Lehre in dem angesprochenen Bereich Umwelt/Wasser.

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## REMOTE EXPERIMENTS IN EXPERIMENTAL PHYSICS

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**KEY WORDS:** eLearning, eTeaching, remote experiments, magnetism, oral examinations

### ABSTRACT:

Information technology has made experimenting *via* the internet possible. Different from simulations, applets or animations, remotely controlled experiments give students the possibility to experience in reality physical situations and the realistic response to parameter variations. We demonstrate how to measure the efficiency of a solar cell by recording the *IV* curve in the dark and under illumination by an artificial light source. In a second experiment, we determine the hysteresis of a Ferro magnet. Both experiments are completely isolated from the operator; they have been implemented in a large engineering class and were accessed several hundred times in the course of a semester. We also discuss employing interactive learning material in oral examinations.

### 1. INTRODUCTION

Performing experiments is an essential part of the learning and teaching experience in natural and engineering sciences; it was always part of these sciences. The new media and technologies allow us – within a *blended learning* concept – to increase the experimental part of the education from very early on. Already in the first or second year experiments can be performed remotely which otherwise would not be accessible for reasons of expense, security, or availability. We show at several specific examples how the interaction of students with learning material increases their learning experience and learning success. We also present first examples of how interactive applets and remote experiments can be used in oral examinations.

#### 1.1 eLearning and eTeaching at universities

eLearning and eTeaching have become increasingly important in their contributions to modern education in today's universities. Basic courses in mathematics or the natural sciences taught for large engineering classes often suffer from an audience too large to individually address questions of students during the lecture, let alone allowing each student to experiment with demonstrator equipment employed during the class. Laboratory courses provide the conventional way to get students in contact with reality in form of an experimental setup which needs to be operated, and which produces data to be analyzed by the student or a group of students. The classical disadvantages of the laboratory courses are the relatively large investment on part of the teaching personnel, the more or less fixed experimental arrangement and a somewhat limited amount of different experiments available in a given laboratory. The tendency of groups of students to not each participate with the same intensity and the existence of previous lab notes further reduce the learning effectiveness of such courses.

#### 1.2 Remote experiments

Information technology has provided teaching with novel didactic methods which become increasingly used and

positively evaluated by the students. These advances encompass both the access to internet information *per se* and programming tools such as interactive applets, which are available abundantly for most physics problems dealt with in class. Furthermore, situations too dangerous or too expensive for in-class treatment can be taught and the related concepts and contents brought to the student. An example of a too dangerous (and too expensive) realization of a physics situation is the core melt down of a nuclear power plant (Eriksson, 2005), see Figure 1.

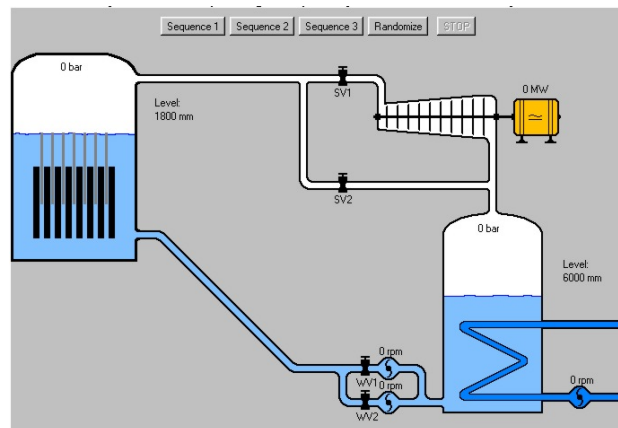


Figure 1: NuclearPowerPlant applet challenging the student to avoid a nuclear melt down following various incidences preventing normal operation. The students get to understand the essential thermodynamic functionality of a power plant. The components are the reactor (*left*), the turbine and the generator (*top right*), and the cooling unit (*bottom right*). Various pressures, water levels, and the power generated are indicated continuously by the running applet. From Eriksson, 2005.

In this paper we present the concept of remote experimenting, which we developed at TU Berlin. Different from the above-mentioned simulations of reality, we feel that it is important to combine the concept of abstract thinking or understanding abstract problems with true experiments for certain physics problems. In such experiments, the true physical setup is

located remotely from the operator or student wishing to do the experiment. Our setup is related to a remote controlled action of electrical parts or switches combined with physics questions to the student which force him or her to gain an understanding of the issue presented. We demonstrate our concept at the example of a solar cell and of the hysteresis loop of a Ferro magnet; generalization to other experiments is straightforward.

## 2. TECHNICAL REALIZATION

Technically, a remote experiment takes place in a location separate from the experimenter. The experimenter may be speaking to an audience and wanting to present experimental results as shown in Figure 2. Or the experiment is located at a distant location where access is difficult or impossible for one or the other reason. A remote experiment consists of two conceptually distinct parts. First of all there is the experiment itself, which is conducted remotely, and secondly there is the method used to provide the necessary remote features. The experiment is controlled *via* software through the internet by issuing commands to an interactive surface, which we shall illustrate below.

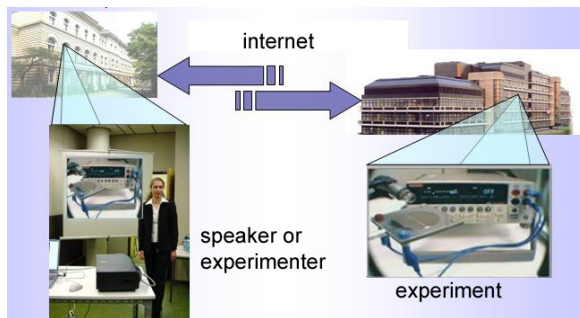


Figure 2: A typical remotely conducted experiment. The speaker or experimenter is in a location different from the laboratory where the experiment resides, *e.g.*, in a seminar room (*left*) and controls a real experiment (*right*). The control of the experiment is mediated to the speaker *via* the internet.

### 2.1 Solar Cell

We have chosen two simple experiments from the broad field of undergraduate experimental physics to demonstrate the functionality and capability of remote experiments. In the first experiment the *I*/*V*-characteristic of a solar cell can be measured in two states: in the dark and under illumination by an incandescent lamp. This is a common experiment to determine the efficiency of a solar cell (Thomsen and Gumlich, 1998). For the actual experiment we have used ADVANTEST R 6243 source-meter which enables us to simultaneously measure the sourced current and the voltage drop across the solar cell. The current source can be controlled via a standard GPIB (IEEE 488) interface. The light is switched using the printer port of the controlling computer.

### 2.2 Hysteresis loop of a Ferro Magnet

The second experiment, the determination of the hysteresis loop in the magnetization of a Ferro magnet, is slightly more complex. The more elaborate setup on the other hand makes it applicable for a wider variety of similar experiments.

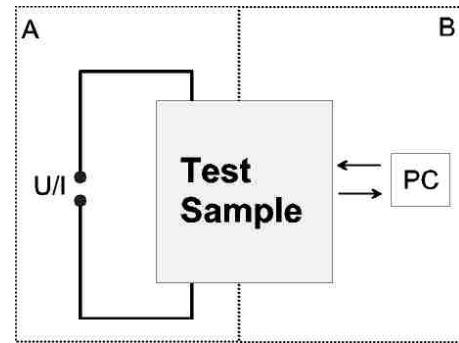


Figure 3: Diagram of the setup for the hysteresis-type experiment. On the left side (Part A) the PC controlled current is pictured. Part B on the right side symbolizes the collection of an arbitrary parameter of the experiment.

Figure 3 shows schematically the setup of the hysteresis experiment. It consists of two parts (A and B). In our case the sample (part A) is an electrical coil which generates a magnetic field when a current is passed through it. Part B is a hall-probe measuring the magnetic field in the hysteresis experiment. The actual interaction with the PC is done *via* a Keithley model 200 multimeter. In a modified setup, part A could be any device which is controllable by a voltage or current. A simple example could be an electric motor. Part B could then be the measurement of the temperature, the rotation frequency or the noise which is being generated.

### 2.3 Software requirements

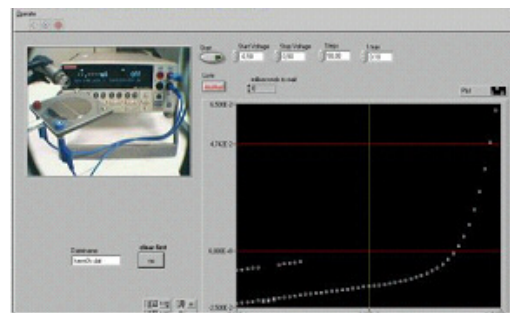


Figure 4: Software from National Instruments used in the remote experiments. The upper left inset shows a video image of the “real” (remote) experiment. One can recognize the current source with a digital display (*back*) and the solar cell (*front, left*) as well as the light bulb which simulates the illumination of the solar cell. Various buttons can be pressed and parameter values entered. They are passed through the internet to the experiment. The display area (*right*) contains the control variable (*x*-axis) and the measured parameter (*y*-axis).

In our remote experiments we used National Instruments LABVIEW to control the hardware and collect the experimental data. LABVIEW also possesses a very convenient web-interface which enables the remote-experimenter to perform any adjustments necessary. In order to view or control the experiment, a freely available web-browser plug-in has to be downloaded and installed. With the modular programming structure of LABVIEW remote experiments can easily be combined or extended.

### 3. USING REMOTE EXPERIMENTS

We describe here how the remote experiments presented can be used effectively in class or by individuals accessing the experiment over the internet. They are particularly suited as extensions or partial replacements of traditional problems in exercise classes. Problems for remote experiments usually cannot be solved simply with paper and pencil, but require some form of interaction with the experiment or with internet information in general. They are designed such that they are easy to use for students, and the learning efficiency is increased substantially by the aspect of playing or interacting with a real experiment, not just a simulation of what “should” happen. Students may use the remote experiment as preparation before class or to complete their understanding and exercise their knowledge gained after class. They also find remote experiments useful for preparing exams. A positive side effect is the increase in IT experience for the students participating in remote experiments.

#### 3.1 The efficiency of a solar cell

One of the educational goals of treating solar cells in physics classes – next to understanding their production and functioning – is to determine their efficiency. The efficiency is given by the ratio of the power of a solar cell delivered under illumination to the power of the incident light (Thomsen and Gumlich, 1998). The power is given by the largest rectangle in between the  $I$ -curve under illumination and the coordinate axes for zero voltage and zero current, see Figure 5. The maximum power of the solar cell occurs at an operating voltage of  $U_{max}$  and at a current  $I_{max}$ . By recording the solar cell in the dark (*upper curve* of Figure 5) and under illumination (*lower curve*) the power rectangle can be determined by the experimenter who is remotely located from the experiment. The software employed directly displays the two curves, proper scaling of the axes occurs either automatically, or predetermined, or by adjustment through the operator. Limiting values may be set to not endanger components of the setup and cannot be exceeded by the operator. Performing two successive voltage scans on the solar cell, one without and one with illumination produces curves similar to those in Figure 5. The maximum power output of the solar cell may be estimated directly from the rectangle in Figure 5, or the data may be exported to other software for further treatment.

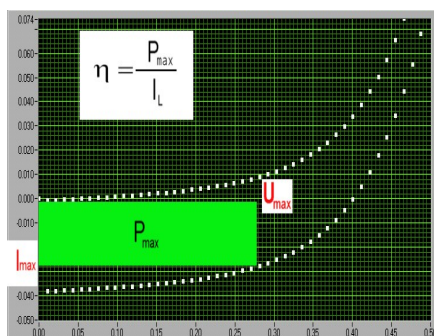


Figure 5:  $I$ - $V$  curves recorded in a remote solar-cell experiment (*dotted lines*). The upper curve was recorded with the solar cell in the dark, the lower one under illumination of a small light bulb. The rectangle between the curves indicates the maximum power of the solar cell.

In this way the efficiency of our specific solar cell was estimated to be around 2%. This experiment was part of our engineering class, and we counted several hundred remote accesses during a period of two weeks. Comments of students on the remote experiment were generally very positive.

#### 3.2 Magnetic hysteresis measurement

Experiments with magnetic material can be an excellent complement to theoretical studies of phase transitions (Jeschke, 2005). We show in Figure 6 what the hysteresis of a magnet looks like. A similar plot can be found in almost any textbook on experimental physics, as shown in the inset to Figure 6, where the magnetization is plotted *versus* the magnetic field, and the remanence and the coercive field are indicated. In the experiment, instead, the outcome of the hysteresis experiment is shown, in which the magnetisation is not directly accessible. The magnetic flux, which can be measured with the hall-probe, is therefore plotted *versus* the magnetic field, *i.e.*, the coil current. Note, that the hysteresis area (*red in the figure*) is rather small as compared to the usual textbook illustrations.

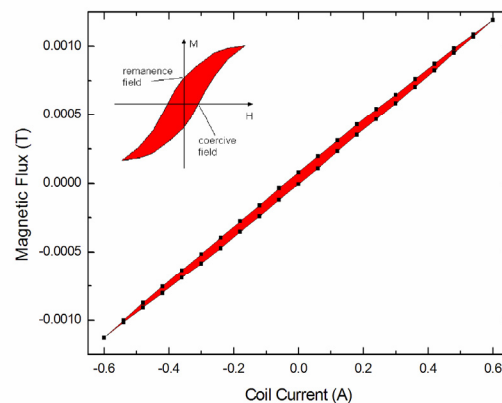


Figure 6: Hysteresis curve of a soft Ferro magnet. We have indicated several important points of the hysteresis curve like the remanence or residual magnetism and the coercive field in the inset which is a typical textbook example.

The student is also able to study the influence of the maximum magnetic field on the remanence and the coercive field within certain ranges only to prevent damage to the coil.

The presented hysteresis experiment can therefore give an important impulse to the understanding of ferromagnetism and the meaning of the three physical values  $H$  (the magnetic field),  $B$  (the magnetic induction or flux) and  $M$  (the magnetization).

### 4. REMOTE EXPERIMENTS IN EXAMINATIONS

One of the challenges of modern education is modernizing the situation a student is in during examination. Traditionally, an oral exam consists of the examiner asking several conceptual and/or technical questions, and the examinee answering those questions to the best of his or her knowledge. In written examinations a whole set of questions is given, and the student is required to gain as many points as possible by answering those questions in writing. By writing down some starting equation the student can show that he or she has a grasp at least of some of the issues in question; a partial number of points may be obtained. What is not challenged in such exams and

what is really an essential qualification in engineering or other applied sciences is the ability to elegantly and efficiently deal with experimental or practical aspects of a problem.

Problem solving in reality encompasses choosing the right tool or instrument, connecting it properly and being able to understand and interpret the result, which may be obtained in form of a data stream output by a computer or by some other form of recording instrument. Recognizing the important and relevant parameters and knowing how to incorporate the data stream in a physics analysis is an integral part of performing an experiment and of understanding a problem. We show how remote experiments can address these issues.

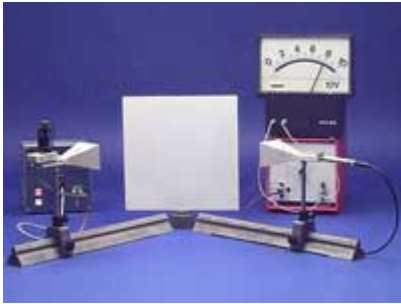


Figure 7: Interactive Screen Experiment (Kirstein, 2005) which allows via mouse movements to vary the angle of the central board, which reflects the incident microwave radiation. The microwave power at the detector is monitored and maximal at an angle of  $45^\circ$ .

#### 4.1 Interactive screen experiments

We began our feasibility study of interactively examining students of first or second year engineering classes which were obliged to pass an exam in introductory physics (Thomsen, 2005). We presented them applets or interactive screen experiments, e.g., that of the simple reflection of microwaves (Kirstein, 2005). In this experiment, the law of reflection may be studied at the example of microwave radiation, see Figure 7. The student, who classically would be asked to write down the law of reflection, is confronted here with the question, what kind of waves are being reflected (microwaves), has to explain what kind of waves they are (electromagnetic waves), has to discuss the size of the reflector vs. the wavelength of radiation (they ought to be of the same order of magnitude). He or she is then asked to demonstrate the reflection law by turning the angle of the board and finding a maximum in the reflected radiation. Further issues to be discussed with the student are why the reflection does not drop to zero instantly at an angle somewhat larger or smaller than the maximum angle (wavelength of microwave radiation compared to the geometry of the setup) or how generator and detector of microwaves work.

#### 4.2 Interactive applets in exams

As a second type of experiment we have employed interactive applets in oral examinations. We downloaded them from the internet and found them particularly suited for students to show their understanding by varying the relevant parameters in physics problems. As an example, we show here the molecular model for an ideal gas, see Figure 8 (Hwang, 2005). Here the number  $N$  of atoms or molecules, the pressure  $p$  in an enclosed system, and the velocity of the particles can be varied; the

resulting volume  $V$  of the container is read out digitally. The relationship  $pV = N k_B T$  can be demonstrated and the students in the oral examination are asked to predict what happens when one of the parameters is varied (Thomsen and Gumlich, 1998). They are then asked to demonstrate the reaction of the molecular gas with the applet.

As a further difficulty, the relationship between temperature  $T$  and particle velocity must be understood when the student is asked to increase the temperature of the gas. Finally, and this particular applet is ideally suited for such a question, the origin of the fluctuations in volume that are apparent in the running applet are to be discussed. The best students are able to show how the fluctuations may be avoided by increasing the number of particles by a factor of 10 or 100 and keeping the volume constant by increasing the pressure. This reduces the fluctuations and gives insight into the averaging qualities of statistical thermodynamics.

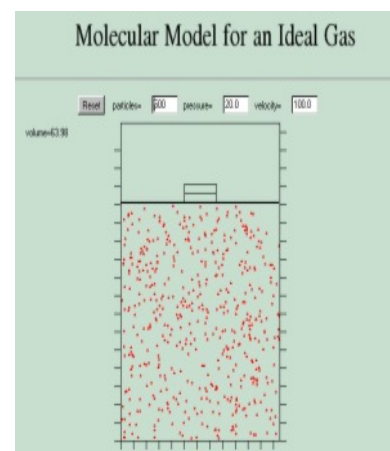


Figure 8: Molecular model for an ideal gas (Hwang, 2005). Students in oral examinations may be asked to demonstrate the ideal gas law or discuss why the piston and the corresponding enclosed volume fluctuate as a function of time.

Remote experiments as described in Sect. 3 are similarly suited for finding out the student's practical understanding of physics or applied sciences. Currently such extensions are being tested in oral examinations.

#### 4.3 Assessment

Our preliminary experience with such extensions of oral examinations to include interactive elements for the examinee is very positive. Many of the students were asked about how they experienced the exam, by an independent person not involved in the exam. Their reactions may be summarized as follows. Generally students were very content with this exam situation. Their unanimous opinion was that they could better present their knowledge than in a traditional exam. They all felt that their fear or nervousness in the exam was much reduced compared to a traditional exam. Having an screen image in front of them was perceived as beneficial in the stress situation; handling the computer was not considered a disadvantage. If an option, they would prefer such interactive components in future examinations.

From the point of view of the examiner, the interactive oral examinations were successful as well. The students appeared to be well in control of what they were asked to do. They could

present the proper physics context and adequately treated the problems presented to them with the applet or with the interactive screen experiment. The interactive experiments may be incorporated to various degrees in an oral examination; they allow seeing how the examinee deals with reality-near situations.

## 5. CONCLUSIONS AND OUTLOOK

In conclusion, we have presented the concept of remote experiments, which are real experiments conducted and controlled through appropriate software through the internet. Such remoteness can be used advantageously to demonstrate a sophisticated experiment remotely during a presentation located far away. Remote experiments offer an advantage as well in situations where access to the experiment is dangerous to the experimenter's health or just difficult to access. We have also discussed the advantages of employing interactive new media or remote experiments in examination situations. The perception of students to this form of examination was generally positive. We find that the interactive elements in general may be used in lecture room classes, exercises, seminars or tutorials. Different types of interactive elements are suited better for different learning situations.

## ACKNOWLEDGEMENTS

We acknowledge funding through the project NEMESIS of the German Federal Ministry of Research (BMBF) and through the center for Multimedia in Learning and Teaching (MuLF) of Technische Universität Berlin.

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## APPENDIX A: LIST OF ITEMS

List of items used in the remote experiments describe here.

Remote experiment: *Solar Cell*  
 Current Source (ADVANTEST R 6243)  
 Solar Cell  
 PC + GPIB Interface + Parallel Port Interface  
 Power Supply for light

Remote experiment: *Magnetic hysteresis*  
 Coil  
 Current Source (ADVANTEST R 6243)  
 Sample (Soft Iron)  
 Hall-Probe  
 Digital Multimeter with PC-Interface (Keithley Model 2000)  
 Current Source for Hall-Probe  
 PC + GPIB Interface

## EDUCATION OF PHOTOGRAMMETRY IN FINLAND

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Commission VI, WG VI/1 and WG VI/2

**KEY WORDS:** Photogrammetry, remote sensing, pedagogy, academy, curriculum, progressive inquiry, academy, primary schools, secondary schools

### 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 Neron-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 (Virrantaus 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.

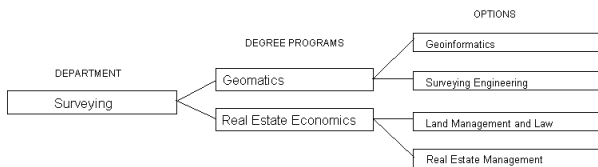


Figure 1. The organization of the degree programme for geomatics within the surveying curriculum at Helsinki University of Technology since 2001. The major subject of remote sensing has been within geoinformatics, whereas photogrammetry has been within surveying engineering. This will change in the new 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.

<b>Master's degree</b>	<b>180</b>
<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 Rönnholm
- 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 2<sup>nd</sup> 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.

<b>Master of Science in Technology (Diploma Engineer)</b>	<b>300</b>	Bachelor's studies <b>180</b>	Master's studies <b>120</b>												
Technical sciences, engineering sciences, common basics of surveying.	<b>100</b>	<table border="1"> <tr> <td><b>P</b></td> <td>80</td> </tr> <tr> <td><b>O</b></td> <td>20</td> </tr> </table>	<b>P</b>	80	<b>O</b>	20									
<b>P</b>	80														
<b>O</b>	20														
Geomatics profession.	<b>100</b>	<table border="1"> <tr> <td><b>A1</b></td> <td>20</td> </tr> <tr> <td><b>A2</b></td> <td>20</td> </tr> <tr> <td><b>B1</b></td> <td>20</td> </tr> </table>	<b>A1</b>	20	<b>A2</b>	20	<b>B1</b>	20	<table border="1"> <tr> <td><b>A3</b></td> <td>20</td> </tr> <tr> <td><b>B2</b></td> <td>20</td> </tr> </table>	<b>A3</b>	20	<b>B2</b>	20		
<b>A1</b>	20														
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<b>B1</b>	20														
<b>A3</b>	20														
<b>B2</b>	20														
Diploma Thesis, Bachelor's Thesis. Competence in performing research and scientific tasks. Social impact, technical implementation, economy and finances, ...	<b>100</b>	<table border="1"> <tr> <td><b>V</b></td> <td>10</td> </tr> <tr> <td><b>K</b></td> <td>10</td> </tr> </table>	<b>V</b>	10	<b>K</b>	10	<table border="1"> <tr> <td><b>C</b></td> <td>20</td> </tr> <tr> <td><b>W</b></td> <td>20</td> </tr> <tr> <td><b>M</b></td> <td>10</td> </tr> <tr> <td><b>D</b></td> <td>30</td> </tr> </table>	<b>C</b>	20	<b>W</b>	20	<b>M</b>	10	<b>D</b>	30
<b>V</b>	10														
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<b>W</b>	20														
<b>M</b>	10														
<b>D</b>	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 <b>P</b> 80		Freely chosen Bachelor's courses <b>V</b> 10	Bachelor's Thesis <b>K</b> 10	Freely chosen Master's courses <b>W</b> 20	Master's Thesis
		Common basics for Minor <b>B</b> 1 20		General application of Minor <b>B</b> 2 20	
				<b>D</b> 30	Scientific methodologies <b>M</b> 10
Common basics for Surveying <b>O</b> 20	Common basics for Geomatics <b>A</b> 1 20	General application of Major <b>A</b> 2 20	Practical application of Major <b>A</b> 3 20	Specialization <b>C</b> 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 B 2 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.

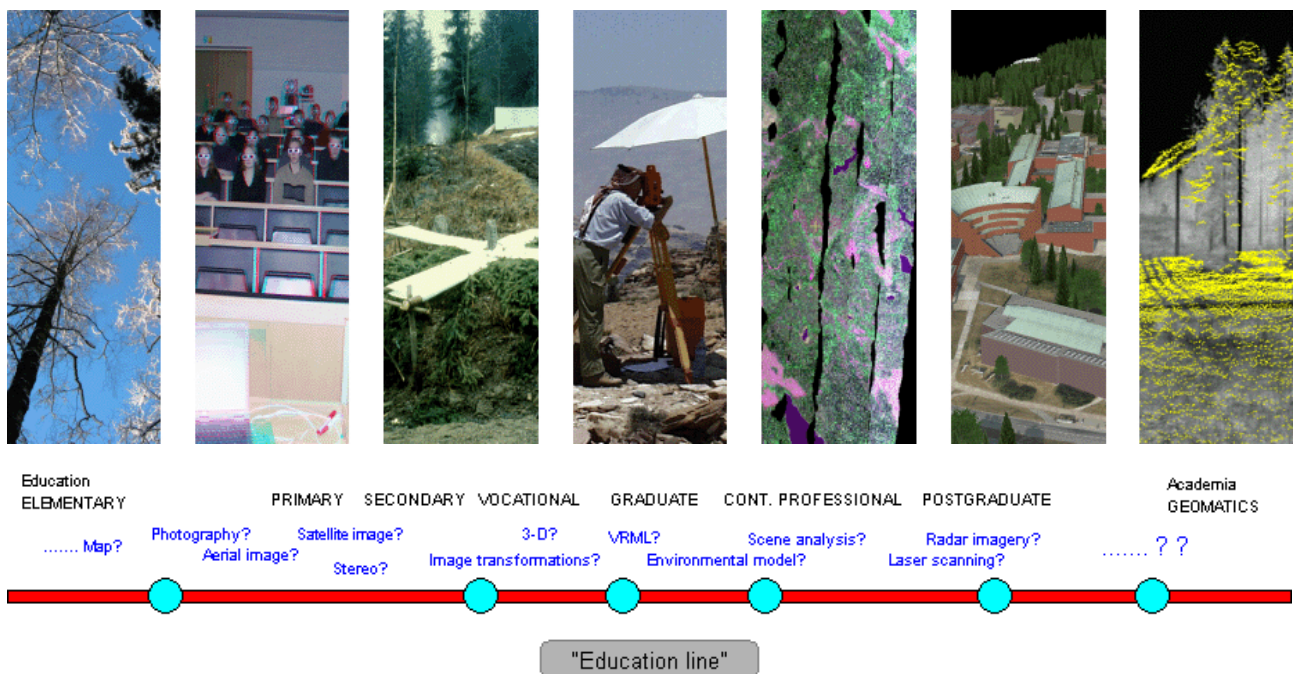


Figure 5. The phases of progressive learning. The range of topics starting from our local environment and its maps, proceeding through photographs, land surveying, images and 3-D models, and ending at modern imaging technologies, can be stretched along the life-long learning career of an individual.

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.

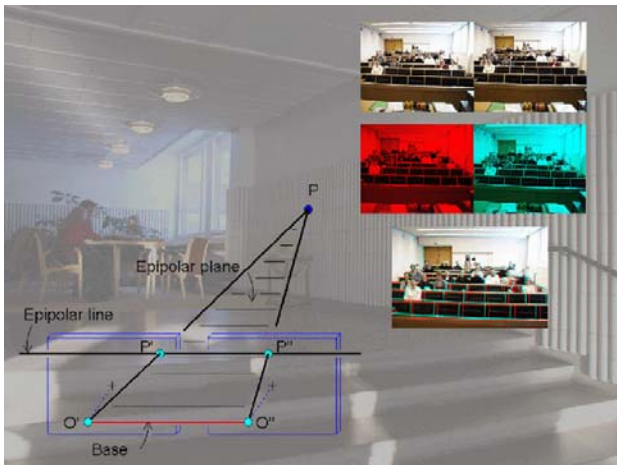


Figure 6. One of the first steps towards progressive learning in photogrammetry has been experienced with the secondary schools. The issue was stereo photography.

#### 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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# PROJECT-BASED LEARNING IN GEOMATICS AT AALBORG UNIVERSITY

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**KEYWORDS:** Education, Learning Environments, Blended Learning, Pedagogy, Project-based Learning, Photogrammetry

### ABSTRACT:

The paper deals with the education in Geomatics at Aalborg University (AAU), Denmark. Since its foundation in 1974 AAU has used Project-Based Learning (PBL) as its educational model. In each of the 10 semesters a project has to be carried out by a group of students. The paper presents the ideas behind PBL and the use of this approach in Geomatics. Some examples of project work in the field of photogrammetry and remote sensing are given. Teachers and researchers at AAU recently published a book on the Aalborg PBL model, in which progress, diversity and challenges of the approach are documented. Some of the findings in this investigation are presented. The on-campus education in Geomatics uses the Internet, and the paper informs about its application on campus. PBL is also practised at AAU's distance education programmes, which combine e-learning and weekend seminars on the campus. Experiences from using PBL in both forms of education are presented.

## 1. INTRODUCTION

Knowledge in the field of Geomatics has changed considerably in the last years and will change in future at even higher speed. Many new theories, methods and tools have to be studied and applied. The contents of the curriculum have continuously to be adapted and new tools have to be acquired. This requires many resources, which may not be available. The updating of knowledge becomes a life-long task. How to learn new things and how to find and access the required information becomes very important. The mapping industry and national mapping organizations need graduates who can communicate in a team and act locally and globally. Therefore the ways of teaching and learning have to consider the new conditions. The task of the universities is not only education on-campus but also off-campus. In both forms of education the Internet is an important tool, which has to be mastered by the teachers and the students.

It is the goal of this contribution to present the pedagogical concept of "Problem-Based Learning" as it is practiced at Aalborg University in the education of the "Danish Chartered Surveyor" and to analyze what impact the Internet has in both forms of the education.

## 2. PROJECT-BASED LEARNING AT AAU

Project-based learning means that projects are carried out by a group of students. A problem has to be defined and solved, and the solution to the problem or the search for a solution has to be documented, presented and defended. The problem is the starting point for acquisition and integration of new knowledge. The learning method is therefore also called Problem-Based Learning, which is again abbreviated with PBL. Therefore PBL has two meanings, Project-Based Learning and Problem-Based Learning, but both methods are

used in combination. Teachers have a different role in PBL; they are advisors and facilitators to the group. The evaluation of the project is in the hands of external examiners. The problem to be solved is part of a theme, and courses are given for introducing the theme and for providing an overview on the theories, methods, tools and applications. The project has to be carried out within one semester.

This way of learning is practised at Aalborg University from the first to the last semester of the study. It was introduced from the beginning of AAU in 1974. Various evaluations proved that this learning method works successfully and has advantages (Kjaersdam et al., 1994). Also other universities in the world have successfully applied PBL in their education. In the discipline of Geomatics the University of Aveiro, Portugal, also became known for using PBL (Gomes Pereira 2004).

The basic idea behind this pedagogical approach can be explained by the didactics triangle (cf. figure 1).

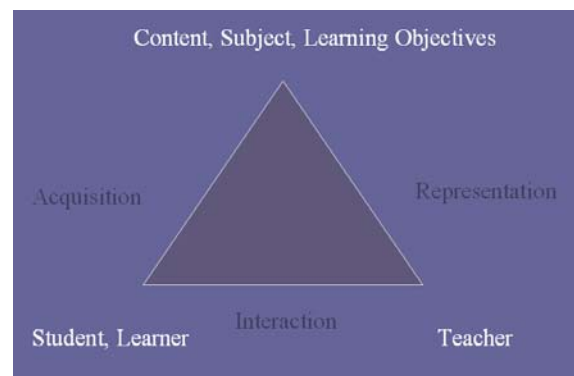


Figure 1: The didactics triangle. Source: Laursen, 2004

In all teaching we have a subject and the contents to be taught, a learner and a teacher. The sides of the triangle are the relation axes: Acquisition, representation and interaction.

The motivating forces behind PBL in the seventies were interested in changing the contents and the relation between students and teachers. The students should have influence on the contents of their learning. Later on when the production of knowledge and information grew very much, it was difficult to decide what the core competences are. Also many new theories, concepts and tools arose. Students are asking which pieces of knowledge and skills have to be acquired in order to get jobs. Teachers are many times only salesmen of certain packages of knowledge. It must be up to the customer, the students, to decide what to buy.

Basically PBL is a student-centred approach. The teachers have to be watched if they update their knowledge too. "Who is to teach the teachers?" became a famous slogan at AAU (Kjærdsdam, 1994). The answer to this question was that the teacher should do research himself and that there should be a strong connection between research and practice. The problems, which have to be found in professional practice or in research, are the best guides for the learning process. But research work is more than to acquire knowledge and to be oriented what happens in practice. It is also creativity and phantasy, which have to be developed in young students. At the place of this seminar, Potsdam Telegrafenberg, Albert Einstein did research and teaching. His famous words, "Phantasy is more important than knowledge", have to be mentioned in this context.

In these times of rapidly growing knowledge and with the many possibilities of acquiring knowledge the teacher and the student must cooperate, and the student has to take responsibility for his or her own learning. The universities have to create conditions and an atmosphere so that creativity and phantasy can develop. New thinking and going new ways were the real driving forces at Aalborg University.

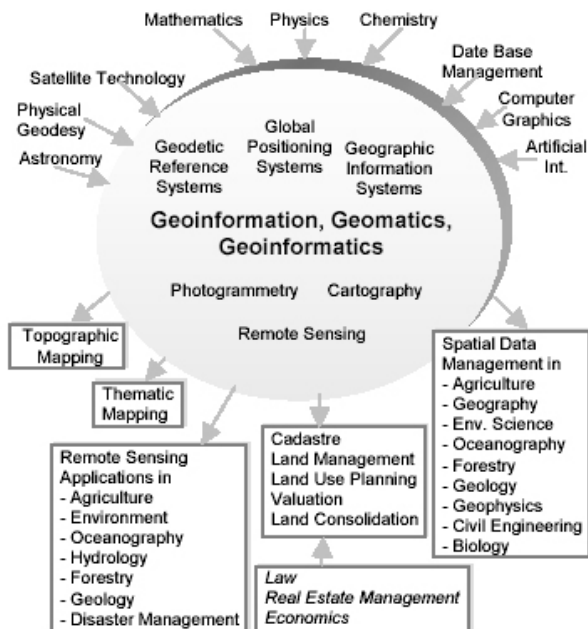


Figure 2: The academic discipline "Geomatics". The diagram shows the core subjects and the disciplines from which theories, methods and tools are used. The applications of Geomatics are depicted as boxes. Source: Konecny, 2002

### 3. GEOMATICS

The academic discipline "Geomatics" integrates new subjects like Geographic Information, Global Positioning, Remote Sensing and the traditional subjects like Surveying, Photogrammetry, Cartography, Cadastre, and Land Management. Geomatics relies on theories of Mathematics, Physics, Computer Science, Satellite Technology and uses tools such as Data Base Management, Computer Graphics, and Image Processing. The applications of Geomatics are in Topographic Mapping, Thematic Mapping and in Spatial Data Management for a number of fields (e.g. Civil Engineering, Environmental Sciences, Agriculture, and Geography). Special areas of professional and economic interest have traditionally been the Cadastre, Land Use Planning, and Land Management. In these tasks, subjects like Law, Real Estate Management and Economics have to be known. The integrated discipline "Geomatics" is also called "Geoinformatics" or "Geoinformation".

A comprehensive discussion of the global changes in the Geomatics education has been published in (Konecny 2002). Figure 2 summarizes these thoughts.

Konecny's thoughts are based on the situation in Germany and some other countries, which had a curriculum for Surveying Engineering for many years. Scandinavian countries including Denmark had a different starting point. Cadastre and related fields played here an important role. AAU educates therefore the Danish "landinspektør" (English translation: "Chartered Surveyor").

### 4. THE CHARTERED SURVEYOR STUDY AT AALBORG UNIVERSITY

The current AAU study programme for "Chartered Surveyors" is the Danish version of a Geomatics curriculum. It has been re-designed after the recommendations of the Bologna agreement of the EU member states. It consists of a three-year bachelors' programme and a two-year master's programme. Figure 3 shows the contents of each of the 10 semesters.

The **Bachelor of Science programme** starts with basic studies such as mathematics, computer science and GIS. The principle of Problem Based Learning and project-organized studies are also taught and practised. Already in the first semester a project is carried out by a group of 5-7 students. Recent topics of student projects are from the field of Spatial Planning and Land Use Management. First after finishing the basic studies the student has to decide if he or she continues within Geomatics or other disciplines within the Faculty of Engineering and Science. In the 3<sup>rd</sup> to the 6<sup>th</sup> semester skills within Spatial Planning, Land Use Management, Surveying, Mapping, Photogrammetry, and Cadastre are learnt. It is the "Learn how" or how professional work in these fields has to be done. The teachers specify the projects. After this general education within the Bachelor programme the students will now specialize and practice the "Learn why" in their projects. This means that they have to be active to find real world problems in the society or in research work and try to solve such problems or parts of it.

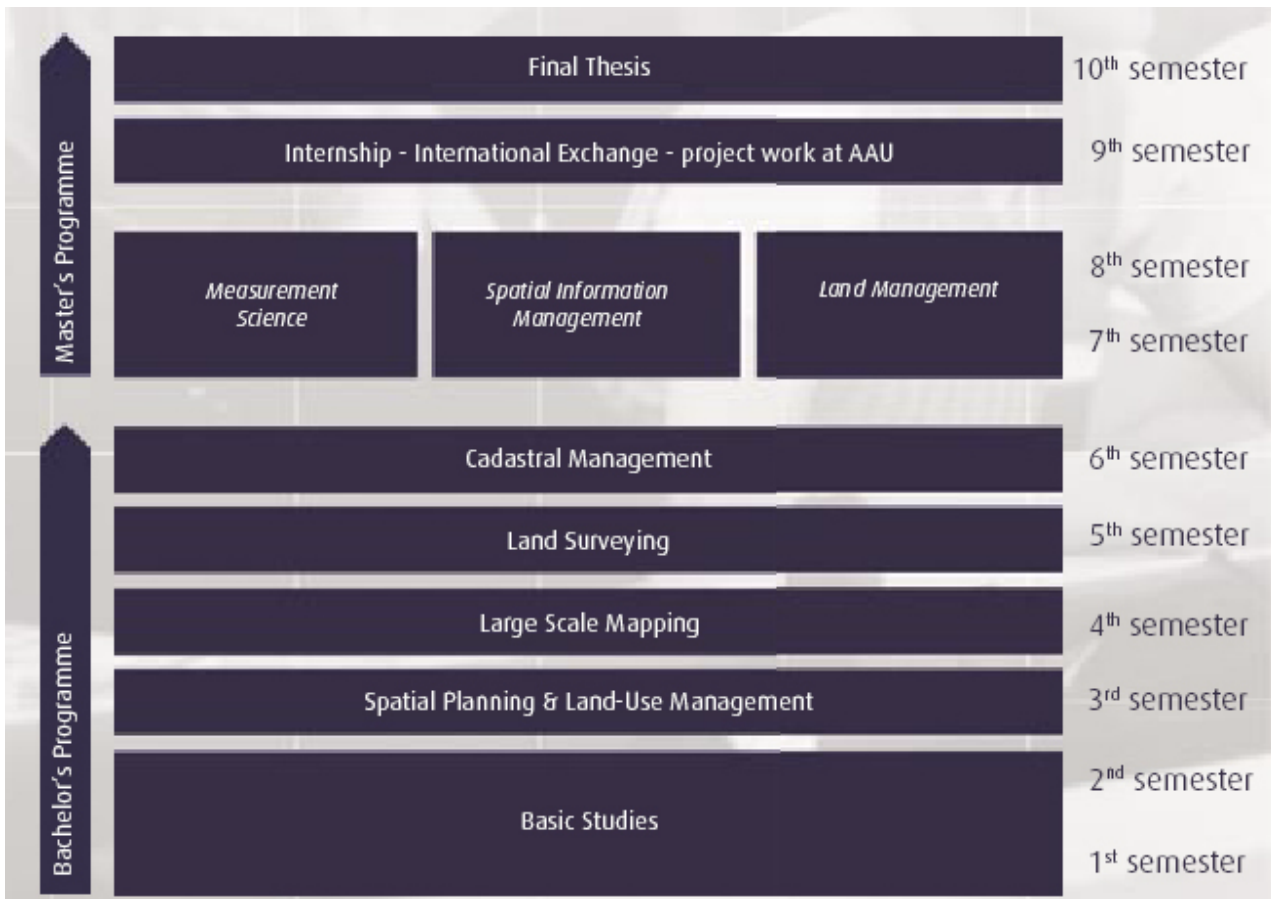


Figure 3: AAU study programme “Chartered Surveyor”

S	Measurement Science	Spatial Information Management	Land Management
7	<b>Positioning</b>	<b>GIS Theory &amp; -Technology</b>	<b>Real Estate</b>
	Surveying & Terr. Laserscanning Global Positioning Systems Advanced Photogrammetry Adjustment Theory Statistics Data Libraries & Data Quality Methodology & Science Theory  System Development Free Study Activity	Geospatial Analysis I Geocommunication I Data Security and Copy Rights  Data Libraries & Data Quality Methodology & Theory of Science Digital Administration System Development	Property Law Property Economy Case Work Legal Method Valuation Data Libraries & Data Quality Methodology & Theory of Science Digital Administration
8	<b>Sensor- &amp; data integration</b>	<b>GIS design &amp; -development</b>	<b>Land Management &amp; Planning</b>
	Sensor Integration in Surveying Sensor Integration in Phm. & RS Data Integration & Image Analysis Co-ordinate Transformations Modelling of Point Clouds Free Study Activity	Geospatial Analysis II Geocommunication II GIS/IT Implementation GIS from a Social Point of View Standards & Exchange Formats	Spatial Planning Urban Management Growth management EU legislation Implementation Theory Legal sociology Nature&Environmental Protection

Table 1: Overview on the themes and courses of the “Chartered Surveyor” study at the 7<sup>th</sup> – 8<sup>th</sup> semester (L-studienævn, 2004)

The **Master of Science programme** has two semesters with new themes in three specializations: Measurement Science, Spatial Information Management, and Land Management. Project relevant courses and other courses are given. A few mini-projects are carried out as free study activities.

Table 1 gives an overview on the themes and courses for the 7<sup>th</sup> and 8<sup>th</sup> semesters for the three specializations. About 25% of the student's time is used for courses and free study activities ('mini-projects'); the rest is used for project work and other activities. There is only one examination at the end of the semester, where the group (consisting of 3-4 members) presents the results of the projects. The students will receive individual marks for their achievements in the project and in the oral examination.

The ninth semester will focus on further professional development. There are four choices:  
The students can either carry out a project in a company or organization, study a semester at another university, start a one-year project at AAU carry out a project in the 9<sup>th</sup> semester followed by a final project with another topic in the 10<sup>th</sup> semester. This freedom of choice will allow for individual development, for example to study at a foreign university or to participate in research work of the Division of Geomatics.

The Chartered Surveyor education is organised by the School of Surveying and Planning, which recruits the teachers from the "Division of Geomatics" with its four research groups (Geoinformatics, Geographic Information & Media Technology, Land Management, and Cadastral Development). The Division is part of AAU's Department of Development and Planning. The School of Surveying and Mapping (also named the 'L-study board') also organises part-time studies in Geoinformatics. Both educations are placed under the Faculty of Engineering and Science of Aalborg University.

The teaching in Geomatics at AAU is carried out in Danish, but in recent years English has been used as well. Danish students are capable of understanding English due to their training in schools and in the everyday life (TV programmes, movies, travels, etc.). Project reports and examinations in English have so far, however, been seldom in the studies of Geomatics. The study at another university is recommended for a period of one semester, but only a few students take advantage of this opportunity.

Internationalization within the studies and research is one of the prime goals of AAU. Several Master of Science programmes in English have been created at AAU in the last few years, among others 'GPS Technology'. In 2004 1333 students (or 10% of all students) came from other countries in order to study at AAU.

**5. THE SUBJECTS "PHOTOGRAMMETRY & REMOTE SENSING" AT AAU**

The general education in Photogrammetry at AAU's **Bachelor of Science programme** starts in the 5<sup>th</sup> semester. This first course in Photogrammetry includes lectures and exercises (cf. Table 2), which amount to four credit points in

the European Credit Transfer System (ECTS)<sup>1</sup>. The project comprises aerotriangulation and ground control determination. This project will be replaced with another project where photogrammetric mapping comprising orthophoto production and data collection for DTMs and topographic databases will be practised. Photographs have been taken by means of a digital camera and the mapping is to be carried out by modern digital stereoworkstations (see figure 4).

<b>Lectures and tasks</b>
Image geometry and orientation Stereoscopy Rectification Photography and scanning Project planning, flight planning, navigation Mathematic concepts in photogrammetry Orthoimaging and monoplottung Introduction into digital photogrammetry Stereomethods and stereo workstations Selection of control points Aerotriangulation Topographic mapping
<b>Exercises</b>
Measurement of parallaxes Rectification Relative and absolute orientation Stereocompilation Orthophoto production Automatic measurement in images Image processing Aerotriangulation

Table 2: Content of the course "Basic Photogrammetry" at AAU's Bachelor's Programme in Geomatics (Status spring 2005)



Figure 4: Digital stereoworkstation "Intergraph Image Station SSK"

<sup>1</sup> One credit in ECTS is the equivalent to 30 hours of student's workload.

The education in the **Master of Science programme** includes the courses Advanced Photogrammetry, Terrestrial Laserscanning, Data Libraries & Data Quality, and free study activities ('mini-projects') about point determination by means of terrestrial digital photogrammetry, and data collection and modelling by means of terrestrial laserscanning in the 7<sup>th</sup> semester. Courses on Sensor Integration in Photogrammetry and Remote Sensing, Data Integration & Image Analysis, and a free study activity ('mini project') about Automated DTM Derivation including Quality Control are part of the education in the 8<sup>th</sup> semester.

#### **Advanced Photogrammetry**

Analytical photogrammetry  
Aerotriangulation techniques  
Terrestrial photogrammetry  
Calibration of non-metric cameras  
Industrial photogrammetry  
Automation of photogrammetric processes

#### **Terrestrial Laserscanning**

Principles, instruments, methods & applications

#### **Data Libraries and Quality of Data**

Image libraries and their characteristics  
Quality of DTMs and orthoimages

#### **Sensor Integration in P&RS**

Imaging sensors in P&RS  
Platforms of sensorer  
Additional sensorer  
Direct georeferencing  
Mapping from space imagery  
Airborne laserscanning  
Combined restitution of laserscanning and aerial images

#### **Data Integration & Image Analysis**

Operations at integrated raster data  
Automated georeferencing of images  
DTM&DSM production  
Production of true orthoimages  
Automated extraction of houses, roads, trees, etc.  
Automated Quality Control of Orthoimages and DTMs.

Table 3: Contents of the courses in Photogrammetry and Remote Sensing at AAU's MSc programme in Geomatics

Altogether, the students can obtain 15 ECTS credit points from courses and free study activities in the 7<sup>th</sup> and 8<sup>th</sup> semester in the subjects Photogrammetry, Remote Sensing and Laserscanning. The lectures are complimented by a few guest lectures, excursions, and presentations of companies.

Table 3 shows the contents of the courses in Photogrammetry and Remote Sensing for the 7<sup>th</sup> and 8<sup>th</sup> semester. Recent projects regarding Photogrammetry, Remotes Sensing and Laserscanning are listed in table 4. The topics of projects are often initiated from contacts of students with persons outside the university. Participation in research projects, for example in the ones of EuroSDR, has also attracted student groups.

<b>Year</b>	<b>Topics</b>
2003	Automated close-up photogrammetry in medicine
2003	Automated 3D models of buildings from airborne laserscannings data
2003	Automated change detection in the topographic database TOP10DK
2004	Surveying of a ship by terrestrial laserscanning
2004	Design of a hand-held mapping system
2004	Photorealistic 3D city models
2004	Mapping by means of high resolution satellite images
2005	Data reduction for laserscanning data
2005	Modelling of laserscanning data
2005	Mobile mapping with a linear laserscanner
2005	Determination of volumes by means of laserscanning data

Table 4: Topics of student projects in Photogrammetry, Remote Sensing and Laserscanning between 2003 and 2005.

## **6. USE OF THE INTERNET IN GEOMATICS**

The education in Geomatics at AAU takes very much advantage of the Internet. Homepages of the study board inform about the syllabus, course contents, timetable, guidelines and announcements. Learning resources such as lecture notes, literature and computer programs are available for the students for reading and storing on their own computers. Distribution of hard copies of learning material is thereby considerably reduced. Each project group sets up a homepage, where working papers, minutes of meetings, diary, etc. are available for group members, teachers, and external partners. Learning resources are also interactive learning programs. They are designed after the principle "Learning by doing". Table 5 lists such learning programs with regard to the subjects Photogrammetry and Surveying. The production of such interactive learning software requires many resources, but many students can use them in large PC rooms at the same time. They also enable self-studies and e-learning. Details on designing such courseware are published in (Höhle 2004). Freeware from Internet sources are used in the Remote Sensing courses, for example the learning material from NASA and the Canadian Centre for Remote Sensing (see website references 1 and 2).

The communication with the students on campus is done face to face, but it is supplemented by e-mail communication. The communication in the 9<sup>th</sup> semester (where a stay outside AAU is possible) can with advantage use a conference and communication software package. At AAU the conference system "FirstClass" has been applied in e-learning for many years. This software package connects a group of students and teachers to a virtual classroom. Questions and answers can be activated and monitored by all participants.

All the mentioned items (homepages, learning programs, lecture notes, etc.) form AAU's Learning Lab Geomatics, which is continuously extended and improved by teachers, students and secretaries.

The distance learning at AAU, for example for a master degree in Geoinformatics, uses the Internet and a few seminars at weekends. This blended e-learning has been

practised for the last 10 years, but on the Danish market only. This part-time study lasts two years and two projects have to be carried out. That means that PBL is applied in distance learning as well. Experiences in another AAU master degree programme, Industrial Information Technology, revealed that in distance learning significant changes have to be made for the PBL approach (Knudsen et al. 2004). A small pilot project should be established at the beginning of web-based distance education. A project free period had to be created so that the students could concentrate on the courses. A strong correlation between courses and projects had also to be realized. It is essential for off-campus education that the students frequently experience success.

Blended e-learning after the AAU model has also been used for the distance learning courses of the European Organization for Spatial Data Research (EuroSDR, formerly OEEPE), which disseminates the knowledge gained in EuroSDR research projects in Photogrammetry, Remote Sensing and GIS by means of e-learning courses. The participants come from many different countries. The first three courses were carried out in 2002 and an introductory seminar took place at AAU. The conference system "FirstClass" was used for the communication. At the introductory seminar its use was presented together with the learning material.

As the same learning material is used on-campus and off-campus, both forms of education influence each other. The Internet is used in both cases and with great advantages.

## 7. ADVANTAGES AND DISADVANTAGES OF THE PBL MODEL

In the PBL model - as it is practised at AAU's education in Geomatics - the students have a very active role. This type of education contributes to independent action of the students and strengthens their self-confidence. There is a short distance between teacher and student - both physically and concerning the power. Group rooms (or student offices) lie near the teachers' rooms, and students can get help at all times of the day. New knowledge and information flow both ways. The teacher is forced to update his knowledge continuously, also in areas which are not his specialty or interest. The students concentrate on the projects, but they reduce participation in courses. This may result in gaps in the students' knowledge. The approach is very vulnerable when the number of students increases. Group rooms and equipment are then lacking and teachers are overburdened if no extra resources are granted. The project-based and group organized learning produces goal-oriented team players. Dropout rates and extension of study times are reduced.

## 7. CONCLUSION

Universities have to produce can graduates, which can solve problems in the society and in research. Such graduates have to be able to know how to learn new knowledge and to access the available information, and this life long. The outsourcing of production to areas with low labour costs creates a lot of unemployment. These losses of jobs must be compensated by innovations and new skills. Graduates, who are creative, with imagination, with self-confidence and initiative, are required in the present situation.

Name	Subj	Contents	Base
LDIPInter1	Phm.	AutomatedMeasurements	Internet
AutoOrient	Phm.	Georeferencing	Internet
LDIPInter2	Phm.	Matching	Internet
TMK	Surveying	Levelling, Co-ordinate calculation GPS	MatLab

Table 5: AAU learning programs with regard to the subjects Photogrammetry and Surveying

Also skills in communication across borders of culture and language are required. The problem-based and project-based learning in groups can create such persons. Teachers for such students have to be experienced in research and to be motivated to act as advisors and facilitators for the student groups. From the teachers it requires a high degree of flexibility to adapt to new projects and to learn new things. Much information can today be found on the Internet and the Internet can be used as a learning tool and a source of knowledge. Photogrammetry, Remote Sensing and Laserscanning are important subjects of the discipline "Geomatics". These subjects have changed a lot in the last years. The innovations have to be mastered in the education. The content of the courses have to be modified, instrumentation and tools have to be updated.

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## **EuroSDR's EduServ SERIES - TRANSFERRING KNOWLEDGE FROM THE RESEARCH TO THE USER DOMAIN BY DISTANCE eLEARNING**

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**KEYWORDS:** Education, Research, Teaching, Training, Web based, Learning, Internet/Web

### **ABSTRACT:**

This paper concerns an initiative of EuroSDR (formerly OEEPE) in the area of continuing professional development (CPD) by distance eLearning and EduServ3 (Spring 2005) represents the third installment of this annual eLearning distance education service. The EduServ series is intended as a means of transferring the findings of the research activities of EuroSDR from the research to the user domain of the spatial information sciences. It is primarily, but not exclusively, aimed at staff of Geographic Information (GI) production organizations such as national mapping and cadastral agencies (NMCA). In practice, however, participants are drawn from NMCAs, the private and public sectors and the academic community.

Each installment consists of a series of short (two-week) eLearning distance courses, which run consecutively. The courses are practically focused and follow the principle of 'learning by doing'. Participants come together for a two-day workshop prior to the commencement of the courses where they meet other participants and receive course material and hear background presentations in the context of the courses.

Challenges that face the course designers and organizers may be seen as (i) accommodating participants from a broad range of diverse organisations with considerable differences in educational and cultural experience; (ii) achieving a practical 'learning by doing' element to Internet-based courses in technical areas; (iii) providing timely and effective learner/learner and learner/teacher communication; (iv) evaluating the performance of the participants in a reliable manner and providing effective feedback; and (v) building a sense of 'class group' and enhancing the learning experience.

In this paper the courses, which range from 'Digital Cameras and Sensors' to 'Positional Accuracy Improvement in GI Databases' are placed in the context of the objects of EuroSDR. The means of designing, delivering and assuring the quality of these courses to meet the pedagogical challenges, as outlined, are addressed in detail.

### **1. EduServ**

#### **1.1 Transferring Knowledge**

EuroSDR is an organization, which was established as OEEPE in 1953 by signature to an International Treaty ratified by the governments of five European countries. EuroSDR currently has nineteen member states represented by delegates from a GI production organization and a Research Institute or University.

The aim of EuroSDR is to address the spatial data research needs of GI production organizations, such as NMCAs, in Europe through its publications and dissemination. These represent the outcomes and findings of a comprehensive series of applied collaborative research projects, focused workshops and active networks, of which a significant number are running at any given time.

The research agenda of EuroSDR is designed by delegates from the member GI organizations and research institutes in order to address real issues affecting members in a practical and timely manner. The dissemination of its results is therefore a key element of EuroSDR's research activities. Its official series of publications has now reached Number 48 (EuroSDR 2005) and these consist of either book or CDROM publications. They are disseminated free of charge to the member countries where they are further distributed by the national delegates. EuroSDR's Taskforce on Education, however, has long felt that the addition of a more effective means of transferring its research findings from the research to the user domain was needed.

In order to improve the effectiveness of its dissemination, EuroSDR initiated EduServ, a series of short eLearning courses in October 2002 to transfer the outcomes of its research activities to GI users and producers (Höhle 2004). EduServ3, the third installment of EduServ, consisting of three two-week eLearning courses ran between April and June 2005.

#### **1.2 EduServ eLearning Courses**

Annual EduServ installments are short (usually two-weeks) Internet-delivered eLearning courses, which are linked to the research activities of EuroSDR. EduServ3 consisted of three courses:

1. Co-ordinate Reference Systems for Spatial Information
2. Positional Accuracy Improvement in GI Databases
3. Digital Cameras/Sensors

The first two courses were included following the outcome of the joint EuroSDR - Dublin Institute of Technology (DIT) workshop on 'The Implications of Improving the Positional Accuracy of GI Databases' held in May 2004 in Dublin (EuroSDR 2005). Served from the DIT WebCT<sup>®</sup> server, they have been developed by DIT, Ordnance Survey Great Britain (OSGB) and the Technical University of Berlin and ran from 11th April to 22nd April and from 2nd May to 13th May 2005 respectively. Course content was designed to specifically address issues raised at the workshop and to convey, in practical terms, an understanding of the essential concepts.

The third course was first included in EduServ2 and liaises closely with the EuroSDR project on 'Digital Camera Calibration' (Cramer 2004). It is served from the Ohio-State University server in the USA and ran from 23rd May to 3rd June 2005.

Twenty-five participants from GI organizations and universities in Belgium, Cyprus, Denmark, Greece, Ireland, Italy, Latvia, the Netherlands, Switzerland and the United Kingdom are registered for EduServ3 with approximately fourteen following each course.

All participants, together with the course developers and tutors met in Dublin for a two-day pre-course workshop at which they heard presentations at three levels in relation to each course, namely:

- The course subject area in its broadest context
- The theoretical background to the course
- The logistics of the course, including schedules, methods of delivery and assessment.

In addition, participants gained hands-on experience of the courses through focused Internet laboratory sessions where they could sample elements of each course and practice downloading and submitting assignments. They were also provided with offline course material and reference documentation. Finally, all participants were required to complete and submit a short questionnaire by way of quality assurance of the workshop.

On returning to their countries, participants followed the courses from their workplace or other Internet-enabled location over a two-week period. During this period, in addition to following the online course content, they received additional online tutorials, reference documentation and detailed assignments. Extensive use was made of discussion board and mail facilities of the eLearning system environment.

Participants were expected to allocate approximately thirty hours to each course and were guaranteed timely responses from course tutors and feedback to submitted assignments. On successful completion of all assignments and the submission of a detailed course evaluation feed back questionnaire, they received a signed 'Certificate of Completion' from EuroSDR.

## **2. THE EduServ PHILOSOPHY**

### **2.1 Learning by Doing**

EduServ courses are designed to follow the principle of 'Learning by Doing' and therefore include practical assignments which require, for example, the participant to manipulate data or processes, evaluate the consequences and draw reasoned conclusions.

This represents a significant challenge to the course designers. In the course 'Co-ordinate Reference Systems for Spatial Information', for example, use was made of Microsoft Excel worksheets where participants could experiment with four-, six- and seven-parameter transformations to investigate the characteristics of the transformation, the effect of redundancy and the influence of gross errors. In the course 'Positional Accuracy Improvement in GI Databases' interactive Flash exercises were developed where participants could move vectors into 'improved' positions and evaluate and report the knock-on consequences.

### **2.2 Enhancing the Learning Experience**

EduServ participants come from diverse educational and cultural backgrounds and are not required to possess any formal academic or personal qualification because it is important not to impose barriers to accessing this type of educational resource. However, participants must possess a working competence in Information Technology (IT). The pre-course workshop helps to identify and remedy weaknesses in this area.

In order to gain knowledge from eLearning courses the learner must find them stimulating and enjoyable. The two-day pre-course workshop is carefully designed to include a social element to give participants time to relax and get to know course tutors and fellow participants. Background presentations on each course topic are presented in a semi-formal manner. In other words, whereas the presenter will use standard conference-typical delivery methods, frequent interruptions with questions and clarifications are encouraged. In this way the participant is helped to feel part of the EduServ process.

During the course, the participant has access to a range of material, some online and some offline. Frequent use of the internal conferencing facilities of the eLearning platform helps to inform the learner of progress and give encouragement where necessary.

The correct balance of content and assignments is essential in enhancing the learning experience. The degree of difficulty of the assignments should increase gradually from the first to the last and be of such complexity that extends the learner without requiring too onerous a commitment within an already busy work schedule.

### **2.3 Sharing Experiences**

Bringing course participants together from over ten European countries and from a variety of working backgrounds generates a synergy which results in fruitful exchange of experience. EduServ organizers have noticed a significant unanticipated benefit of the pre-course workshop, that of providing a forum for the inter-country exchange of ideas on the practical implementation of methods covered by the courses. This, in turn, informs the course tutors of the practical realization of theory in busy GI production environments, which can only improve the effectiveness of current and future course development.

### **2.4 Accessing Experts**

EuroSDR, by its nature, brings delegates from GI production and user organizations together with GI researchers and experts. It is a natural philosophy of EduServ, therefore, that course participants should enjoy effective access to course tutors. All course tutors are invited to participate in the pre-course workshop including the social events. For mid-career staff following CPD courses, there is often a perceived barrier between them and the so-called experts in the field. This barrier is intended to be removed in EduServ.

Participants are encouraged to ask as many questions as they need of tutors throughout the course in order to maximize their understanding and gain maximum benefit from participation.

Course tutors, generally invite participants, where practical, to maintain this contact long after the EduServ courses have finished.

### 2.5 Establishing Contacts

Course participants are encouraged to exchange contact details, thereby becoming part of a network, which they can utilize in the future as appropriate. The effectiveness of this has not yet been monitored by EuroSDR and represents an interesting exercise to be undertaken by the taskforce in its regular reviews of EduServ. Anecdotal evidence suggests that such contacts are difficult to maintain in the context of busy and changing working environments.

## 3. DELIVERING EduServ

### 3.1 EuroSDR Taskforce on Education

EuroSDR created a Taskforce on Education in 2001 under the chairmanship of Professor Joachim Höhle of Aalborg University (Höhle 2004). Its tasks are to

- Organize the annual EduServ installments
- Select course topics together with EuroSDR project leaders and workshop organizers
- To monitor the effectiveness of the EduServ series and report to the EuroSDR Steering Committee.

To date, the taskforce has overseen three EduServ installments. Prior to EduServ3, courses were delivered in

- Automatic Orientation of Aerial Images on Database Information
- Integrated Sensor Orientation
- Airborne Laser Scanning and Interferometric SAR

Further information about the EuroSDR Taskforce on Education is available at its website <http://www.plan.aau.dk/~jh/eduserv/>.

### 3.2 Course Development

The development of eLearning courses requires a significant commitment of time and resources on the part of course developers. The development of eLearning courses may, therefore, not be a realistic expectation in many cases of EuroSDR research activities. However, the availability of a course template and access to a learning technology team can greatly facilitate the development of such courses by reducing the workload of the project leader.

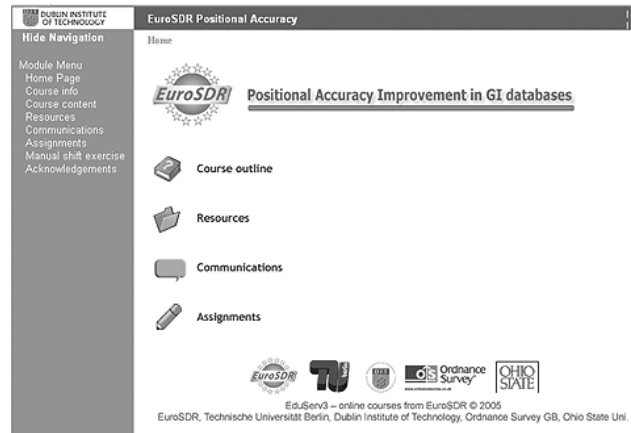


Figure 1. The Homepage of one of the EduServ3 eLearning courses showing the structure of the course and navigational links

In the case of EduServ3, the Learning Technology Team of the DIT had previously developed an eLearning template for courses of the Department of Geomatics (Martin et. al. 2003) and adapted it to accommodate two of the EduServ courses.

The template has been designed with the following sections:

- Course Outline (including the intended learning outcomes)
- Course Requirements (such as schedules, assignment and other key dates)
- Introductory (Pre-course workshop) Seminar Presentations
- Course Material (divided into logical sections)
- Reference Material (recommended reading, online/offline/references)
- Practical Exercises (to include any required download programs)
- Assignments
- Gallery (Photo of each course tutor and possibly each participant)
- Contact Information (EuroSDR, tutors)
- External Links (course specific and relevant general links).

Course material content pages include

- A java enabled means of interactive graphic illustration
- A comprehensive glossary of terms and
- The facility for self testing through multiple choice questions

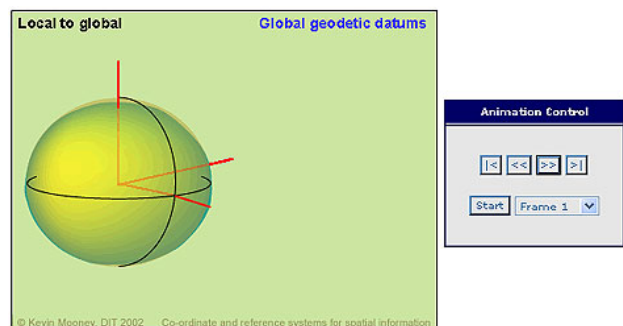


Figure 2. An interactive Applet allowing course participants to step through a detailed set of illustrations of a complex concept.

It is intended that content for future courses may be provided in generic form by topic experts and 'dropped into' the template requiring a minimum amount of editing and linking to produce

the Internet-enabled course. It is worth stating that course material developed for eLearning must meet the high standard demanded by participants who, themselves, are professionals used to a high level of performance in their own work area. Any material developed for such courses will, of course, have a life outside of such courses and many course developers use the material for multiple courses in their own institutions, thereby justifying the investment of time in its development.

However, it is important to emphasise that this 'technical' element is but one part of the course development. The pedagogical aspects of the course design are of equivalent or more importance. If the learning experience for the participant is a fulfilling one, then it will also be productive. Course designers must, therefore, give serious consideration to this aspect of the development of their courses. They must achieve an appropriate balance of content and tasks that stimulate the learner, while providing a rich source of up-to-date reference material and sources. Above all, courses must encourage as much learner/learner and learner/tutor interaction as possible.

### 3.3 The Host Organisation

Each installment of EduServ is hosted by a different organization, which may or may not also provide one of the courses. EduServ3 was hosted by the DIT in Ireland. The host organization is responsible for all logistical arrangements relating to

- Marketing of the courses (together with the EuroSDR taskforce and Secretariat)
- Enrolling of students
- Collection of course fees
- Organization and hosting of pre-course workshop
- Provision of appropriate support throughout the courses

### 3.4 Marketing of the Courses

EuroSDR is anxious that those individuals, who might benefit from EduServ courses, should be aware of the courses on offer and how to apply for them. Marketing can always be improved and the organizers rely on extensive emailing lists and promotion through all usual channels.

It has become clear from a review of the country of origin of course participants that marketing should be improved in those countries that do not enjoy a comprehensive 'basket' of resources for the CPD of GI staff, such as the smaller and emerging European states.

## 4. EduServ IN CONTEXT

### 4.1 Continuing Professional Development

Due to rapid technological advances and the changing needs of users of geographic information there is a constant need for the updating of skills of the staff of GI production organizations such as national mapping and cadastral agencies. NMCAs increasingly identify the CPD of their staff as an area of vital importance and many allocate a significant percentage of their annual budget to training and development (Kirwan and Greenway, 2002). Until recently, CPD within NMCAs has taken one of three forms (Martin et. al., 2003) i.e.

- In-house short courses or seminars directed at small groups of key staff,

- Distance-learning courses from 'Open Universities' and other Colleges and Universities, and/or
- Limited study leave for individual courses.

However, such traditional CPD methods of training are not always practical in a busy working environment due to:

- Disruption to the organization when short courses are held for large numbers of personnel,
- Inadequate dissemination of information provided by in-house seminars,
- Difficulties in accessing various courses due to location, as traveling often impinges on work time, and
- Difficulties experienced in sourcing relevant CPD courses.

It has clearly emerged in recent times that distance eLearning represents a valuable resource for the CPD of staff in GI organizations (Höhle, 2004; Mooney & Martin, 2004). This is particularly so in the case of countries where CPD resources are not widely available. In such cases, eLearning can provide access to a wide range of otherwise inaccessible courses if properly managed.

### 4.2 International eLearning Networks

It makes very little sense to duplicate the considerable effort involved in developing eLearning courses. Wherever possible, resources should be pooled to the benefit of the target community of learners. This is not always practical and certainly not a trivial matter. Issues relating to language and cultural differences between countries together with variation in national education systems can lead to barriers to such integration.

The EduServ series, however, brings a disparate group of learners and teachers together and successfully combines courses from different education centres in Europe and beyond. It demonstrates the potential of collaboration in course development and delivery in the GI disciplines.

Various Directorates of the European Commission, from time to time, issue funding to support a variety of eLearning initiatives, particularly those which support lifelong learning, cultural understanding and those that reach outside the European Community. Such funding sources should be exploited by the GI community in order to more effectively bring the potential of eLearning to those that require it.

### 4.3 Awards

Course designers must be sensitive to the consequences of their marking and award schemes. It must be realized that the essential purpose of EuroSDR's courses is to transfer knowledge and skills. The marking of, and feedback to, the submitted assignments should aim to identify strengths and weaknesses in a participants understanding and remedy the latter in so far as practical. Grading should be avoided where possible, particularly where a participant's status within an organization might be affected.

However this presents course designers with an important difficulty. Many potential participants and participants of courses with which the author has been associated have expressed the wish to receive an accredited recognized award on completion of the courses such as ECTS (European Credit Transfer Scheme) credits (Mooney & Martin, 2004). ECTS

credits can only be awarded, however, following the assessment and grading of participants.

## 5. CONCLUSIONS

Participants have reacted positively to EduServ courses as reflected in workshop feedback questionnaires and end-of-course questionnaires. They regard eLearning resources of this type as useful and are likely to undertake similar courses in the future. They report, however, that the time commitment to following the courses is significant and onerous in the context of continuing work responsibilities. They expect and demand a high standard of course material and interaction with tutors.

EuroSDR recognizes that its EduServ series provides a CPD resource among many resources that are available to GI production organizations in Europe. It is clear from the countries of origin of participants in EduServ courses that some countries enjoy more CPD resources than others and therefore may not regard the courses as providing an economical or useful addition. However, EduServ courses frequently cover topics not widely covered through eLearning resources elsewhere. It is hoped that effective marketing of EduServ courses will bring them to the attention of those members of staff of GI organizations that can benefit from their content and who are required to effect the practical implementation of many of the outcomes of research developments.

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## **DISTANCE LEARNING COURSES FOR DISSEMINATING REMOTE SENSING TECHNOLOGY AND ENHANCING UNDERGRADUATE EDUCATION**

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### **Commission VI, WG VI/4**

**KEY WORDS:** Remote Sensing, in-service teacher training, e-learning, distance education, TelEduc, CBERS, SPRING.

### **ABSTRACT:**

This paper presents the results of three seven-week distance education courses entitled The Use of Remote Sensing for Environmental Studies for Undergraduate Professors. In Brazil distance learning has become a crucial tool for broadening education outreach to its territory and making available quality programs and materials to different audiences. Among selection criteria, student geographic location was one of the most important. Students residing far away from the Brazilian Institute for Space Research (INPE) headquarters had preference, because they have less chances of attending courses at INPE and less access to information.

The main goal of these introductory courses is to diffuse the use of remote sensing as part of the curriculum and pedagogical resource to teaching science topics in universities. The objective is to create collaborative learning opportunities through on-line courses for in-service college educators fostering their continuing professional development, reinforcing the importance of applying new technologies and encouraging them to disseminate what they have learned among students and colleagues.

A free distance education software called Teleduc has been used to support these web-based courses. It has facilitated the interaction among students with different backgrounds (Geography, Geology, Agronomy etc.) creating a rich cooperative environment.

Hands-on exercises have been made available through specially structured tutorials and selected datasets. Students are encouraged to use SPRING (INPE's image processing free software) and gather data for their own study areas among the several public sources available (CBERS and LANDSAT images, digital maps, SRTM topographic data etc.).

The outcome of these courses has been extremely positive. It turns out that on-line courses meet the need for flexible and interactive training enabling students to increase their knowledge and dissemination skills. Our group intends to keep improving and encouraging the creation of more advanced distance courses such as remote sensing applied to Hydrosphere, Agriculture, and Urban Studies.

### **1. INTRODUCTION**

One of INPE's main goals is to foster scientific research and build professional skills in the fields of Space and Atmospheric Sciences and Applications, Space Engineering, and Earth Observation Technology Applications. Remote Sensing education started in 1972 as one of the missions of INPE's Earth Observation Coordination (OBT) when a Masters degree program was created. More recently, in 1998, a Doctoral program was also established.

In July of 1998, the Remote Sensing Division (DSR/OBT) offered a first forty-hour course for elementary and high school in-service teachers from both public and private schools entitled "The use of Remote Sensing for studying the Environment at School Settings". Since then, INPE has been offering this course every year and it has been very successful

in disseminating the use of remote sensing as an educational tool among teachers. Since 1999, the Image Processing Division (DPI/OBT), in partnership with SELPER-Brazil (Society of Latin-American Specialists in Remote Sensing), has offered conventional (presential) short-term courses aiming at supporting the usage of geotechnology in Brazil. The students come from a variety of backgrounds and application interest areas such as geology, geography, engineering, cartography, etc. Most of them work at institutions or companies that require an application of remote sensing at some level.

The demand for courses has been increasing over the past few years and INPE has not been able to match it. There is a limitation in the number of instructors available for teaching as well as suited facilities. Moreover, students usually have limited financial resources that precludes them from traveling since many of them live in cities far away from São José dos Campos (where INPE headquarters is located). Therefore, most of them have to pay not only for the

course but also for accommodation, food, and local transportation.

In order to provide means of access to information considering the current scenario, the authors of this article formed a group at INPE with the task of redesigning the educational outreach program and defining new methodologies that could effectively replace traditional classroom learning environments. With the strong belief that e-learning (a combination of education and Internet using different web technologies) is the answer for attending INPE's demand for an effective educational delivery system, our group has decided to invest on distance education courses.

There are several advantages in using this new approach to education, such as flexibility of time, independence of geographic location and distance, more cost-effective meaning than in-person training, and the adoption of a learner-centered approach where learners control their learning pace and development. The efficiency of distance education must involve constant interaction among teachers and students, students and e-learning environment, and among students themselves. One of the main challenges that our group (and most other groups) faces today is to reach a high quality standard on e-learning courses.

In May of 2004 we created our first e-learning course ("The Use of Remote Sensing for Environmental Studies for Undergraduate Professors") aiming at disseminating Remote Sensing as part of the curriculum and pedagogical resource to teaching science topics in universities. The main idea was to create collaborative learning opportunities for college educators fostering their continuing professional development, reinforce the importance of applying new technologies, and encourage them to disseminate what they have learned among students and colleagues. There has been offered a total of three courses up to this date and the last two were offered in August, 2004 and February, 2005 with improvements based on suggestions received from students.

The remainder of this paper is organized as follows. Section 2 presents the materials used in the courses. Section 3 describes and compares the three courses taught and the methodologies applied in each of them. Finally, conclusions are drawn and suggestions made for further initiatives related to improving remote sensing e-learning.

## 2. MATERIALS

The in-service teacher training courses were carried out using a distance education managing system called TelEduc. A combined image processing and GIS freeware package called SPRING ([www.dpi.inpe.br/spring](http://www.dpi.inpe.br/spring)) with Portuguese, Spanish and English versions was also used. This software is a state-of-the-art GIS and remote sensing image processing system with an object-oriented data model which provides for the integration of raster and vector

data. Selected instructional materials including books, CD-ROM, and specific tutorials were used in the courses. The book entitled "Satellite Images for Environmental Studies" (Florenzano, 2002) was one of the main sources of remote sensing information. This book provides information on satellites and sensors, image interpretation, and remote sensing applications to environmental studies. The interactive educational CD-ROM entitled "Remote Sensing: Applications for Preservation, Conservation and Sustainable Development of the Amazon" (Dias et al., 2003), along with the book, were sent to all students by mail. This CD-ROM is divided in three sections (1) introduction to preservation and conservation, (2) introduction to remote sensing principles and satellite image processing, and (3) Amazon case studies based on LBA-Ecology research. The CD includes several high quality graphics, animations, audio, video, interactive activities and quizzes. Many aspects of this CD-ROM are based on an existing set of CDs developed by Indiana State University under a NASA grant (Mausel et al., 2001). Specially structured tutorials for guiding students on digital image processing techniques including procedures for image registration, enhancement, segmentation, and classification (Mello et al. 2004) were prepared and made available to students for download. These tutorials include a selected example of satellite images over the Brazilian Amazon (CCD\_CBERS images Orbit\_Point: 165\_112 of bands 2, 3, 4 for 2004/06/24 - <http://www.dgi.inpe.br/CDSR>) for student hands-on experience. The GeoCover Orthorectified Landsat Thematic Mapper Mosaics were used for geometric correction of CBERS images (Figure 1) during the course (GeoCover Mosaic - Chart S 21-10 ; <https://zulu.ssc.nasa.gov/mrsid/>).

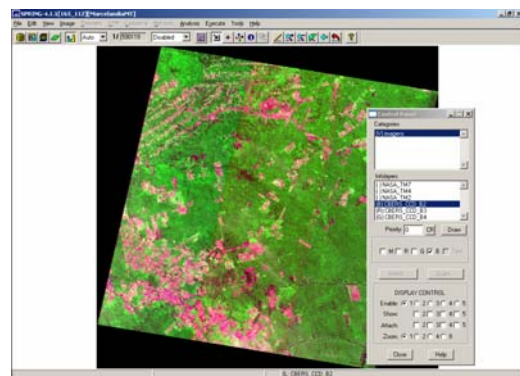


Figure1. The color composite image of the study area processed and displayed by SPRING (CCD\_CBERS bands 2, 3 and 4)

## 3. METHODOLOGY

The first e-learning course (a pilot experience) lasted three weeks and had four instructors and 18 students. The second and third courses lasted seven weeks and had 30 students selected in each course. There were four instructors for the second course and seven for the third course. Undergraduate professors with different backgrounds (Engineering – Civil,

Agronomic, Agriculture, Environmental and Fishing, Geography, Biology, Architecture, Chemistry, Physics and Geology) were selected (see Table 1):

Course	Eng.	Geog	Bio.	Arc.	Che.	Phy.	Geol
1	8	2	3	1	-	-	-
2	10	5	1	1	1	-	4
3	7	8	2	2	-	3	2

Table 1 – Backgrounds of enrolled undergraduate professors

Student selection criteria included geographic location as one of the most important. Students residing far away from the Brazilian Institute for Space Research (INPE) headquarters had preference, because they have more difficulty in attending courses at INPE and, also, have less access to information.

The first course was structured with a predicted student involvement of twelve hours per week, distributed between classes (mandatory ones), activities, and complementary and optional readings, in addition to a weekly chat with instructors. The activities included the development of a project proposal that should incorporate an environmental theme addressed by a remote sensing technique. Students were encouraged to use the software SPRING and gather data for their own study areas among the several public sources available (CBERS and LANDSAT images, digital maps, SRTM topographic data, etc.).

The total of nine classes (three per week) in the first course covered the following topics: 1) How to use TelEduc and prepare a project proposal, 2) Basic environmental concepts, 3) Remote Sensing principles, 4) Image Interpretation, 5) Image processing, 6) Examples of Remote Sensing applications, 7) Proposal preparation help through distant student advisement, and 8) Final evaluation and assessment.

The content of the second and third courses was basically the same as the first course, but with more emphasis on digital image processing and divided in two classes per week. The increased length of these courses, as well as the extended chat sessions in two periods (morning and afternoon) were implemented due to student suggestions received during the evaluation of the first course. Besides these changes made in advance, several small adjustments were made during the courses, such as, the addition of three more instructors and the use of extra chat sessions (some at night).

The instructors, students, instructional materials and software (TelEduc and SPRING) were evaluated at the end of the three courses by all participants. Students were also asked to make a self-assessment of their performance during the course.

#### 4. RESULTS AND DISCUSSION

According to the literature, the average dropout of distance education courses is near 30%. This percentage was also observed in the three courses implemented (see Table 2).

Course	Candidates	Selected	Enrolled	Conclusion
1	61	18	14	11
2	96	30	22	14
3	65	30	24	18

Table 2 – Number of candidates at the beginning and at the end of the courses

Table 3 presents some of the results obtained from the three courses regarding the widespread participation of undergraduate professors from all regions of Brazil with different academic backgrounds.

Courses/ Regions	N	NE	SE	CW	S	Latin- America	Total
Course 1	1	2	7	3	1	-	14
Course 2	5	10	4	2	1	-	22
Course 3	5	7	3	3	4	2	24

Table 3 – Enrolled students by region

During the chat sessions the average participation was six students. However, most of the instructors were present in all sessions. At the beginning of the third course the students were asked about the best times to conduct the chat sessions considering their own schedules. Based on their answers the most selected weekday and times were used for setting the schedule of the chats. Their relative participation in the chat sessions, however, did not increase significantly (seven students). Our experience shows that chats are one of the most important tools for e-learning since it provides synchronous interaction among all participants. In the other hand, this tool, according to Otsuka et al. (2003) is the most difficult to utilize successfully in a distance education environment. Our group intends to explore new ways of improving and encouraging student participation with synchronous strategies.

The best student performance was obtained in the third course mainly due to the introduction of the specifically designed image processing tutorials. This is because students usually have little background in image processing techniques and have difficulty learning such complex and unfriendly packages (e.g. SPRING) in a couple of weeks.

Overall both materials and instructors received good evaluations for most of the students in all three courses. TelEduc demonstrated to be a robust and reliable distance education managing system that had the crucial role of supporting courses' development and performance during implementation. All the students evaluated this system as being very efficient and friendly.

## 5. CONCLUSIONS

Despite of the traditional difficulty in learning complex knowledge such as remote sensing techniques, most students had a good performance in the tasks proposed and were able to learn the concepts, principles and processes presented. The results were even more satisfactory considering the wide range of topics covered and the diversity of the student population that usually affect negatively the learning that takes place in distance education courses. The outcome of these courses was positive showing that learning about image interpretation and image processing is possible through e-learning. We attribute the success of teaching such complex topics via e-learning to the quality of the materials provided to students and the amount of support given to students by each and every instructor on top, of course, the exceptional dedication to learning demonstrated by most students.

However, additional adjustments are needed in order to improve course performance, such as course duration, tutorial updates and evaluation improvement. Exploring additional tools that constantly become available via new versions of TelEduc released every year is also needed. One of the improvements that will be implemented in the next version of the course in providing an extended session on cartographic concepts and a new session presenting semi hands-on case studies.

The experience acquired during the first three courses encourages this group at INPE to invest in developing new courses focusing on more advanced topics to be taught via distance education courses, such as remote sensing applied to the hydrosphere, agriculture, and urban analysis.

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## CUSTOMIZING LECTURES AND EXTENDING THE CONTENT POOL BY USING *GEOINFORMATION.NET*

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**KEY WORDS:** Blended Learning, Maintenance, Learning Environment, Future Trends

### ABSTRACT:

The internet platform *geoinformation.net* offers 14 modules with a huge amount of content to support blended learning proposals. The content covers a basic set of academics with the intention to provide a basic curriculum for geoinformation.

A fundamental concern during the development of *geoinformation.net* was to ensure a maximum of flexibility in terms of content combination and extensibility of the content pool. Closely connected with this point was the hope to increase the level of content reuse by reducing the content adoption barrier level.

Starting from the *geoinformation.net* platform there are several demands to make on the functionality of the interaction tool, the LectureBuilder. Those demands include technical demands on the one hand and interaction demands on the other hand. Due to this, one demand was to support the *geoinformation.net* specific lecture navigation, as described in (Steinrücken&Plümer, 2004), and the *geoinformation.net* specific stylesheets for any lecture created by the LectureBuilder. Furthermore a user management is required to remember once created lectures of registered users to enable them to edit these lectures and then download them again.

To achieve a long-term usability of the LectureBuilder and the connected product, the lectures, the LectureBuilder is based on popular international standards, like the content modules. These standards are in particular standards of the world wide web consortium [W3C] (XML, HTML et. al.). This proceeding compared with proprietary solutions offers several advantages like no license fees, downward compatibility of standard successors and a high level of interoperability. These are advantages which are essential for the long-term availability of project contents and services. In addition a couple of presentation tools like PowerPoint offer the possibility to export HTML and open by this way a possibility to generate slides to expand the content pool of *geoinformation.net*.

Nowadays the LectureBuilder tool is available via <http://www.geoinformation.net>.

### KURZFASSUNG:

Die Lehr- und Lernplattform *geoinformation.net* stellt im Internet mit den 14 Lernmodulen bereits einen umfangreichen Satz an Material zur Unterstützung von Blended-Learning-Angeboten bereit. Hierbei handelt es sich um einen Fächerkanon, wie er für die Lehre im Rahmen eines Geoinformationscurriculums benötigt wird.

Ein wesentliches Anliegen bei der Entwicklung der Plattform *geoinformation.net* war hierbei eine möglichst weitgehende Flexibilität hinsichtlich der freien Kombinierbarkeit von Materialien und Erweiterbarkeit der Materialsammlung zu erreichen. Hiermit verbunden war die Hoffnung hierdurch die Hürden für eine Übernahme der Vorlesungsmaterialien an nicht projektbeteiligten universitären Lehrinrichtungen zu senken und dadurch die Chancen einer Wiederverwendung zu erhöhen.

Aus der Plattform heraus ergaben sich jedoch auch Anforderungen an die Funktionalität des Interaktionswerkzeugs des LectureBuilders. So muss für alle herunterladbaren Vorlesungen gewährleistet sein, dass sie über die in (Steinrücken&Plümer, 2004) beschriebene Navigation verfügen und dem projekteigenen Layout folgen. Außerdem sollten einmal zusammengestellte Vorlesungen nachträglich geändert und/oder ergänzt und dann erneut heruntergeladen werden können, was eine Nutzerverwaltung notwendig macht.

Um eine langfristige Verwendbarkeit des LectureBuilders zu erreichen wurde, wie bei den Lernmodulen auf verbreitete internationale Standards gesetzt. Insbesondere sind dies die Standards des WWW-Consortiums (u.a. XML, HTML, CSS, JavaScript). Dieses Vorgehen bringt gegenüber proprietären Lösungen mehrere Vorteile mit sich, wie z.B. das Entfallen von Lizenzkosten und eine Abwärtskompatibilität von Nachfolgestandards. Gründe die eine langfristige Verfügbarkeit der Projektergebnisse leicht verhindern können. Daneben bieten verbreitete Präsentationswerkzeuge wie z.B. PowerPoint die Möglichkeit HTML zu exportieren und öffnen somit eine einfache Möglichkeit um Folien zur Ergänzung des Folienpool zu generieren.

Der LectureBuilder ist mittlerweile in der Version 2.0 online auf <http://www.geoinformation.net> verfügbar.

## 1. INTRODUCTION

The creation process of a lecture requires a huge amount of time to plan the general layout, design the slides and generate the required animations. Even if there are no actual didactical and design research results taken into account.

A reduction of the time quota for the creation phase of a lecture results in a reduction of its perceivability. This may lead to a higher workload for connected exercise courses and a lack of understanding within constructive lectures.

By increasing the rate of reuse it is possible to avoid these problems on the one hand and to reduce the time quota needed for lecture creation on the other hand. One precondition for such a kind of proceeding is publicly accessible, well documented teaching material with a high didactical and design quality level. It is also important to ensure flexible combination capabilities for the available teaching material. Nevertheless such a kind of a teaching material pool offers the opportunity to provide the material of a lecture for pre- and postprocessing which should be done by the students.

Nowadays many universities like the University of Stuttgart (<http://www.uni-stuttgart.de/online/>) or the Massachusetts Institute of Technology (<http://ocw.mit.edu/index.html>) provide teaching material online via the internet.

The internet platform *geoinformation.net* represents the teaching material pool for the LectureBuilder tool, which will be presented within this article. The whole teaching material is publicly available, freeware and enfold a basic curriculum for geoinformation. The material from the pool can be downloaded as prefabricated lectures or via the LectureBuilder as collection to generate new customized lectures. Further features of the LectureBuilder are the capability to generate offline lectures, the upload and integration of new material and the generation of a consistent layout and navigation.

Parallel to the project *geoinformation.net* there have been several other projects in the context of blended learning like GITTA (Weibel, 2004) (<http://www.virtualcampus.ch>), FerGI (Schiewe et al., 2004), gimolus (Müller, 2004) (<http://www.gimolus.de>) and WEBGEO (Sauer et al., 2004) (<http://www.webgeo.de>). The focus of those projects was the creation of e-learning material and connected tests for self-study at home or exercises.

Another important difference exists within the access authorization and the size of the atomic components. Each of the projects mentioned before requires a registration to access the teaching material and some of them, like FerGI, require special proprietary software to gain access. All of the projects have blocks of slides as atomic components.

## 2. TECHNICAL CONCEPT

By developing the LectureBuilder *geoinformation.net* meets the demands of its users, who want to adapt the teaching material to their context. This capability is given within commercial presentation software like PowerPoint, which supports the reorganisation of the slides within the sequence of the lecture. Similar features should be realised to support the reorganisation capability for the slides of *geoinformation.net* given as HTML files, to automatically generate the lecture navigation described by (Steinrücken&Plümer, 2004) and to apply the *geoinformation.net* specific stylesheets. The features have to work with the *geoinformation.net* slides as well as with the slides uploaded by the users.

### 2.1 Data pool

The data pool of *geoinformation.net* is organised by using the file system as shown in fig. 1. Any slide, its metadata file and its connected content like images are in separate folders, which are the atomic parts of the data pool. The connected metadata file contains information about the author, the copyright and the creation date. All the slide folders that belong to one lesson are in one folder and all the lesson folders belonging to one modul are grouped in one folder. All modul folders together constitute the data pool of *geoinformation.net*.

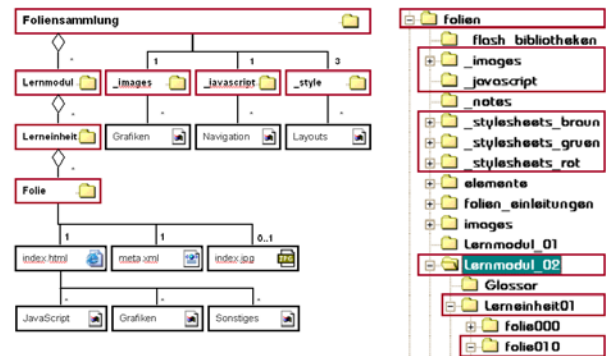


Figure 1 : Structure of the data pool

This internal structure has to be taken into account during the creation of new lectures, because there are several compartments of the HTML file like scripts or stylesheets which are referenced by relative links within the HTML files. If there are any changes within the folder structure, this will lead to layout and navigation problems that could only be removed by editing every HTML file.

The pool index is generated by a separate tool, which also ensures correct metadata files and detects the local content files associated with the HTML files.

Every uploaded slide has to be integrated into the structure described above and has to get a metadata file. During the upload process many changes will be performed within the source code of the HTML file to integrate the geoinformation stylesheets and the navigation scripts. Any registered user will get an individual modul folder, which contains a lesson folder for separate uploaded slides and separate folders for every lesson uploaded as zip file with more than two slides.

Other users will be handled as guest and can upload only single slides into the default folder of the guest modul folder.

### 2.2 Features

The LectureBuilder provides several features. The central feature is the composition part where new lectures can be created and downloaded for later use. The realization of this feature is based on a combination of HTML and JavaScript. Both are supported by any common browser like the Mozilla Firefox or the Internet Explorer. One important reason for the shift from the java applet technology to the new technology was the reduction of loading time and the chance to resign the java plugin. Created lectures will be served as zip archive, which contains the slides, the associated metadata, all navigation scripts, stylesheets and required images.

The second feature is the upload part, which accepts HTML, jpg and zip files. Uploaded separate html files will be supplemented by stylesheet and script code for navigation and layout reasons. Uploaded separate jpg files will be embedded in a new generated html file. Uploaded zip files will be decompressed and the packed html files will be transformed into *geoinformation.net* conform files in separate folders. This process can handle as html exported PowerPoint presentations if they were submitted as zip archives. Animations will be removed during the transformation process. For every generated or transformed slide a metadata file will be generated.

The uploaded files will be publicly available and cannot be removed or edited by the user.

The third feature is the user management. This feature enables users to become registered user. While a

registered user is logged in any downloaded lecture will be remembered and can be reopened for editing. Registered users have the advantage that during the upload process some metadata will be derived automatically from the user registration informations.

### 2.3 User interface

The user interface has four parts (Figure 2).



Figure 2: menu of the LectureBuilder portal

The first part is the lecture composition part as shown in Figure 3 and Figure 4. On the left hand side (Fig. 3) can be found the slides available in the pool on *geoinformation.net*. The modules, their lessons and slides are organized in a tree structure. The modules and lesson can be opened by the plus symbol (Figure 3: Nr. 1) in front of the connected name (Figure 3: Nr. 5+6) and closed by the minus symbol (Figure 3: Nr. 2). Behind any modul or lesson there is a button to deselect all slides within the modul or lesson (Figure 3: Nr. 7+8). If a lesson is open, any slide in this lesson can be selected by using the associated symbol (Figure 3: Nr. 9). The metadata of a slide can be accessed by using the document symbol (Figure 3: Nr. 4) in front of the slide title (Figure 3: Nr. 3). Behind the slide title is a checkbox (Figure 3: Nr. 10). Checked boxes represent selected slides. If slides are selected, they will be automatically added to the new lecture (Figure 4), deselected slides will automatically be removed.

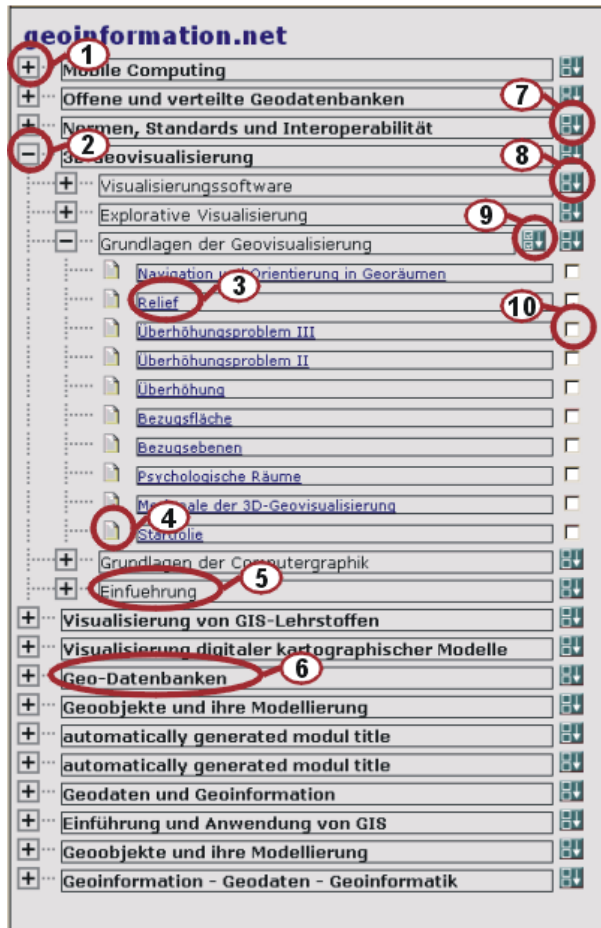


Figure 3: visualization of the accessible pool content

On the right hand side (Fig. 4) can be found the created lecture. Any slide is listed in the presentation order. The order within the lecture could be reversed by using the reverse button (Figure 4: Nr. 7). By clicking the slide title (Figure 4: Nr. 3) it is possible to get a preview of this slide, which will be opened in a new browser window. The metadata can be accessed by the associated document symbol (Figure 4: Nr. 2). Selected slides can be moved up (Figure 4: Nr. 5) or down (Figure 4: Nr. 6) by the up or down symbol. A slide can be selected by checking the checkbox in front of the slide (Figure 4: Nr. 1). The slide navigation type could be selected by the combo box behind the slide (Figure 4: Nr. 4). Possible navigation types are linear for content slides, tiefe for slides with additional information and examples for one content slide and zwischen for slides which do not contain content but separate topics of a lecture. Finished lectures can be downloaded by using the download button (Figure 4: Nr. 8).

The second part is the upload part. The upload part is realized as a combination of html forms and java servlets. First of all the user has to submit a html, jpg or zip file in combination with information that is needed to create the metadata. If zip files are submitted the title tag in its html files will be taken to generate the slide titles within the metadata. Wrong file types of submitted files will be detected and rejected. In this case the servlet generates an error message.

If a single html file is submitted the system performs a check routine to ensure that all relative to the html file referenced parts will be submitted to. To achieve this, a special upload form will be generated.

Submitted zip files have to have all the needed relative linked parts for any of its html files inside. No framesets are allowed. Otherwise an error message will be generated.

The third part is the user management. The user management opens an easy way for users to perform changes within once downloaded lectures and supports the metadata creation by auto completion.

The fourth part is the online documentation.



Figure 4: Creating a lecture with the LectureBuilder

The final product (Figure 5) is a compressed presentation, provided as zip archive. The archive contains all slides,

the associated metadata, the navigation and the layout information. During the decompression process, a geoinformation folder will be created which contains the presentation. The presentation can be started by the index.html file in the geoinformation folder. The substructure of the subfolders of geoinformation is similar to that on *geoinformation.net*.

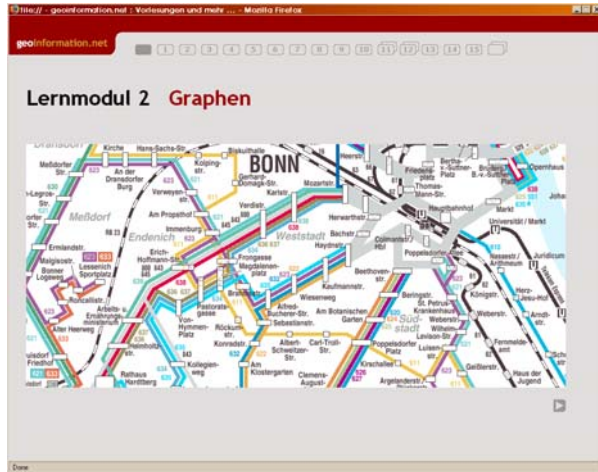


Figure 5: A created lecture

### 3. CONCLUSIONS

The adaptivity, the extensibility and the reusability of the teaching material within the modules was a very important concern during the creation of *geoinformation.net*. Based on this fact the use of open standards and opensource internet technologies was focussed instead of proprietary solutions.

This leads to the fact that users of *geoinformation.net* need to have an internet browser and some plugins like flash but no expensive software systems. The chosen design demands an extra tool to support lecture developers during the lecture creation process to keep the technical complexity of the underlying system out of it. This job does the tool presented in this article. Finally remains the hope that the tool will help to keep the created content up to date and boost the reuse quota.

During the development process many required new features could be identified. First of all the internationalisation of the created content. We have had several requests from non-german-speaking countries, which want to integrate the *geoinformation.net* material into their lectures. To fit this demand some future work has to be done.

Another focus of future work will be the changeover to xml as base technology instead of html. This will offer the possibility to have smaller atomic components on a sub slide level and an easy creation of different output formats like pdf or others.

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## VIRTUAL PATIENT - INTERACTIVE STORYTELLING

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**KEY WORDS:** Virtual Patient, Interactive film, *QuickTime*, Type Movie, Data Dialog

### ABSTRACT:

This e-learning simulation project makes it possible for medical students to practice conducting a diagnostic discussion with a "Virtual Patient". Based on these simulated conversations with a "Virtual Patient", the future doctor can practice diagnostic technique, trying to determine the ailment at hand. The patient is played by an actor who acts out a range of reactions. These responses are captured on digital video and organized in a databank. The fundamental principle is to analyze and represent the type of conversation that a doctor would have with his or her patient. Interaction occurs by entering text on the keyboard.

The project focuses on using cinematic means to immerse the user in a situation as close to a real conversation with a patient as possible. The basic idea behind the project is the non-medical specific use of human communication, interaction between individuals, which is essential. This could be expanded on, for example, to incorporate narrative. "Type-Movies" would be feasible, allowing the viewer to respond, in text form, to what is occurring in any space or even contacting the characters in a film, communicating directly with them.

### 1. INTRODUCTION

The combination of moving images - as one of the main technological basics of communication, and text - as the origin of human communication, is the concern of this work.

The topics in this paper vary from basic medical issues over communication theory to technical achievements. Elementary steps of patient-doctor interviewing practices are examined. A short overview about interactive film solutions at the last available state is given. They are objected in their various forms of interaction. Our main instinctive media knowledge is inspected, starting from cinematic rules.

A close look at the approaches of this work is summarized, which leads towards the elements of "Virtual Patient" from the didactic approach, the technical concept to steps of production and the single components and features in detail.

It has to be considered that the point of view of this presentation is that of a Designer and Filmmaker, not of a Scientist. Moreover of someone who is highly enthusiastic about the future of interactive film.

"Virtual Patient" is based on the research program "Visualization and Simulation Environments to Solve Difficult Learning Situations" [VASE1] of the "Learning Lab Lower Saxony" [L3S], Hannover. It has been developed to a preliminary state at the College of Fine Arts Braunschweig "Institute of Media Research" [IMF] in cooperation with the "Karolinska Institute", Stockholm [KI].



Fig. 1. "Virtual Patient" unfold in time

### 2. REVISED DIALOGUE TRAINING

The normal training situation for medical students of anamnesis diagnoses is a setting that

- won't bear repeating identical
- can't be reconsidered and comparable
- can't deliver a high emotional impact.

These elements are required to apply at the same time to deliver a measurable learning curve. Beside this, a presetting of a most realistic simulation of doctor-patient aural confrontation is required, before a real patient is met. A simulation to immerse the student into his future human-to-human confrontation is needed to focus on one of the main challenges the doctor has to solve: To gain information about the person, sitting in front of him - before the body is about to be examined.

### 3. PATIENT-DOCTOR INTERVIEWING PRACTICE AND BEYOND

Skills of special knowledge, e.g. "pathophysiology and clinical epidemiology, at one hand and knowledge of human behavior and social and cultural contexts" [Coulehan/Block, 2001] at the other are the two main basic fields required to interview a person. This can be done with different type of media.

### Student - Book

The main source for our skills are books. From a book the student can retrieve the contextual meaning of different levels of human communication, such as "active listening skills, therapeutic core qualities, symptom words, respect, genuineness, empathy" etc. and the different topics of "patient history" [Coulehan/Block, 2001] or facilitating skills of "questioning and relation-building" [Smith, 1996]. This is the basic information required, but it remains theory until the first interview takes place.

### Student - Student

With a face to face practice students can apply their knowledge prior achieved. One student pretends to be ill - the other does the interview. They know each other and they are studying medicine, not drama. Here a first simulation takes place which helps to shift theory into practice.

### Student - Actor

A practice with a trained actor with special skills, e.g. on patient history facts and symptoms, is another possible training method. This provides the highest emotional impact: the student is confronted with a real person. Although this is preferably the most realistic way to simulate a patient, it's far from being the efficient solution. There are strong limitations in availability, reproducibility, costs, reconsideration and comparability.

### Student - Computer

Various e-learning solutions in all fields of knowledge are developed up to now. They all base on human-machine ergonomic schemes: the user interface with a combination of text, icons and active elements, such as buttons lead to forms of information presented as text, pictures, video, audio, 3D and combinations thereof. This environment is a simulation itself. As long as the main element (the simulated person) has not the topmost focus, such as in size, position, quality and realistic approach, the interaction still remains a human-machine connection.

### Interactive Film

Definitions and solutions on the subject of interactivity in movies do vary from a branch or web-based structure and "spans to new narrative forms with unfamiliar names such as 'elastic media', 'Thinkies', and multithreaded interactive movies" [Hippolyte, 1995]. Any movie with a story time > presentation time can be declared as interactive film as a basic identification. This implies that the user/recipient has a choice to extend or shorten the presentation time. Besides the structure of nonlinear movies, the main challenge for interactivity in this media is the form of interactivity itself, the time interactivity can occur and the point of view (POV). The specifics of synthetic and real images/characters as well as the similarities and differences between interactive movies and games are significant as well. These topics will be dropped here to increase to focus on the most relevant items.

### Form of Interaction

- a random selection, choice is not made by user
- context based selection by mouse click on icons or text
- visual selection by mouse click on elements in the movie
- language based interaction

### Time of Interaction

- decision is made after segments of film
- decisions can be made while movie is playing within a preselections of choices (e.g. multiangle on DVDs, iTV, any level based media, such as games)
- decisions/choices all time

### POV of Recipient

- 3rd person "they do"  
The characters are observed from a god like, objective position (master shot).
- 2nd person "you do"  
The recipient identifies and acts together with the protagonist (e.g. over shoulder shot).
- 1st person "I do"  
The recipient takes part in the story from a subjective position  
(position of camera = position of protagonist AND protagonist = recipient).

### Examples

Most of the interactive media combine elements within the given categories. The following list determines the essential elements in each category. The examples are chosen to present the variety of media which has to be inspected to consider useful elements and forms of interaction.

"Myst, Riven, Exile" © Cyan Worlds, Inc.,  
<http://www.myst.com>, adventure games, 3D environment,  
Form: visual, Time: preselection, POV: 1<sup>st</sup>

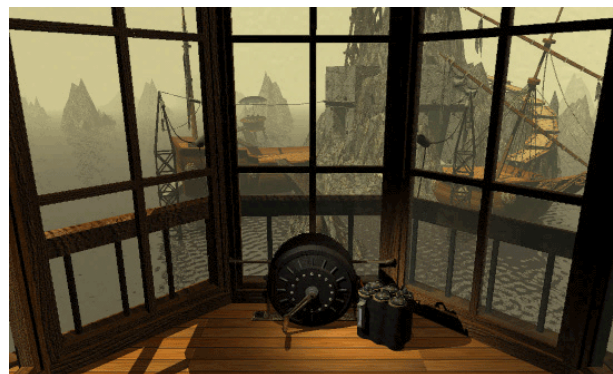


Fig. 2. The adventure game "Myst" © Cyan Worlds, Inc.

"Virtual Cinema" © Hyper Bole Studios,  
<http://www.hyperbole.com>,  
 authoring software for interactive movies,  
 Form: context based, Time: after,  
 POV: 2nd/1st person

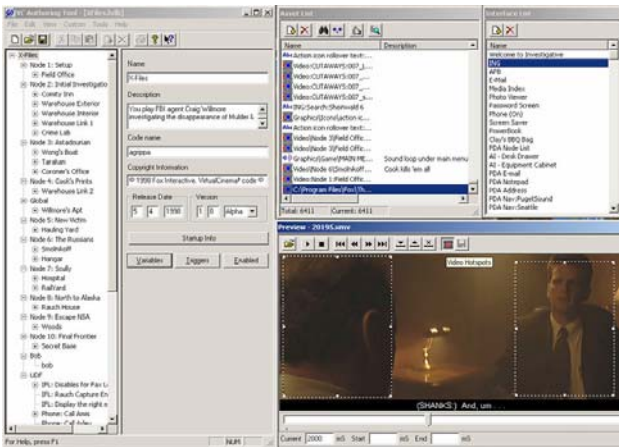


Fig. 3. The Authoring Software "Virtual Cinema" © Hyper Bole Studios

"Korsakow" © Florian Thalhofer, <http://www.korsakow.com>,  
 authoring software for keyword based interactive movies,  
 Form: visual, Time: after, POV: any

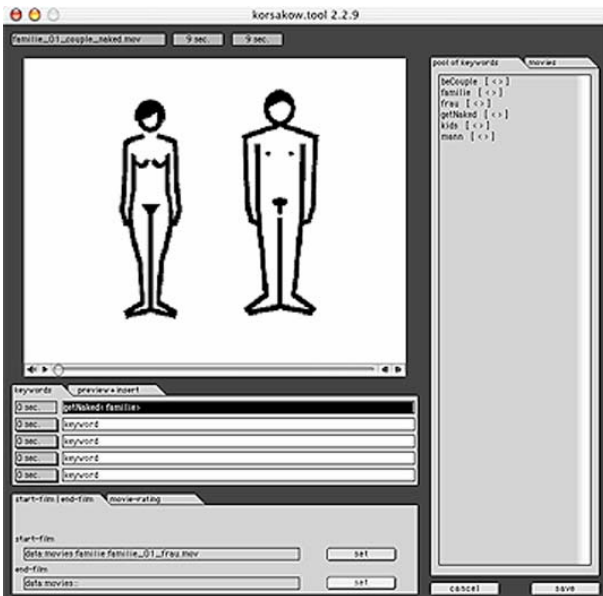


Fig. 4. The Authoring Software "Korsakow" © Florian Thalhofer

"Subservient Chicken" © Burger King,  
<http://www.subservientchicken.com>,  
 online advertisement as interactive movie, Form: language,  
 Time: all time,  
 POV: 1st person

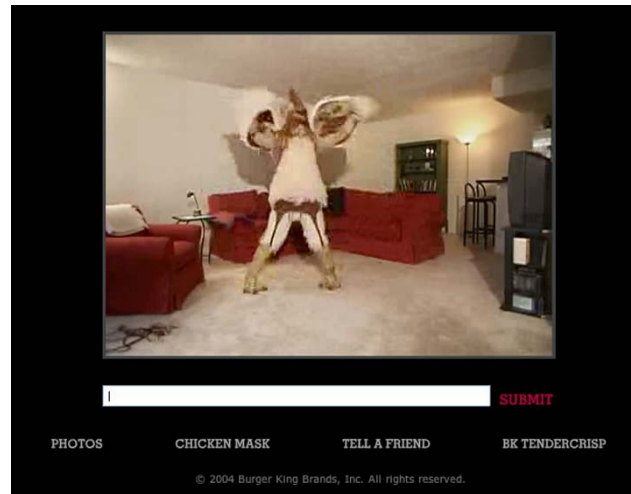


Fig. 5. "Subservient Chicken" online advertisement as interactive movie © Burger King

"ISP Medical History Module" (ISP-VL) © Karolinska Institute Stockholm,  
<http://www.lime.ki.se>  
 patient interview simulation,  
 Form: language, Time: after,  
 POV: 1st person

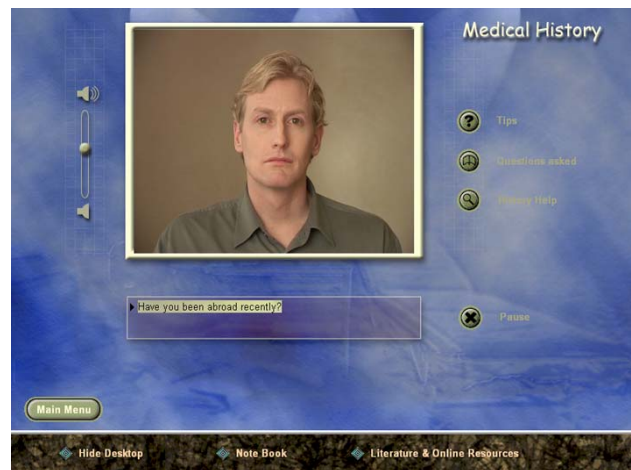


Fig. 6. "ISP Medical History Module" © Karolinska Institute

#### 4. A VIRTUAL PATIENT IN INTERACTIVE FILM

##### 4.1 Interfere with Language

The written word is currently experiencing a renaissance. SMS, email, and chat have "thrown us back" upon our original form of indirect human communication. Yet we automatically associate interaction with the man-machine link, with the computer as a tool that extends the human arm and the symbiosis this produces.

Let us now image we could actively and interactively participate in a film. And our only means of intervening is to flail away with the extension of our arm (mouse or joystick) and to "poke around" with every click: In a manner far removed from how we are used to viewing films, we poke buttons, houses, cars, plants, and people. I feel that current approaches of this sort can at best be termed active because they primarily emphasize motor skills.

What if we really could intervene? Intervene? Yes, I mean becoming interactive in the sense that we could add our opinion to the action! Yet to do so requires that we first downgrade from all the 3D game graphics to the medium I am using here to communicate with you: letters of the alphabet. I would like to intervene in the interactive film by including the keyboard's primary function (M is M and not "shield" and the space bar is a space and not "fire"). I can "speak" to the figures in my film, maybe in a dialog, as an inner voice, as almighty God, or I speak for them.

My research of interactive film is based to a great extent on the experience I have acquired in the international research project "Virtual Patient". This experience involves the semantic structuring and synthesis of a simulated learning environment that allows communication between the user and video material that has been produced in advance, thus enabling the trainee to experience the content from within the context of the film.

##### 4.2 Student - Interactive Film

"Virtual Patient" is studying the possibility of activating, motivating and creating an emotional relationship between students and the characters in simulated learning systems. This is achieved by studying the impact of different techniques to simulate patient history interviewing.

A simulated dialog between physician and patient gives medical students the opportunity to test their diagnostic skills. They can use the keyboard to ask the virtual patient questions that the patient then immediately answers. The application primarily utilizes the language of film to achieve the flow of subjective experience. The basis for the application consists of an extendable system of keyword links that uses a special search algorithm in XML data, a database with specific and generic answers in the form of film clips, and a programmed algorithm for dynamic real-time editing with QuickTime.

Since the form of interaction has to be language based, the time of interaction has to be continuously and the POV must be 1st person for a subjective immersion.

This project continued where the existing WGLN VSP-VL [ISP-VL] and VASE 1 [VASE1] project left off, utilizing recent developments in full-motion video simulation based on editing

patterns established in cinema, in real time. Modern cinematic techniques make a greater degree of realism and depth possible. A main demand for further application has been the aim to use common software. This is required to extend the area of possible users, which run ordinary computers with no hardware extensions. The second attention has been the hybrid employment to develop one solution for local and online use. The only difference of both versions should be video quality, because of bandwidth limits. The online version should still offer all other features.

The list of required features range from:

- large scaled video
- local and online use
- platform independent
- realtime edit
- dynamic montage
- extendibility
- maximum of immersion
- to ease of use

#### 5. THE PARSING AND OTHER APPROACHES

##### 5.1 Text Interaction

As we eliminate other interaction elements other than typed language, there is a strong focus on the keyword parsing. Basically one-word-questions have to be prevented and there are additional elements to provide a satisfactory result. E.g. short term memory keywords have to be read with each answer and dropped with additional answers, regional different meanings might be available, sensitive information is triggered with a continuous questioning only and the character might respond in different moods.

##### 5.2 Video Masses

Because of the cinematic focus of the project, answers are shot with three cameras simultaneously (to provide movie montage behavior). This has to be solved in storage and steps of production and documentation.

##### 5.3 Dynamic Editing and Realtime Behavior

The most challenging feature is the request for a continuous movie-like experience. Together with large scaled video, even in local use this request has to solve various obstacles, such as speed in parsing and loading, as well as the problem to load and play a movie without a noticeable stop or glitch. Not to mention the online problems.

#### 6. HOW TO BRING LIFE TO THE IMAGES?

##### 6.1 Didactic Approach

The didactic approach focuses on improving and encouraging communication in the simulated "doctor/patient" situation. There are clear stages in this type of conversation: the introduction, small talk to "break the ice", the diagnostic issues at hand, waiting (the patient waits for reactions at various points in a diagnostic conversation), comments (to the doctor's remarks, not questions per se) and various reasons for breakdown in communication (misspelled questions, time out,

loosing the patient's confidence). This ought to aid the process of establishing some sort of relationship.

## 6.2 Technical Concept

We looked for a widely accepted software which is able to cope with all our required tasks and configurations. A software that has been sufficiently developed and is easy to install. We had to learn more about QuickTime software of Apple Inc., to take full advantage of its possibilities. In this cross platform solution, which works as a digital container of various communication media in the virtual digital world, one can manipulate and edit the required movies ad hoc. We investigated the use of codex on larger scale video images and developed a scripting solution using (the programming language) Qscript for editing real-time events.

## 7. THE VIRTUAL PATIENT

### 7.1 Working Procedure

The concept can be divided into four sub-topics: the visual/aesthetic framework, the human interaction/parsing, production and authoring/programming.

### 7.2 Defining Aesthetic Elements (Cinematic)

The images provide the visual and logical framework for the usage of interactive video. The decision was taken to "immerse" the viewer, creating a simulated patient. It is then imperative to a) capture the user's attention in a film-like manner and b) increase interactivity. As a result, the following possibilities emerge: a) a dynamic montage of the patient's response, or b) interaction within virtual space/film invoking the patient's response to the doctor's physical presence. Altering the frame size and composition in realtime can help maintain motivation and provide a immersive film experience.



Fig. 7. Shooting Impression

### 7.3 Classification of Human Interaction

The starting point has been a database with the main medical related topics in patient-doctor interviewing, based on the medical experience of the project partners at the Karolinska Institute. This database has been altered and extended with major elements in a broad range of human reactions, such as general answers, red herrings and personal details of a predefined character.

The parsing is and will be based on keywords which yet provide a specific response. Three things which will improve the results to the patients response: 1) a keyword area which will help to prevent unwanted or illogical answer from being formulated, 2) the further development, by monitoring recent questions/ answers to assure that all reactions reflect what the patients require, 3) the addition of communication headings and sub-divisions to retain the structure and yet allow it to expand as is needed. Answers can be added continuously.

### 7.4 Pre-, Production and Post-Production

Main steps of movie production where required to:

- write a script and a description of the character
- cast a actor
- build a team
- rent a studio
- build the set
- maintain technical equipment
- shoot within a week
- capture and edit material
- compress files
- maintain database entries



Fig. 8. Shooting in Studio

## 8. AUTHORIZING INTERACTIVE QUICKTIME

The logic structure is implemented within a interactive QuickTime, also known as wired QuickTime. Through the complex, but efficient programming language "QScript" used in the QuickTime authoring software "LivestagePro", various algorithms have been developed, which offer the required results. Although a missing support in parsing delayed the whole project, which actually terminated end of 2003. With the development of a 3rd party component "QSXE", which extends massive the wired abilities of QuickTime, the further development of the project has been done on the own behalf of Heizo Schulze. The result has been a complete new programming to implement the features of QSXE within 2004.

### 8.1 How to Prevent the Loop?

One main element to detain a repetitive experience are the available frame sizes of each clip (A - Medium, B - Close Up, C- Extreme Close Up). Following cinematic basic rules a "A-

clip" can follow B or C, but not A. "B-clip" and "C-clip" are treated similar: no clip of the same size will be loaded after one segment has finished.



Fig. 9. Three Frame Sizes of each Clip for dynamic Editing

Additional situations of interactivity states are defined - which will be played for specific use. Such as: Intro, Waiting, Repetition, Misunderstood, Specify, Timeout, Interruption, Insulting and Leaving. These are called General Responses.

The key feature is the classification and link of three objects: Parsing, Answers and Clips. Keywords are NOT linked to static clips, they are linked to Answers. Each Answer can have associated clips for Neutral, Hesitant, Aggressive response, can hold up to 3 Repetitions and up to 3 Follow Ups, 1 Short Time Memory and currently not used triggers such as: EU/US Region, Question Required and Sensitive Topic.

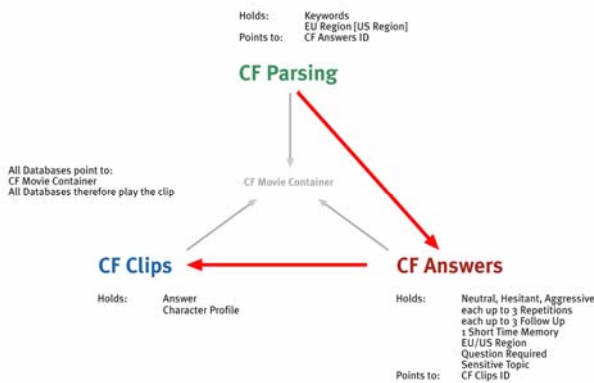


Fig. 10. Parsing - Answers - Clip Connectivity in Database and XML

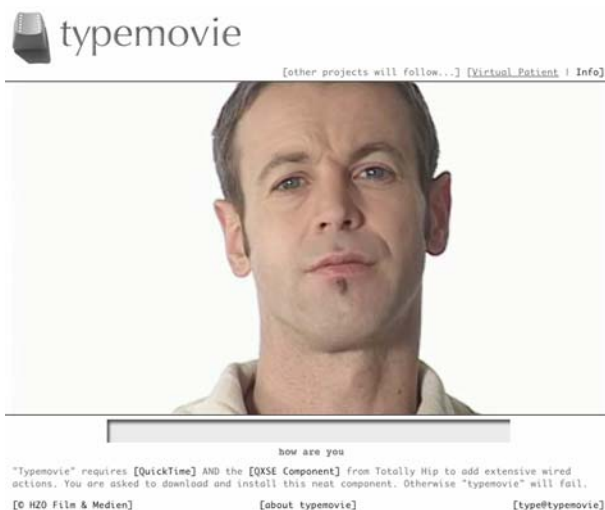


Fig. 11. The current state of this "Virtual Patient" project and additional text interaction based movies can hopefully be found in near future at:

<http://www.typemovie.com>

## 8.2 Storyworlds

I consider the examination of the following scenarios for further narratives:

User Actor (one way communication)  
Question Answer

User Actor (alternating directions)  
Question Answer  
Answer Question

User Scene (one way, first person, 2nd person or 3rd person)  
Question Answer

User Scene (alternating, first person, 2nd person or 3rd person)  
Question Answer  
Answer Question

## 8.3 Cinematic and Historical Examples

As one example how to use text as interaction in narratives I would like to take this opportunity to apply in theory the use of "Type-Movie" technology, to relay ideas and make the cinematic exploration of history possible.

Most of what our forefathers created is now perceived as lifeless, even dull material. Castles, museums, monasteries and cloisters, prisons, ruins, even factories are all buildings with some semblance of complete interiors, and they also contain historic objects. When we enter them we are immediately immersed in their atmosphere. They impress, yet remain distant, regardless of how much time we spend there. They are loaded with historical, human emotion. It is only when we begin to learn about the previous residents, who created connections of all sorts, and that is precisely that which gets us emotionally involved, and we cease being outsiders and approach what was once foreign, or even feel that we understand it.

There are, basically, two different approaches that one can take:

a) a mosaic-like structure, or b) narrative form.

1) relies on the collection of information using codes, and the decoding of these codes proceeds, based, for example, on text, images, or architecture. Only those trained in the field are able to assemble this mosaic, as it forms a counterpole to pure authenticity.

2) on the other hand, is based on emotional response, i.e. in the form of a book, a film, or a very vivid presentation delivered by a gifted and motivated art historian while conducting a tour.

Current interactive media, unfortunately, function according to a). Regardless of how complex and extensive they may be. Using "TalkMovie", I would aim for a synthesis of a) and b). Self-contained spaces form the framework for a). This is, undoubtedly, a conventional notion. What adds a new dimension to all of this, beyond conventional exploration of space, would be the introduction of life to these spaces.

In the small room in the cloisters, for example, one would actually find a nun going about her everyday routine, hundreds of years ago. Mother Superior has taken her special place, at the fireside, and, in the kitchen, dinner is being prepared. Using the keyboard, I can, at any moment, establish contact with them or ask questions. They respond, answer, or show me something and I learn a bit about their lives, in a world hundreds of years ago.

Each separate room remains an island unto itself. The user has the option, due to the complexity involved, of a limited extent of immersion in the convent's activities. Each "station" on one's visit would form a stone in the mosaic. One could even consider using a figure/character to explain elements of the societal and political issues of the period. This would enable the human-friendly transfer of information to occur in a new manner.

**9. DIALOGUE OF DATA**

QSXE has to be installed in order to take advantage of "Virtual Patient".

The Master Movie - the Data Shell  
The Movie itself is about 52KB. It holds all algorithms for parsing, dynamic processing etc.

QuickTime Movies  
Over 1250 clips have been shot with 3 cameras simultaneously (Medium, Close Up, Extreme Close Up).

Filemaker Database  
Filemaker is used to incorporate the various connections between clips, parsing and answers.



Fig. 12. Database Clips

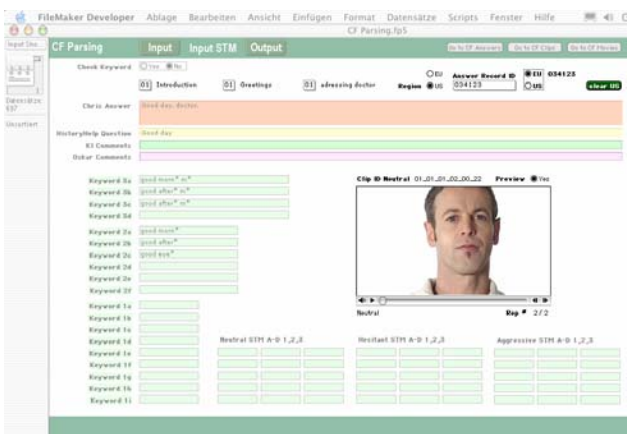


Fig. 13. Database Parsing

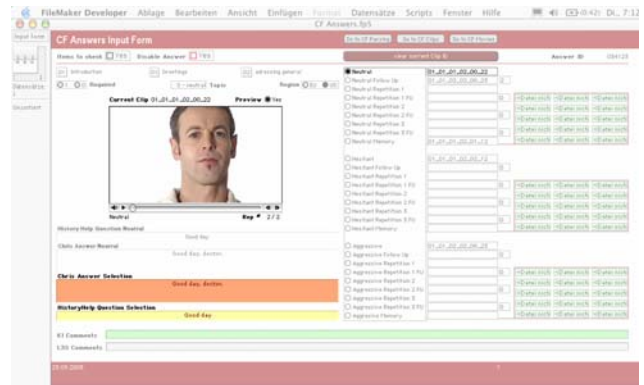


Fig. 14. Database Answers

XML Structure  
XML files are the essential knowledge of the master movie and are loaded on startup. These files hold all information of the database setups.

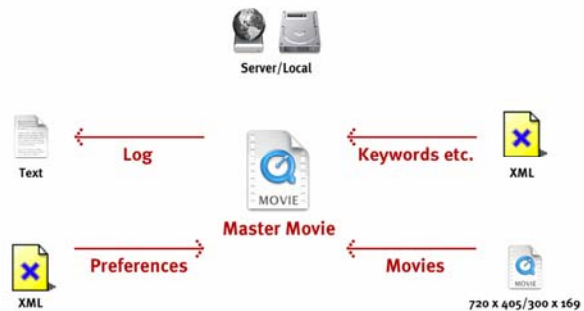


Fig. 15. Dataflow

Log Files  
User input is monitored and stored remotely, such as answer, keywords found, played clip, etc..

type: VirtualPatient-Log/Apple\_4151\_6.520\_1\_15.1.2005\_No\_23295\_Time\_22-22-0\_Session\_1.txt  
Question: hello  
Answer: Hello, nice to see you, doctor.  
AnswerID: 34129  
Clip: 01\_01\_01\_02\_00\_12  
KeywordString: hi hello  
KeywordMatches: 34129 : hi hello  
UserTime: 0.546 Minutes after last input - at: 22:22:24

Fig. 16. Log File Example

**10. CONCLUSION**

The different frame sizes with the realtime edit and the dynamic montage as the major part evoke the aimed emotional involvement of the user. A big emotional impact and immersion has been obtained. There have been doubts about the technical feasibility regarding the online solution. The results were able to wipe this uncertainty. The current state of "Virtual Patient" shows a huge potential for extensive use in dialogue simulations of various area - local and/or online.

There are further steps for development to follow soon: extension of the answers, clips and keyword databases, therefore the addition of available reactions and answers of the "Virtual Patient". In near future a linguist should provide assistance for the optimization of the parsing process on the keyword basis, such as short term memory keywords, regional differences, repetitions, topics with sensitive information and mood changes of the character. These elements are already incorporated in the interactive algorithms, but are not yet used in the database.

Speech recognition seems to be a possible combination/extension to eliminate the restrictions of human-computer interaction. In addition the depicted character needs further attention in terms of comparability between a "real" person and a synthetic image, such as 2D or 3D animated characters. The extension of additional reactions/answers with these types of visuals would offer a broader and flexible feasibility, but may lack in immersion of the user.

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<http://www.l3s.de/>
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- [KI] Karolinska Institute, Stockholm, <http://www.lime.ki.se/>
- [IMF] Institute of Media Research, Braunschweig,  
<http://www.hbk-bs.de/>
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[http://www.lime.ki.se/cul\\_cd\\_et\\_projects\\_isp.htm#226](http://www.lime.ki.se/cul_cd_et_projects_isp.htm#226)
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## 12. ACKNOWLEDGMENTS

It goes without saying that my research fellows deserves many thanks: Rolf Bergin, Uno Fors, Olivier Courteille from KI. Uli Plank for supporting my work from the beginning of my time at the IMF. Christoph Strutz for doing so at the L3S. Kathrin Koch for her tireless emotional support.

## **DEFINING EFFICIENT INTERNET-LEARNING FROM COMMON E-LEARNING**

### **A MOTIVATION FOR DESIGNERS OF LEARNING-TOOLS TO HAVE A CLOSER LOOK ON MEDIAS CHANCES AND CORRESPONDING LEARNING TECHNIQUES**

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**KEY WORDS:** Education, Teaching, Media, Internet, Multimedia, Software, Learning Environment, Design

#### **ABSTRACT:**

E-Learning is considered as the approach to facilitate and enhance learning by means of personal computers (PC), CD-ROMs (and alike media) and the Internet. While CD-ROMs are used to demonstrate and to train by use of PCs' multimedia capabilities, this mostly behaviouristic or instructional approach is also still dominating the construction of Internet-based learning-tools such as learning-management-systems (LMS). Although the Internet is a huge medium to store and transport knowledge of networked people, and informational services like Usenet, Google and Wikipedia, or commercial services like Amazon are considered successful, whereas LMS – built to transform information into knowledge – are widely unknown and unused.

The more sufficiently services make use of a medium's capabilities the more successful they are. In case of the Internet this means the use of public services, open standards, learner networking and the use of learner behaviour as criteria for rating and co-construction of learning materials. Sufficient use of the Internet in learning context supports corresponding learning techniques like constructivism-based cooperative, collaborative and self-determined learning. It can be concluded that Internet-Learning is useful, but it is not efficient by itself in any (institutional) learner organization.

Solutions for successful Internet-Learning differ from current E-Learning approaches. Only the combination of certain subjects, medium, methods and organization leads to a successful learning synergy. As an example for simple but sophisticated Internet-Learning, COMETS could open creators' minds for constructing new efficient learning tools und environments.

#### **KURZFASSUNG:**

E-Learning bezeichnet eine mit Hilfe von elektronischen Hilfsmitteln wie PCs, CD-ROMs und Internet unterstützte Lernform. Während CD-ROMs insbesondere zu Demonstration und Training mit Hilfe multimedialen PCs herangezogen werden, dominiert diese Herangehensweise auch die Konstruktion von Internet basierten Lernwerkzeugen wie Learning-Management-Systemen (LMS). Obwohl das Internet ein gewaltiges Medium zur Speicherung und zum Transports von Wissen der darüber verbundenen Menschen darstellt, sind einfache Informationsdienste wie das Usenet, Google und Wikipedia oder kommerzielle Dienste wie Amazon allgemein bekannt und erfolgreich, während LMS – die eigentlich zur Transformation von Wissen aus Informationen aufgebaut wurden – der Allgemeinheit völlig unbekannt sind.

Je suffizienter ein Dienst die Möglichkeiten des Mediums ausschöpft, desto erfolgreicher kann er sein. Für Internet-Lernanwendungen heißt dies, Eigenschaften wie Öffentlichkeit, offene Standards, Vernetzung von Lernenden und Einbeziehung des natürlichen Verhaltens von E-Lernern für die Bewertung und das persönliche Co-Arrangement der Inhalte für die Anwendung zu verwenden. Die Ausnutzung typischer Internet-Eigenschaften im Lernkontext fördert die damit übereinstimmenden Lernmethoden wie konstruktivistisch basiertes kooperatives, kollaboratives und selbstbestimmtes Lernen. Es liegt der Schluss nahe, dass Internet-Learning nützlich ist, aber nicht per se in jedem (institutionellem) Lernkontext angewendet werden kann.

Lösungen für erfolgreiches Internet-Learning unterscheiden sich von üblichem E-Learning. Nur eine geeignete Kombination aus Inhalten, Medium, Methoden und Organisation führt zu Synergien beim Lernen. COMETS dient als Beispiel für derartiges Internet-Learning, das abschließend Entwicklern Ideen für neue Lernwerkzeuge und Umgebungen geben soll.

## **1. INTRODUCTION**

### **1.1 Motivation**

Current work on evaluation of E-Learning systems conclude that E-Learning has no higher learning outcome compared to common learning arrangements (Schulmeister 2002, Lehner 2004a). Authors agree mostly in the fact that the didactical possibilities of the Internet are not exhausted yet.

### **1.2 Related Work**

Because of its founding by technicians E-Learning is mostly defined from a technical point of view. After initial restraint the area of E-Learning is taken increasingly by the pedagogues who comment on didactic necessities and examination from teaching experiences. Constructivism becomes an important meaning in this (Arnold, 1998, Kochan 1999, Schulmeister 2002).

The high synergy potential of constructivist didactics and E-Learning becomes clear first with a containment of the area on

the Internet under aid of the media theory (McLuhan; Tapscott) and leads to a decisive role the Internet might play.

## 2. FROM E-LEARNING TO INTERNET-LEARNING

E-learning is considered as the approach to facilitate and enhance learning by means of personal computers (PC) as an interface to content taken from CD-ROMs (and of course alike closed media) and the Internet. While most of the content in the Internet is free, the closed media were used to be applied due to their high data capacity and a common sales model.

With the running trend towards higher bandwidth and more storage capacity on the Internet closed media will further lose weight and remain at most for economic reasons.

While CD-ROMs are used to demonstrate and to train by use of pc's multimedia capabilities, this mostly behaviouristic or instructional approach is also still dominating the construction of Internet based learning-tools such as learning-management-systems (LMS) (Schulmeister 2002). Although the Internet will be the dominating medium in E-Learning, only the old didactics to closed media is used. The more sophisticated capabilities of the Internet have to be uncovered and must be analysed on usefulness for learning purposes.

### 2.1 The Internet from a Social Perspective

In the later sixties of the last century, a long time before the Internet developed, Herbert Marshall McLuhan founded the actual media theory and gave means to analyse the development of media and their impact. The intensive use of a certain medium will influence people in their attitudes and structures in thoughts. He proposed, an "electric net" decentralizes and leads to a social behaviour like in villages, a narrative culture, but in a global scope. In addition, the Internet owns many other qualities by which some should be lifted out that can be considered important for upcoming conclusions.

1. The Internet has to be seen as a network of people rather than a network of data storage.
2. With a computer interface the network is usable individually.
3. The Internet holds an infinite digital data space.
4. The technical and social union on the Internet is voluntary. Hence, there is no hierarchy or power structures.
5. Everyone obtains the possibility to participate easily.
6. Content is topical, but of varying quality.

### 2.2 Corresponding Structures in Education

The characteristic points of the Internet advantage certain didactics and organisation of education:

1. Finding people of the same interest supports learning in subject oriented groups, especially intrinsically motivated co-learners.
2. Individual use of a medium supports self-determined learning organisation and learning subjects.
3. Digital data leads to a culture of copying, sharing, using and advancing content (Negroponte, Tapscott).
4. Just being a teacher gives no authority: The voluntariness of the interaction demands indirectly attention, quality of contributions and friendliness towards others.

5. Easy participation makes it possible for learners to join other group works or even to improve learning materials offered by teachers.
6. Especially actual and discursively handled, pluralistic content offers to make an issue with E-Learning (Schulmeister 2002).

These points show that learning with the Internet goes along with so-called "new learning cultures" (Arnold 1998) which stand in opposite to current teaching in educational institutions like schools, colleges and universities.

### 2.3 Limitations in Institutional Use

If educational institutions decide on a certain E-Learning system, their criteria tend to fit the teaching organisation rather than improved and motivating learning techniques: today all universities in Berlin establish learning-management-systems (LMS) reproducing the traditional organisation for monetary reasons. Necessary improvements from this objectivistic learning approach towards constructivist insights as strongly demanded by Arnold & Schüßler are neglected. Even university teachers choose a type of software that only reduces their effort in making lectures (e.g. Microsoft PowerPoint) instead of establishing software that makes students work *active* on the subject, although there are partial promising approaches such as EASE in computer science education (Draheim 2003).

Lehner (2004b) cites Schulmeister and Kerres (2001) and concludes that LMS used for virtual learning settings don't enhance learning in general. And even though the Internet is a overwhelmingly huge storage of information, only insiders know about LMS or ITS, while other services like Google, Amazon, Ebay and even the Usenet are known by many.

The problem with the application of E-Learning software is structural and leads to "frictional losses". The didactical potential offered by the Internet is in contradiction to the momentary learning culture at higher educational institutions:

1. Learning in groups is considered to be good for practise, but bad for examination, which is an extrinsic driving force that overlaps intrinsic motivation.
2. Self-determined learning competes against the curriculum.
3. Solved exercises can be shared easily. Teachers must give different exercises for each unit. Commercial courses must hide useful material from other users on the net.
4. The authority is the examiner. Specialists among the learners become unimportant.
5. Juristic necessities and the belief in objectively true knowledge of the teacher that should not be falsified argue against participation on learning material.
6. Other material on the Internet could question the given learning material and shows unwanted opinions on a subject.

The Internet seems not to be an appropriate medium in conservative institutional education. To benefit from its sophisticated didactics, learning institutions have to establish a new learning culture.

## 2.4 Efficient Internet-Learning

Internet-Learning in a narrow sense means learning based on the use of the Internet, where especially those qualities are exhausted that differ from other media's qualities and that correspond to learning promoting didactics. From today's point of view this means especially learning based on constructivist learning theory.

Efficiency in the first place means efficiency in learning, thus

- faster learning, when answers and insights can be found faster, or
- more sustainable learning, which can be achieved by active working with the contents rather than reception by reading or listening.

Also the teacher or the author or the producer can improve her job. In this case efficiency means

- faster production of learning-material,
- up-to-date quality of contents and
- reaching more learners.

Internet-Learning is not restricted to institutional education. On the contrary Internet-Learning seems in the moment more sensibly in connection with Computer Supported Cooperative Learning (CSCL) and Just In Time Open Learning (JITOL) (Grune 2000, McConnel 2000). It is vital to have a personal interest in a learning object. Thus efficient Internet-Learning applications have to be disposed where people turn to desiring to solve a problem of their own that requires deeper learning.

## 3. DESIGNING APPLICATIONS FOR INTERNET-LEARNING

### 3.1 Learning from Successful Internet Services

No explicit learning application is widely known among the people on the net. For learning purposes people use to "google" for their subject of interest by typing the keyword, often in combination with "tutorial" to reach an online-tutorial. Other useful resources are the Usenet or Wikipedia, and even commercial sites like Amazon offer required information. What makes sites as Google, Wikipedia or Amazon more successful in a network that has been built up for knowledge purposes than actual learning systems?

In my opinion – it's a pity – these services are simply more useful than current learning systems. These successful systems accumulate additional information from users just by letting them do what they wanted to do anyway:

- Google uses the natural behaviour of homepage-editors to link the pages they find useful. More often linked pages are ranked higher.
- Wikipedia uses readers being irritated about mistakes or vacancies and lets them improve the text.
- Amazon gives links to related products by tracing other users' interests ("customers who bought this also bought that").

### 3.2 A Synergy between Content, Media and Didactics

Working on a subject intensively lets learners remember longer than they would have been done if they had only read or listened. Constructivism emphasizes the personal relation of new information to obtained knowledge. Best motivation is intrinsic motivation.

A personal problem gives intrinsic motivation for starting and continuing a self-determined learning process. This Just In Time Open Learning is based on constructivist learning theory. Methods on learning are considered more important than the subject itself. Knowledge that develops and changes is more useful to be learned in the moment it is needed.

The Internet is a space where knowledge can be obtained. If this is open content as in Wikiwikis, the learning process could be used to work on improving this content. The possibility of easy participation on the Internet lets learners work with just gained information in the same place. Computer Supported Cooperative Learning uses learner networks that the learning-system has formed automatically. Peer tutoring lets learners help each other so that they get personal help or even consolidate their knowledge by helping others. Free learning applications bring the most people together and enhance the probability of finding collaborators.

Learning with the Internet on open content with free applications and constructivism based new learning cultures go hand in hand with each other.

### 3.3 Successful Internet-Learning Applications

In order to build up useful Internet-Learning applications we should profit from synergies between the Internet, its typical content, learning-cultures corresponding to the acting among the internet-community and modern didactics – and learn from other successful internet-services:

1. Internet-Learning software has to be free, at least available to everyone. The more people use the application, the greater is the advantage for each learner. This can be achieved, in particular, with open-source licensing and platform independence.
2. Internet-Learning software has to be built up in places where people could have a problem. Ideally they have to be integrated in the application that makes them want to know more while working with it.
3. Internet-Learning software has to be easy to use. The learner must be relieved from organisational overhead of his personal learning intention to concentrate on the content he really wants understand.
4. Internet-Learning software offers content that helps solving a problem and in a way that motivates to go broader or deeper into subjects that authors consider important to know. Let the personal problem just be the first step into a great explorative learning session!
5. Internet-Learning software organizes personal support if this is needed for understanding. Ideally this support helps with other useful work automatically (e.g. learning by explaining, building up FAQ etc).
6. Internet-Learning software has to be set up easily by authors of free learning materials and frees them from other organisational work or support. If free content is wanted, then voluntary work of authors should be made easy.

## 4. EXAMPLES OF PROMISING INTERNET-LEARNING

### 4.1 Social Software

When cooperation and working on the learning subject are main criteria for beneficial Internet-Learning applications, any social

software could be used. The term “social software” came up 2002 as a name for software as Wikiwikis and Blogs and refers to applications that “facilitate virtual connection and collaboration between people on a network” (Wikipedia). Thus, even Instant Messaging, forums, etc. and learning applications such as VITAL belong to social software. The use of Social Software for learning purposes – especially Weblogs – is at the moment new and interesting for students. Due to the additional motivation using a Blog for learning activities this is a current subject of research as described in Beuschel 2005.

## 4.2 COMETS

The Communication Enhanced Tutorial System (COMETS) also belongs to the category “Social Software” even though it has been designed especially for CSCL / JITOL learning purposes. It is a simple but sophisticated tool for Internet-Learning (Rademacher 2003, 2005):

COMETS uses the tension of users to read common online-tutorials when they have a problem and they are intrinsically motivated to go deeper into the subject. When they reached such COMETS enhanced tutorial, the system networks those readers that are working on the same topic anyway to facilitate cooperative learning between them. COMETS organizes the peers for peer tutoring and offers a well known chat, so that readers can ask questions to other learners that work on the same or related content.

COMETS is a free system designed for freely offered content. Learning should be improved without demanding further work done by voluntary authors to set up the system and keep it running. Therefore, the system identifies related interested co-readers automatically from tracing the learner’s way through the tutorial.

## 5. CONCLUSION

In the field of E-Learning especially Internet-Learning offers rich synergy effects with new and favoured learning methods. Using E-Learning could be a symbolic action to establish new learning cultures in traditional learning institutions (Lehner 2004a). Besides this recommended development, Internet-Learning applications can facilitate learning anytime and anywhere to exhaust a learner’s intrinsic motivation just when it appears. The question whether E-Learning is more efficient than traditional learning has not to be answered if E-Learning just leads to an *additional* successful learning activity.

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## E-BOARD TOOLSET

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### ABSTRACT:

This project has been developed within the "Multimedia-Förderprogramm 2003" of the Humboldt-University, Berlin. Additional team members have been Prof. Dr. Dr. h.c. Harald von Witzke and Uwe Pirr.

To combine knowledge in presentations, lectures and various forms of learning material with pictures, sound, video and 3D to make it more obvious is nowadays quite necessary. "E-Board" uses a compact interface and nonlinear structure with a easy-to-use external data structure.

The "E-Board Toolset" consists of a editor and a reader which both are based on the QuickTime architecture and technology. They are QuickTime movies itself, combined and programmed with the interactive functions of an application.

- Arrange presentations in hierarchical chapters with Pictures, Text, Rollover, Audio or Video/3D
- Synchronize Audio with Pictures, Text and Rollover
- Synchronize Video with Text
- Prepare your content with easy-to-use droplets
- Store presentation in XML format
- Distribute your multimedia presentation easily to any individual who uses QuickTime
- Integrate your presentation on CD`s, DVD`s or websites

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