Modules for the education of civil engineers and the management of expert knowledge

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Summary
In the focus of the Bologna-contract of the European secretaries of education the universities are invited to aim a unification and comparability of certificates and to offer compatible and cooperative models of education. Among existing lectures in the Internet there will arise a new competition between the universities in netbased teaching and learning environments.
For the use of distributed sources of information and for the possibility to generate free configurable sequences of education modules you need management systems which are able to handle different formats of documents and to assemble it to consistent and valid lessons. Beside elementar viewing-functions, fusion of information also administrative tasks are needed, e.g. automated efficiency controls, adaptive learning surroundings.
This paper attends to three aspects:
- netbased teaching and learning in the area of the instruction of civil engineers
- netbased information assembling and fusion of knowledge bases to higher level documents
- netbased learning with international coordinated projects

1 Introduction
Universities are challenged by the use of multimedia in education and they react with different emphasis and specific concepts on it. While some install consequently a technical infrastructure for the use of mobile devices at the campus (e.g. notebook universities) and promote trans-sectoral the development of multimedia teaching materials pay others not the needed attention to the arising competition offering e-learning suites. It may be appropriate to deliberate about new kinds of teaching, in special acceptance, efficiency, feasibilty and quality against traditional methods but it seems impossible to elude the change of paradigm in teaching and learning: multimedia will influence learning in future! Flexible forms of education across different areas, countries and cultures will achive acceptance.

2 The change of processes in teaching and learning
The possibility for the multiple use of digital media in varying characteristics and in changing context opens a bandwidth of methods preparing teaching materials. With special formatted learning units the always predominant instructional classroom teaching at the universities can as well be supported as individual learning sequences or further education projects. The practice of document sharing between lecturers is no longer restricted to printed media. In common pools they can assemble e-learning materials for a netbased use.
Students which in past depended from the pre-determined sequences of classroom teaching can now choose between different ways of netbased learning, independent from place and time. Depending from their actual intention they will rework lessons in a structured scheme or in a free navigation look around for different formatted learning units to compensate gaps in her knowledge, they may use the e-learning platform for preparing to examinations by fulfilling exercises and tests or simple browse through the media for interesting content. It is obvious, that the platform must be able to react to the different ways of learning and to offer different arrangements of media.

For the face-to-face education you need in general a restricted variety of digital media (e.g. scripts, slides, video presentations, simulation environments) in contrast to a multimedia working place for a student, where the whole diversity of formats must be visualisable native or converted. To avoid excessive demands to the competence of students concerning media-technique and to bridge from these to a familiar learning surrounding we followed in a first step the idea of a confidence-building measure (Fig. 1):

- Via a learning portal find the students an entry to an area of expertise, e.g. engineering mechanics and structural mechanics (Fig. 1a).
- On the next screen are in an intimate (virtual) working room traditional learning materials presented like books, manuals, scripts to the special fields of the subject (Fig 1b). Only on selection of one topic you will be leaded to the e-learning place.
- At the multimedia working place (Fig. 1c) you finally find all the control elements for navigation, for filtering the information and for viewing the whole world of multimedia.

Fig. 1a: Portal for Engineering Mechanics and Structural Mechanics.

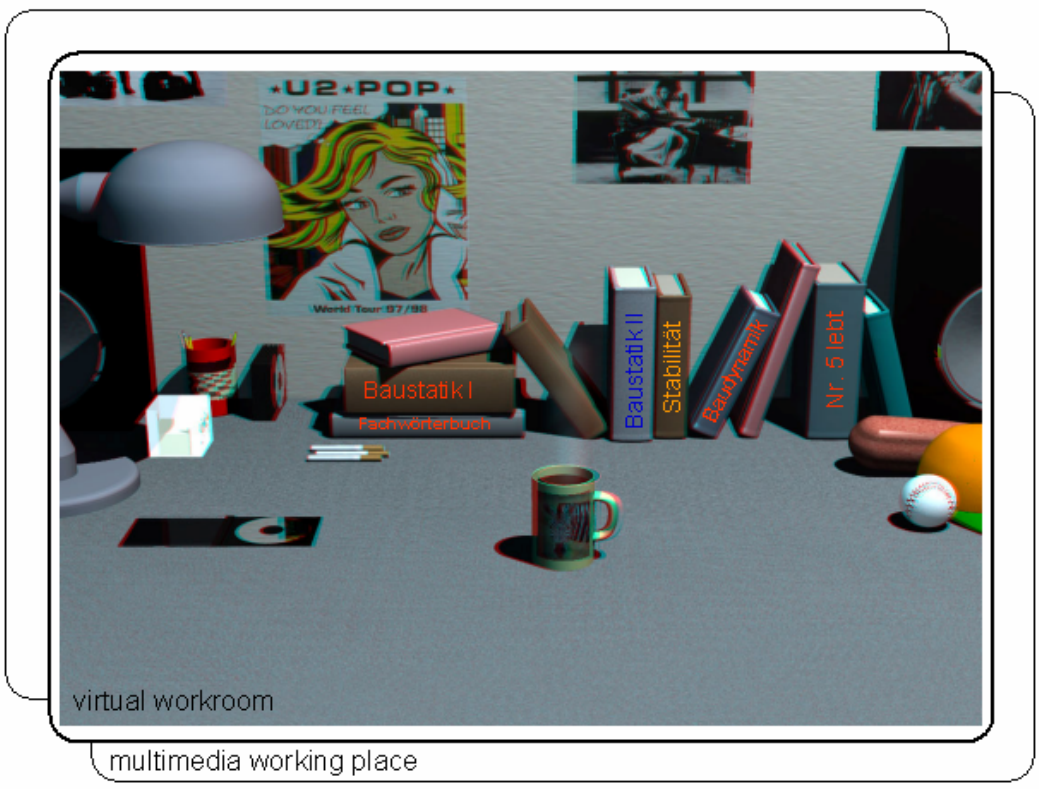


Fig. 1b: Familiar learning environment of a student

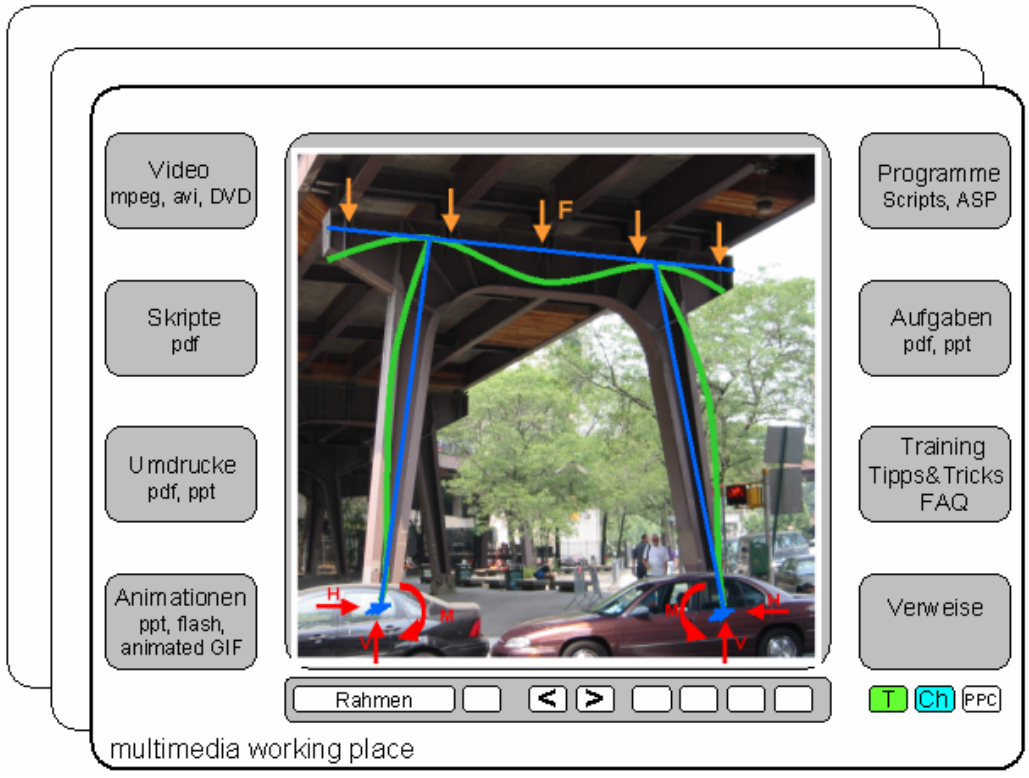


Fig. 1c: Students multimedia working place (first concept)

At the multimedia working place the small fields represent placeholder for the different types of media. Independent from linear or nonlinear navigation in each case you see in this fields the available media. Free fields indicate that inquiries to special formats failed. The assembled media are selected from different and for special media optimized servers. The content of this servers can be administered dynamically and you can imagine, that all kinds of information gathering can take place in this field, e.g. multiagent systems.
The colour of the T-field (T=tutor) signalises if a tutor is online available. With the Ch-field (Ch=chat) you can activate synchron or asynchron communication within a work group. The PPC-field shows the availability of downloadable PocketPC-programs in special to the selected subject.

3 Requirements for a learning platform

In past there were developed some significant teachware in engineering technology. The main focus of this programs were the mediation of difficult parts of lessons, the visualisation of special phenomena or the identification of system characteristics by the variation of parameters. The most programs are singular applications which can not be used as courseware in a computerbased instruction. The quality of the used computer graphic was for the evaluation of these programs of more interest as a paedagogical concept.
Trend-setting programs came e.g. from the Cornell-University (NY), the SOCRATES-teachware (SOCRATES 1993). The functionality of the programs were presented in many workshops which were arranged from the institute of the authors. The open source programs were distributed free of charge to nearly 50 institutes of 20 European universities where they are partly still in use. The highlights of the SOCRATES-programs are the objectoriented graphical interface, the intuitive handling, the interactive generation and modification of systems, the authoring tools and the added value because some of the programs can be used as well in teaching as in research (Fig. 2) with the great advantage of immediate feedback between research results and learning content.
Elder high level teachware may be used further on but it should be embedded in an all out e-learning concept because it is necessary to integrate the manifold formats, the variety of authoring tools, simulation systems and animations in one learning platform.

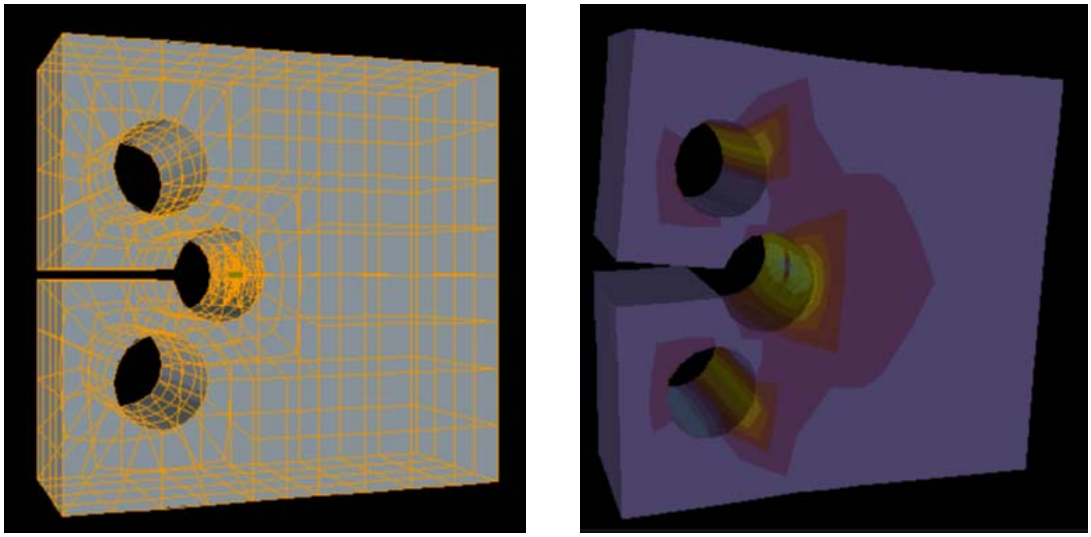


Fig. 2: 3D-crack propagation analysis on a specimen. FE-model and principal stress. A SOCRATES-program both for teaching and research.

With the experience of earlier teachware-systems and numerous learning content management systems in presence it is possible to extract some essentials for the evaluation of e-learning platforms.

- Reuse:
  The development of e-learning content is very expensive. All efforts should therefore be focused on the reduction of the costs for software production and maintenance. The exploitation of the technical standard in software development and a comprehensive documentation deliver the basis for the sustained use of the learning programs and an optional reuse if the teaching platform is redesigned.
- Concurrent use of platforms:
  The e-learning environments should be able to integrate all standardized formats from different sources. In this way communities of lecturers can be founded which cover certain disciplines with multimedia learning units. This enlarges the possibilities for alternative combinations of own materials with such of coauthors and thus the offer of new lessons.
- Dynamic of the content:
  Learning content must continously be updated and completed. Therfore it must be possible to include actualised material dynamically into the database.
- Transparency of sources:
  For the learner should be the locality of the sources transparent. Content management systems must be able to administrate medias on distributed servers and if these are reconfigured to ensure the consistency of the data.
- Offer of various learning modes:
  The learner must be free choosing various learning modes according to his own preferences. Beside predefined schemes for sequential oriented content should a free navigation always be possible. The change of learning steps should be possible on the fly, but to avoid the loss of orientation it is necessary to indicate the coherence of the learning elements.
- Online tutoring:
  This is one of the most important aspects of e-learning because group dynamics in learning processes are poorly reflected from a learning environment and individual assistance from a lecturer is insufficient. Therefore alternative forms for communication between single users, learner groups and tutors must be inherent to the system.
- User modeling/adaptivity:
  Adaptive reactions of the learning system to the learning process of the user may be a high motivation and should be implemented.
- Selection and configuration:
  The free combination of learning units for different teaching scenarios is essential. This is also a precondition for common use of materials from various sources.
- Multilinguality:
  Because the European universities are invited to aim a unification and comparibility of certificates and to offer compatible and cooperative models of education thus is the necessarity for multingual learning components obvious.

4 Didactic aspects

Unfortunately exist only a few learning platforms which can be classified as excellent. It seems that in the most cases the technical aspects dominated the development and the didactical concept is deficient. But the last decides about acceptance and success of a system.
For all computerisation of our everyday life it is for students not self-evident to use computers as learning aid. Therefore should e-learning stimulate to experiments and to compare tradional ways of learning in contrast to new media.
The most impact to a learner is surely the unrestricted self-determined sequenzing of the learning materials. We are convinced that each learner will find back to structured learning units

if he has explored enough the playground of the e-learning system. There is no need to regulate the use of such a system.

5 The e-learning platform ELAT

In one of the Federal Ministry of Education and Research sponsored project „2MN- modules for the multimedia netbased teaching“ the learning platform ELAT (Environment for Learning and Teaching) was developed. In the development were involved a number of researchers from different universities and companies from different countries. The intention was, to produce a visually well arranged and media appropriate design of a learning platform and of the learning content (Stengel et al 2003). This means, that the efforts to use and to produce the content of the system should be so easy as possible.

The ELAT architecture is implemented as a client-server system, which is composed of two main parts (Fig. 3):

- the frontend which provides the client for different classes of users, e.g. students, authors or administrators ,
- the backend, where the client requests are processed by the server. Depending from the kind of the needed information different types of data storage are retrieved, including a XML database (Tamino from the Software AG).

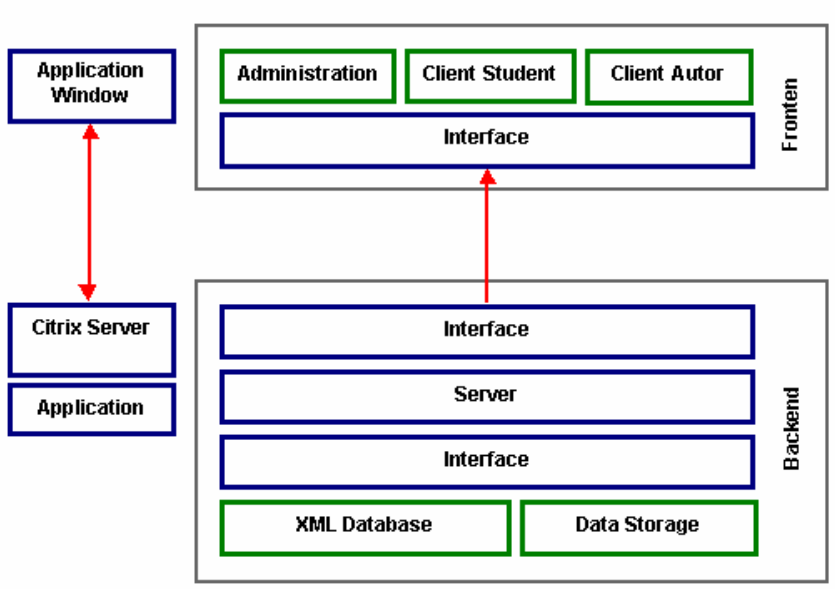


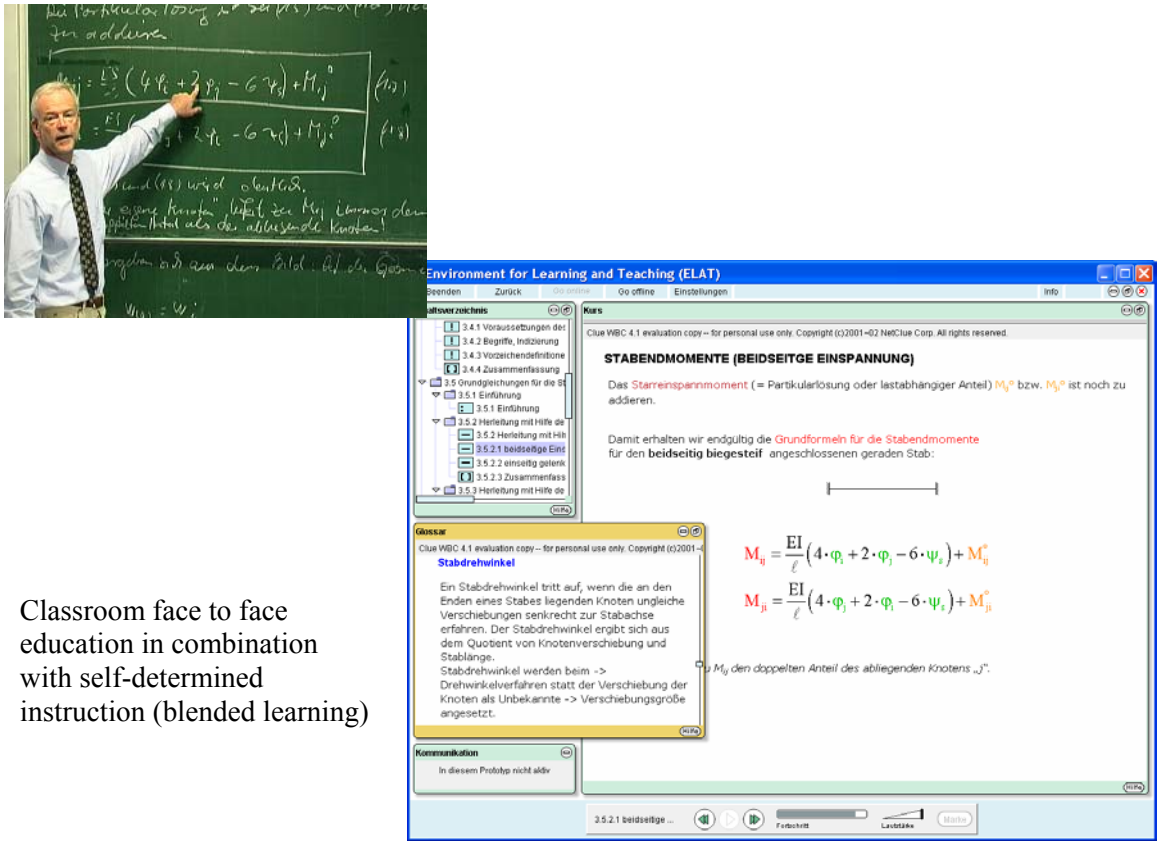
Fig. 3: The ELAT Architecture

The main component of the backend is the ELAT Logic Server, which is a J2EE based application server. This server contains the logic of the whole system and uses different interfaces and protocols to communicate with the clients and the database. The HTML and WAP communication is handled with the Java interface while the SOAP protocol is used for the handling of XML-data. At the XML database are stored e.g. user id, session data, course statistics, content.

The authoring modul of the frontend enables the teachers to set up their courses and upload them to the main system. The student client is equipped among other things with a navigation field for differnt ways of learning and information gathering and a center for synchron and asynchron communication between students, workgroups and teachers (Fig. 4). To guarantee full independence of the different existing internet-browsers and operating systems the client is implemented as a Java application.

It is nice to find elements of the first abstract idea for the presentation of the multimedia content (Fig. 1c) at the meanwhile realised ELAT interface (Fig. 4, Fig. 5).

Fig. 4: The student client in a video presentation of a lesson



Classroom face to face education in combination with self-determined instruction (blended learning)

Fig. 5: ELAT client for the structural analysis

6 Further experimental environments

Beside ELAT, which was not available in the early state of the 2MN-project, the team of the authors was involved in the development of some special e-learning applications respectively produced netbased training material to obtain experience of acceptance and a feedback by students. Some of this experimental environments should be mentioned here.
In a diploma thesis with the title „Interuniversity grading system – database and applications“ (Ionita 2003) was experimented with a system for testing students. Examination questions are random-selected from a pool and the quality of answers is automatically evaluated with different criteria, e.g. the number of correct answers or the needed time for the test. Main aspects for the development of the system were the security of data and the process of examination, high availability and multiplatform clients. Formatting queries for the database is done at an application server and also the propagation of the arranged data to the clients. There is no direct communication between the clients and the database (Fig. 6), the client Java applications are very small. All system components e.g. data processing, queries to the database or the evaluation logic are realized with Java Beans. The choosen database is Oracle8i because it includes a combination of database and application server, a premise for this project. A further advantage of the Oracle database are the mechanisms for the optional distribution on multiple servers for switching to redundant configurations in the case of hardware failure.

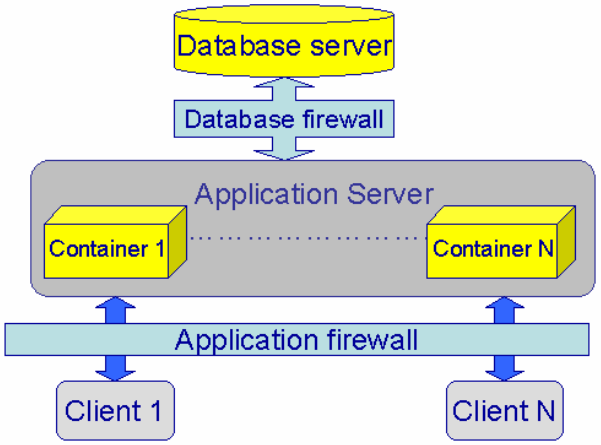


Fig. 6: Architecture of the grading system

An other kind of training modules and multiple choice tests were created on the base of Java script. Some highlights of this development are the significant graphics, the support of cognition through typical colours and the immediate comments and declarations in popup-windows. Fig. 7 shows one example of this tool.

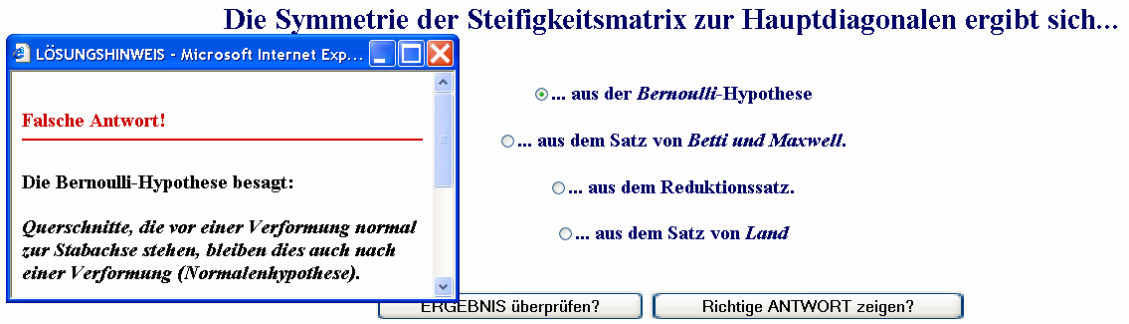


Fig. 7: Example of a multiple choice test

With the intention to support the mobility of students were some new programs developed for PocketPC respectively adopted from desktop-versions. The programs may be helpful in some learning situations and can be downloaded everytime. Fig. 8 shows the adaption of a program for the calculation of influence lines.

Desktop-version PocketPC-version

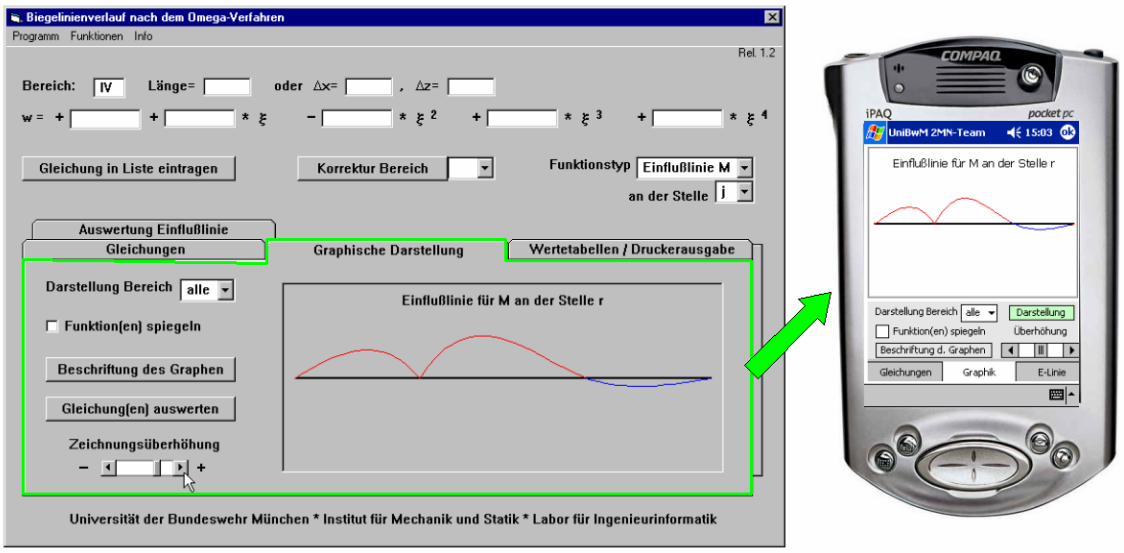


Fig. 8: PocketPC adaption of a desktop program for the calculation of influence lines

6 Conclusions

The development of the presented programs will be continued.

7 Acknowledgement

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