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How Real is the Virtual University in the Upper Rhine Valley?*

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Technological innovation and socio-economic change have been leading to a reconfiguration of educational systems worldwide. The buzz-words are 'virtual teaching' and 'learning anytime, anywhere', and they are having an especially large affect on universities. Four universities in Baden, in South-West Germany, are also gaining experience in this area thanks to an extensive interdisciplinary pilot project. The main part of the paper focuses on the means and methods used and developed within the project. Moreover, we point out some observations we have made attempting to take the first steps towards a structural change in the universities.

INTRODUCTION

> *So the question facing every educational leader in America is clear: 'How can I introduce a transformative vision to my campus?'* [3]

UNIVERSITIES are amongst the oldest and most stable institutions that mankind has ever created. Their modern form was shaped in the 19th century by Alexander Von Humboldt's ideal of the unity of research and teaching; basic university conditions have changed radically since Humboldt's time, however. The rapid expansion of data networks and the widescale distribution of networked computers do not just intensify the structural and financial crises of the universities; they can also be seen as a chance to overcome future challenges to the educational system.

- **Lifelong learning.** Today, knowledge is being seen as more than just a personal qualification; knowledge is a critical production factor. For this reason, it is necessary for increasingly large sections of the population to receive qualified training to enter the work force. And continuing education is demanded of those who are already employed, so that they can meet the constantly changing challenges of the work world. Traditional courses of study often cannot live up to these shifting challenges because they are too monolithic and require the full-time presence of the students. 'Lifelong learners', however, require customized educational opportunities that enable them to learn at work or at home, to gain specialized qualifications, and to divide up the time of their studies. A single university alone usually cannot provide such opportunities.
- **Technological innovation.** The multimedia processing of contents and broadband computer networking make possible a new quality of self-directed as well as tutorial-supported teaching and learning: audio, video, text, databases, and programs can be used together on one machine, the computer, and can be exchanged over networks. Multimedia telecommunication facilitates educationally beneficial forms of tutorial guidance and communication amongst students.
- **Competition with classical educational institutions.** New types of demands call for new types of suppliers. There is already a rapidly growing global education market with a wide spectrum of suppliers: international consortiums made up of big businesses and universities, company-owned corporate universities, purely virtual universities, and networks of classical educational institutions, all of which see students as customers, and all of which promise customized educational opportunities independent of time and space. The classical Alma Mater must stand up to this colorful and, in part, extremely financially strong competition. This task is not made any easier by the ever-shrinking public budget, which leaves very little room for expensive innovations. In answer to this, efforts are being undertaken in Germany to react to these developments, and concepts are being created to secure the future of the universities. In the following, we want to report on our experiences with a concrete project while keeping the long-term goals in sight.

THE JOINT VIROR PROJECT

> *We're investing in the information society!* (Brochure from the Ministry of Science, Research and the Arts of Baden-Württemberg)

Within the framework of a 'Virtual University' grant program, which has been running since mid-1998, the state of Baden-Württemberg has

* Accepted 2 August 2000.

provided a total of 50 million DM to finance various joint projects that are intended to examine and establish opportunities for multimedia and teleteaching in university education. Amongst these projects, *VIROR—The Virtual University in the Upper Rhine Valley* [1] is the most extensive in every respect. Around 30 university instructors from the four participating universities of Freiburg, Heidelberg, Karlsruhe, and Mannheim have begun to create a cooperative multimedia teaching program. There are also computer centers, university libraries, and several publishing houses and businesses involved. The plan is aimed at five years with an initial financial volume of DM5.3m for three years. After this, all of the projects running under the state program will be evaluated; a positive evaluation and further support means that a total of DM8.8m will be designated to VIROR.

Because of its extent, VIROR has been divided into four parts. These sub-projects orient themselves on different types of problems, and they are each locally distributed amongst several partner universities. The first and most important part of VIROR, called *Content Building*, has the widest scope; here multimedia modules from the areas of computer science, physics, statistics, economics, psychology, and medicine are prepared and used. The second part, *Technology*, deals with the construction, maintenance, and further development of the technological infrastructure; this includes networking, authoring tools, educational servers, and much more. The project is accompanied by an *Evaluation* part carried out by media specialists, educationalists, and psychologists. The *Organizational Issues* are addressed in a separate project part, because the universities have taken on the improvement of organizational conditions, which includes voting on examination regulations, the mutual recognition of seminars, and agreement on a common technological infrastructure.

MEANS AND SCENARIOS

> *Lessons in your own home, a discussion of school exercises at work—and all of this anywhere in the world with just a click of the mouse button.* (Brochure from the Ministry of Science, Research and the Arts of Baden-Württemberg)

The terms 'multimedia supported teaching' and 'teleteaching' are often used together, even though they actually signify different objectives. The goal of multimedia-supported teaching is to make teaching and learning more lively and varied through the use of animations, simulations, and audio and video clips. Teleteaching, on the other hand, strives to make traditional learning less dependent on time and space. These two goals can be combined, of course. It is a well-known fact that taking full advantage of the technological possibilities that are available today is both expensive and time consuming. This calls for cooperation beyond the boundaries of departments, faculties, and universities. However, a project like VIROR, with its highly innovative and experimental character, cannot be expected to make definite statements on the financial consequences of the future everyday use of these new technologies. But there is the reasonable hope that VIROR can make suggestions as to what means should be put to use in what situations; after all, a large part of the spectrum of possible methods and scenarios is being tested by VIROR. Some of these scenarios will be described in more detail in the following.

EXCHANGE OF ENTIRE COURSES

Taking over entire lectures from any university to another mainly serves to expand the course selection in locations where there is no one with the appropriate level of competence to teach certain subjects. This usually takes place in the context of a *synchronous scenario*, that is, a transmission from one lecture hall to another. This type of export does not initially require any complex multimedia processing of the lecture materials. It is sufficient to verbally comment on a normal presentation which uses digital slides, and to mark or add to things using tools from a *whiteboard* (the electronic equivalent of a blackboard). These data streams (audio, video, whiteboard, and animations, if used) are transmitted to other locations using multicast connections; questions can be asked the other way around. Thus far, the VIROR project has mainly used the MBone tools [7]. Because of the 'best effort' principle of transmitting continuous data streams over the Internet, these tools also allow the simple transmission to personal computers by way of narrowband connections, such as via ISDN lines. However, from lecture hall to lecture hall the data is transmitted via a special 'VIROR-LAN', a PVC-ATM connection with a guaranteed quality of service.

In parallel to the synchronous scenario the recording of the data streams created by a telepresentation is a step towards making educational content reusable and independent of time. According to the *note-taking* principle [2] the data streams created by the lecturer are recorded and automatically converted to multimedia documents that can be used offline, without any complicated post-processing. The 'Authoring on the Fly' system (AOF for short) [4] which was developed over recent years for this purpose, allows the synchronous replay of all recorded data streams in a way that no other comparable system has been able to match [8]. AOF transforms the data streams created during a live presentation into directly accessible object lists, so that any number of such data streams can be replayed synchronously by interprocess communication. The advantages of the note-taking approach are the low creation costs, the currency of information

corresponding to the typically ephemeral character of university lectures, and the personal, instructor-influenced flavor of the recordings. Up to now, there are over 100 hours of recorded lectures available, mainly from the area of computer science, but also from the areas of biology, archaeology, and astronomy. This signifies that it is possible to overcome a university practice that is normal today, and that D. Tsichritzis recently described in the following way:

> '*Universities generate content every day through their courses and seminars. Then they throw it away. There is a certain charm to this approach, but it is not cost effective . . .It is frustrating to be in universities where famous people have taught and not have their "live performances" available.*' [10]

The material that is systematically captured using the note-taking method and that is made available on servers (the latter turns out to be not at all an easy task, see below) or CD-ROMs opens up an entirely new range of possible uses. Instead of repeatedly presenting the same contents, a lecturer can (at least partially) focus on annotating and discussing the content that is already available. Beyond that, the recordings are a valuable resource for exam preparation or all types of research. In principle, it will be possible to make inquiries such as 'find the place in a presentation in which the lecturer discusses the principle of recursion and runs an animation.'

Even before the start of the project, the partners had gained a lot of experience with synchronous and asynchronous scenarios [5]. In the mean time, working with these technologies has become almost routine. But for everyday use, especially by non-experts, the technology is still not simple enough. In particular, there are problems reconciling the normally analog audio technology in the lecture halls with the digital data transmission. And because of the high degree of complexity, even trifling matters—such as the pulling of a plug by the cleaning team or a careless mistake while calling up a program—lead to breakdowns or call for time-consuming post-processing. The quality of the video transmission with the help of the MBone tool *vic* is inadequate for the lecture hall to lecture hall scenario and is only acceptable for the transmission to a personal computer over narrowband networks. Even if the 'talking head' of the lecturer is, in some cases, only of secondary importance from an educational point of view, the transmission between lecture halls in the future should be of at least PAL quality. The standards here are set by the entertainment industry—which, incidentally, is the driving force behind the implementation of new technology in 'edutainment'. However, within VIROR recently first experiments with a direct MPEG-2 encoding of Audio/Video using hardware codecs have been carried out, showing very promising results.

Training the lecturers is also of prime importance. Mastering an electronic whiteboard and its tools such as the telepointer, annotations, and drawing facilities requires some experience. Precisely because the look and feel of a large whiteboard is very similar to that of a traditional projection surface or blackboard, unpracticed lecturers often point to details with their hands, for example, not realizing that their gestures will be captured in a video recording, but not as annotations of the whiteboard action stream.

Problems with temporal and contextual agreement in the synchronous scenarios described above have led to the idea of the on-location integration of any pre-recorded or specially developed parts of a lecture; these parts are integrated in the lecturer's local presentation in the form of modules. This will be explained in more detail in the following.

Multimedia modules for repeated use

In many fields the curricula at different locations and the contents of lectures tend to overlap broadly. Hence, there is an opportunity for high-quality processing and cooperative use of these contents. To this end, modules are being exchanged amongst the partners and integrated in their lectures as well as used for private study. The granularity of such modules ranges from 5-minute presentations (e.g. presentations of various encryption techniques) to an hour-long overview lecture (for instance, on *Parallel Algorithms*). A particular interesting example are commentated Java programs. Running such a module, students find the Java code on their screen. They listen to the voice of the instructor, in sync with annotations to the Java code and the instructor's video. Finally, the runtime behavior of the Java program is also shown (e.g. opening a window and drawing a graphical object). When developing such material, using the AOF method shows benefits again.

As a last example, interactive modules in the form of platform-independent Java applets are being developed. An entire series of such modules already exists for the area of *Algorithms and Data Structures*.

Interactive teaching material

In contrast to the exchange of individual building blocks or entire lectures, which mainly aims at an economical expansion of course selections, the purpose of enriching educational presentations through the use of interactive material is to improve the overall educational quality of these presentations. For VIROR, teaching applications are being created in the areas of physics (animations of statistical concepts), economics (simulations of expense calculation and marketing with the model data of a virtual business), psychology (carrying out and statistically analyzing psychological experiments), and medicine (learning systems for biomathematics and pathology, case simulations for pediatrics and the study of infectious diseases). There are fluid boundaries between the paradigms of importing building blocks as

presented in the last section and of using interactive modules in educational presentations.

During the conception of such applications, special attention must be paid to compatibility, because there is always the danger that a product created with great effort and involvement will so strongly reflect the specific profile of the developer that the sphere of potential users remains small. For a virtual university, the effort can only be justified if a larger number of interested parties are attracted either through usage which is going beyond a single institution or a significant reduction of the time and space dependency of the course selection. Thus, it is essential to work out a clear plan and agreements, in which institutions the material will be used and how it will be integrated in the curriculum formally. This should be done before starting implementation work. Just to 'put material on the web' and to know that a learning application shows pedagogical benefits and should be interesting for a large number of students definitely is not enough! Unfortunately, content providers very often use a too naive approach to embodiment of their work.

Joint group seminars

Distributed joint seminars can be held in different locations by synchronously transmitting lectures, discussions, and commentaries. It is even reasonable to cooperate during the preparation phase, either in a synchronous or an asynchronous mode. The same technical problems occur here as they do in the transmission of lectures. From an educational point of view, it has been shown yet again that without previous training, it is not possible for a student to take full advantage of the available tools, especially regarding location-spanning communication (questions, discussions, joint use of the whiteboard, etc.). Therefore, it is important to make the proper use of the communication and presentation technology an explicit goal in itself within such distributed seminars, just as training in rhetoric and the presentation of content was an important learning goal in classical seminars. Here a further educational investigation would definitely be worthwhile. Our experience, however, shows that the success of a joint distributed seminar crucially depends on its content: the interactive, joint elaboration of a nontrivial, interesting theme should be the main focus of such a seminar.

NEW CHALLENGES TO TEACHING

> From the sage on the stage to the guide at the side. (Anonymous)

The implementation of interactive teaching material, the use of computers for presentations and communication, the recourse to lesson materials that have been created by other authors, and the provision of all teaching and learning materials on servers do not just present significant challenges to the technical competence of the lecturers. All of this also has significant consequences for education. For one thing, the proportion of formal presentations, as opposed to interaction, training, and test modules, is reduced. For another thing, experiences to date have shown that students have considerable difficulty coping with the abundance of material that is already digitally accessible. The role of the lecturer, therefore, must change from being that of an information provider to that of an information mediator and 'training coach', in order for lecturers to live up to the new teaching tasks. Some authors even expect that scientists and scholars themselves will have practically no direct contact to students, but rather that moderators and tutors, who are well-trained professionals but who play no part in the actual creation of content, will act as mediators of preprepared information [6]. This is also known as the 'Taylorization' of education, a prospect which, depending on your standpoint, can be seen as either a promise or a threat. Still, in VIROR a detailed accompanying investigation of an imported lecture has shown that students can deal expertly with the new technological possibilities of knowledge acquisition.

Furthermore, it is an open question how digital teaching material can be maintained and long-term archived, such that the new tasks of a lecturer as described above are sufficiently supported. Of course there are several course maintenance systems on the market like *Lotus Learning Space* or *WebCT*. However, the features of such systems do not match the requirements of university teaching. Unlike a commercial provider at least at present a university usually does not produce a manageable quantity of courses, which once produced as extensive unities remain unchanged for a longer period. It is exactly for this scenario that course maintenance systems are designed. Rather, lecturers of a university will produce a large amount of very heterogeneous material, most of them being small modules with very specific content, as we have described above. Therefore, a fundamental prerequisite for reusing such modules is the markup of the material with technical, administrative, and pedagogical metadata. The author of any pedagogical material must be forced (and supported) to deliver sufficient metadata, following, for example, the IEEE LOM (Learning Objects Metadata) standard proposal [11]. On the other hand, a lecturer needs a comfortable database where he or she can find suitable modules (using metadata search) and authoring support when putting together a lecture.

VIROR has set up a so-called Local Knowledge Pool (LKP) within the European network Ariadne [12], a distributed database for pedagogical material conforming to upcoming metadata standards. We see Ariadne as an important step towards long-term availability and a widespread exchange of teaching material. In addition, we are examining

the benefits of course management systems (since universities will deliver courses over the Internet in the future). However, in order to put all those systems together and develop appropriate authoring support there is still a lot of work to do. Moreover, it may very well be that de-facto standards will emerge in a university environment.

ORGANIZATIONAL EXPERIENCES

Although inter-university cooperation in research projects is not unusual, a formalized teaching cooperation as in VIROR is something entirely new. It soon became obvious that there has been very little experience with this, and that it is very unusual to think in terms of larger structures when organizing university teaching. It is not surprising, then, that it is difficult to draw together divergent interests for the purpose of joint project goals. The participating universities and fields do not want to give up their individual identities. But the joint development and use of teaching modules inevitably demands a certain standardization of content. Lecturers have found this to be acceptable when they can incorporate foreign modules of sufficiently fine granularity into their own lectures. The adoption of large blocks of multimedia content in an unchanged form—for instance, lectures which were created entirely by colleagues and which are simply supported by accompanying tutorials—does not seem to be an acceptable method of cooperative teaching. An exception to this is the importation of complete courses where the provider is entirely responsible for content, supervision, and giving credits. A positive side effect of multimedia and computer-support teaching is that, perhaps for the first time in a long period, scholars and scientists are thinking about, arguing over, and experimenting on a wide scale with the form and substance of imparting knowledge. In VIROR widespread and highly detailed accompanying investigations in the areas of education, psychology, and media studies ensure that this does not take place aimlessly. Naturally, this only works when lecturers are open to criticism from outside of their own fields which is not always the case.

In addition to the difficulties rooted in the long tradition of university teaching, there are also completely banal organizational problems such as the times at which seminars are held at different universities; two partner universities wanting to carry out a joint teleseminar may find that such joint lectures are only possible at unrealistic timeslots during the day. These are problems that are beyond the influence of the VIROR project participants. Likewise, questions about the official recognition of educational achievements from other universities and about voting on examination regulations cannot be solved by the VIROR participants alone.

Another field, which maybe has been underestimated in the beginning, are legal issues. Especially the very tight (German) copyright rules can cause problems. As an example, students who have developed software in the course of their masters thesis may block its usage, unless it has been taken care of beforehand by appropriate contracts, which is very unusual in universities. Or, libraries are rarely allowed to distribute learning software over the Internet (even in restricted areas), since publishing houses, treating software just like traditional books, will prosecute it as illegal copying.

There were also not entirely unexpected problems with filling posts on the VIROR project. The current shortage of specialists with computer science skills—especially in the areas of multimedia, computer networks, communication systems, and electronic publishing—can also be felt at the universities. The problem here is that academic colleagues are only willing to commit themselves to a project such as VIROR if, by doing so, they receive the opportunity to gain further qualifications for themselves personally. However, due to the very nature of building a virtual university a major part of the work will be routine not challenging for a scientist.

Despite the difficulties that have been mentioned, the project has had a promising start. In view of the lofty goals there is, of course, still a lot to do, even outside of and independent of the project. But to live up to its function as a leading project for a change of direction in university development, it is necessary for VIROR to avoid losing track of long-term goals.

VISIONS

> *One important aspect is the way in which multimedia technology can bring about enduring structural changes in teaching.* [9]

It is a well known—and often unheeded—principle that the structure and organization of a process must first be made clear before one can take on its technical implementation. Unfortunately, with the implementation of multimedia and telematics in university teaching, this principle is reversed. For instance, the exchange of lectures has already been technically mastered and carried out (with the restrictions mentioned above), but their routine inclusion into a students record (independent of ad hoc clarifications in individual cases) is still not possible, both from an administrative view and because of exam regulations. There is an agreement between the universities of Mannheim and Heidelberg regarding the subjects of computer science and physics. But a problem-free inclusion of educational achievements essentially requires the thorough modularization of exams and entire courses of study. The comparabilty of achievements from different universities could be guaranteed by a Credit Point System

(ECTS for example [13]). This would make it clear to students which achievements at any given partner university could be counted towards their own course of study. This is especially applicable to courses that the partners exchange or offer electronically on the WWW under the name of VIROR. The name VIROR should, at least informally, have the reputation of being a stamp of quality. Within the first three-year-long stage of VIROR, the partner universities should have come to an agreement on study regulations in at least some areas of study (computer science, for instance). The prospect of international exchange also demands such an agreement. The study of computer science at one of the partner universities could then be a mixture of traditional seminars and VIROR seminars; the VIROR seminars would be called up from an attractively and comfortably structured server and would be supervised by competent lecturers and tutors with the help of computer-supported communication tools. The international credit point system would also make it possible for students outside the sphere of VIROR universities to receive a widely accepted proof of achievement for their own university (and vice versa, VIROR students could take advantage of attractive study opportunities worldwide).

Because the courses are generally offered in the context of on-campus study at one of the participating VIROR universities, students will accept materials that may not be technically or stylistically perfect, but that are absolutely current and economical (such as those produced by the note-taking method). Therefore, the ability to compete with industrial products (in regards to structure and marketing) is not of prime importance; universities cannot afford such competition anyway, at least in the short term. What is more important is that supervision is offered, and that students are not left alone with their academic and personal problems.

In principle, the step-by-step construction of a selection of network-supported courses also creates opportunities for further scientific education. It is still unclear as to how the appropriate content will be developed in the course of regular operations at the universities, or how such course selections can be financed by returns on fees.

Providers—that is, teachers—require trouble-free access to multimedia and network technology. The universities must provide central lecture halls and seminar rooms that are permanently equipped with multimedia tools such as computers and data projectors, as well as with network connections. This equipment must at the same time be flexible enough to allow for adaptation to quickly changing technological developments.

Computer centers should have service capacities which allow for setting up connections and instructing content providers in the use of the technology. It may also be practical to combine some of the functions of libraries and computer centers, thus creating media centers at the universities. Such media centers could offer consultation services, could take over some aspects of design and technology for content providers, could operate teaching-learning servers, and could keep an overview of the complicated market for teaching applications. Libraries have gained experience and are able to give support in gathering metadata efficiently, as they already do it for printed media.

Many of the questions that we have mentioned have been raised expressly through the work of VIROR, but answers could only be found in a context broader than that of the project. So, how real is the Virtual University in the Upper Rhine Valley? After more than a year, the vision has begun to take on real contours—but as a reality, the Virtual University is, unfortunately, still mostly visionary.

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