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## ARCHIMED KNOWLEDGE VILLAGE – Development and Approbation of a Distributed Learning Environment<sup>1</sup>

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**Abstract:** *The paper describes a pilot implementation of an open distributed learning equipment, developed under an international project. It is organized on the basis of the modern computer-assisted education metaphor of “virtual campus” and takes into account the contemporary principles of active learning. The virtual environments and the supporting multimedia courses are discussed, as well as the two variants of the pilot implementation (Intranet and Internet oriented). The results from the experimental application of the environment are studied.*

**Keywords:** *computer-assisted education, open learning environments, multimedia courseware, virtual campus, pilot application*

### 1. Introduction

The aim of this paper is to discuss the pilot implementation of an open distributed learning environment, developed under the international project ARCHIMED “Advanced Multimedia-System Architectures and Applications for Educational Telematics” (1998–2000) with partners from Greece, France, Austria, Hungary, Bulgaria, Portugal. The environment, called Archimed Knowledge Village (AKV), is organised around the modern computer-assisted education metaphor of “virtual campus”, ensuring sufficient functionality, relevant to the modern pedagogical approaches and tendencies for teacher-assisted and learner-centred education in

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<sup>1</sup> The work reported in this paper has been supported by the EC Grant No. PL961060 ARCHIMED and Project IIT-010051 “Advanced methods and tools for knowledge presentation and processing”.

local and global computer networks with some collaborative learning possibilities. The experiments with the pilot application with different user groups revealed the AKV potential and shortcomings and lead to some decisions about the further development and improvement of the environment.

The modern computer-supported learning environments and especially the ODL (open distant learning) environments [1, 2, 5] apply sound conceptual pedagogical models, incorporating the constructivist pedagogy approach. These models specify both the structure of multimedia courses and various ways of their use. The AKV design and development was lead by the following requirements:

- The necessity to use interactively multimedia courseware, allowing individualised feedback and discussion.
- Extensive use of learning-by-doing approach, incorporating practical work in the learning process.
- Extensive use and re-use of distributed multimedia resources.
- The necessity for versatility of courseware composition for fast update and modernisation of educational content.
- The necessity of modular and open-system organisation.
- The need of intelligent assistance in information handling.
- Possibilities for discussions and collaboration in the learning process.

## 2. Archimed knowledge village

According to the above requirements the AKV pilot implementation realizes the following virtual spaces [3, 4]:

– **Learning space**, enabling the learners to do computer-assisted learning. The learner uses interactively the produced courses and courseware modules. S/he executes the tests and assessments, included in the courses as well as personal assessments, assigned by the teacher and develops projects on the course materials. The learner exchanges information (questions/results) with the instructor and with other students. The learning space integrates the educational activities of learners and teachers/instructors around the offered distant learning courses. The teacher monitors the teaching process by offline/online connection with the learners of the group and has access to local section of the repository with materials for finished/on-going tests, assessments, projects.

– **Information space** – supports the ARCHIMED Knowledge Village by providing the various types of necessary information for the learners and trainers. The core element of the space is the courseware repository, containing courses, courseware modules and documents, used as courseware building blocks. The pedagogical resources are structured around the concept of a course, consisting of courseware elements. The repository include user catalogue applying the approach and standards of educational metadata. The courseware elements are stored centrally or in a distributed way in the courseware database.



– **Author's space** – supports all AKV activities of the authors of multimedia educational materials. Its main part is the virtual author studia, that constitutes the global publishing environment covering methods, services and tools for the publishing and delivery of courseware materials.

– **Administrative space** – it organises two groups of administrative activities in the AKV: management of the learning/teaching/authoring processes with registration of learners, teachers and authors with appropriate access rights; management of the AKV information resources, including further development of the sites, realising the ARCHIMED Knowledge Village.

The AKV pilot implementation includes also the following basic multimedia courses:

- Human-computer interaction
- Hypermedia
- Authoring computer graphics with two different modules
- Authoring 2D animation
- TV and film language

According to the educational interaction mode AKV supports the following types of courseware:

– **Expositive courses** – oriented to presentation with text, graphics and video. In these courses the information flows mainly from the resource (teacher or computer environment) to the learner. The learners' input to the course is mostly in the form of navigation clicks for continuation/selection. Expositive courses are typically used for learning-by-reading.

– **Active courses** – often oriented to skill acquisition and mastering. In these courses the information flows in both directions – from the resource to the learner, but also from the learner to this resource. The courseware expects and processes semantically meaningful input from the learner. Active courses are typically used for learning-by-doing.

This dichotomy is valid for the introductory, intermediate and advanced courses. For the courses, experimented within AKV the following tendency was observed: introductory courses were more expositive than the intermediate and advanced courses.

According to course content organisation AKV supports the following types of courseware:

Courses/modules, organised as electronic books/book chapters, natural for domains with predominant verbal content in presentations and learning goals.

– **Project-oriented courses/modules**, requiring more online interaction with the learning environment and supporting more effectively the learner-centered education

The modular organization allows flexibility with easy reconfiguration of courseware and encourages the reusability of the educational materials in the databases. The AKV environment permits different levels of access granularity of AKV courseware.

The pilot implementation of AKV multimedia environment organizes distant training centres which integrate a set of necessary methods, services and tools assuring a self-paced and/or remotely monitored learning in a given knowledge field with the help of available courseware materials and the pedagogical interactivity between a teacher/instructor and a student/learner. All real implementations of systems, dealing with multimedia content, have to compromise between the requirements for full functionality and the constraints imposed by the available resources. The AKV environment contains two types of distant training centres:

– **Intranet-based distant training centre**, built upon a local computer network of an institution in Client-Server mode and accessed also through remote terminals. This organisation takes into account the state-of-the-art of the public communications on a part of the Archimed partner countries, where on-line access to multimedia courseware is not always feasible. The technologies used for the implementation of the Intranet version include:

- *Client machine*: Archimed Client Programme, Windows NT Workstation or Windows 2000 Professional, Windows 2000 Server, Internet Explorers 4.0 or higher.
- *Server machine*: Archimed Server Programme, Windows NT 4.0 or Windows 2000 Server, MS SQL Server 7.0, COM + Service, Internet Information Server 4.0 or higher

For the terminal extension Windows Terminal server is needed.

– **Internet-based distant training centre**: this version of the system has as its objective to serve the needs of working people who have no capability to move and remain for extended time periods at the premises of the teaching organization. The technologies used for the implementation of the Internet version include:

- Relational database management system (SQL server) for the backbone of the system and for supporting the model (data model plus operation's model – transactions) of the learning environment.
- Access to the functionality of the learning model and tools from distance using the standard Internet protocols (HTTP, web browser, web server).
- Use of ODBC for accessing the database functionality of an SQL database
- HTML, Dynamic HTML, Document Object Model, Cascading Style Sheets, scripting
- Active Server Pages (ASP's) for scripting on the web server site
- Java Script for scripting the client side.

### 3. Approbation methodology and procedures

During the AKV approbation the following evaluation methodology was applied: free (autonomous) and directed use of the environment; targeted questioning concerning specific parts and functions of the pilot implementation; demonstrations; peer reviews from educational and technological points of view.



The AKV environment and courseware were experimented during teaching courses in the on-going academic education with undergraduate, graduate and PhD students. The user acceptance feedback was obtained by means of:

- user questionnaires from the students;
- conclusions of instructors/authors, summarised in the approbation protocols.

The approbation took place in Bourgas Free University (BFU), National Academy of Fine Arts, Sofia State University (SU) and as well in the frame of the training program for Ph.D. students of Bulgarian Academy of Sciences. The educational modules were approbated in classroom based scenario using up to ten workplaces bind in fast Ethernet environment and using the functionality of the communication and specialized servers of the respective Intranets at the partners sites.

The approbation was performed with the following courses/modules:

**“Authoring computer graphics through Photoshop”** – active course with more than 210 screens, 12 video demonstrations and 19 project-oriented exercises

**“Authoring computer graphics for artists”** – active course with more than 120 screens, 7 video demonstrations and 11 project-oriented exercises

**“Film and TV language”** – expositive course including 12 video demonstrations of film fragments.

The user evaluation results were reported in the student questionnaires and summarised in the approbation protocols by the lecturers:

– The work of AKV environment in the client-server configuration was stable, though in some sites (BFU) with insufficient computer and communication resources some time problems arouse.

– The multimedia courseware was presented without problems and with affordable speed.

– The students were satisfied in general with the course interface and had no problems to handle the material. Some students requested more information (internal or in the form of manuals) about the different functions of the environment.

– The learning-by-doing approach was evaluated positively by all students as more stimulating than the lecture-centred presentations.

– The PhD students’ evaluation of the pilot implementation was positive, irrespective of their diverse background (informatics, sciences, humanities).

– The use of AKV authors’ studio for authoring multimedia courseware facilitates the module development, though more lecture scenarios were claimed desirable, especially by IT specialists acting as lecturers/authors of teaching materials.

The general feedback has been very positive. Potential users have expressed their interest to exploit the AKV environment and to contribute to further development of the courseware included.

#### 4. AKV performance measurement

The measurements were based on System Management Server (SMS) and custom made extension of this software with additional package for capturing and statistics. The observed problems could be formulated in the following directions:

- Bandwidth – insufficiency for real-time multimedia display (min. 100 Mb per second). This causes strong limitations for the Internet version.
- The client/server organization sets limitations for Internet throughput.
- Organizing realtime package transport in remote branches of the Intranet. Organizing the realtime package transport through semi-transparent and non-transparent network devices on the Intranet.
- Limitations in using all the functionalities of the environment in terminal mode. Some delay in the realtime multimedia display with more than 20 simultaneous users was observed.

- Propagation of the multimedia packages through transparent network devices throughout the Intranet, causing heavy traffic on the intranet.

The analysis of the AKV information flow concerns data types, data ownership, data integrity constraints, data delivery, data routing, time constraints for data delivery, data redundancy etc. The information flow analysis permits to map the various information flow attributes to software technologies and products such as Microsoft Message Queue Server (MSMQ), Message Transfer System (MTS), Exchange, or sockets and to map the data requirements to products such as SQL databases or file storage.

After analysis of the information flow and the problems revealed during performance measurements AKV is in process of extension to improve the capabilities of the Intranet version and overcome the communication limitations as well as to upgrade the Internet version.

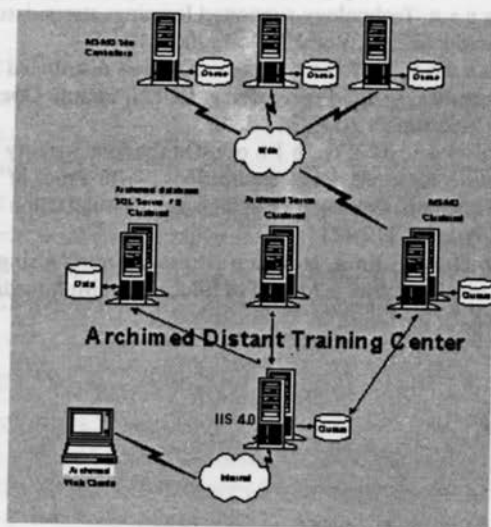


Fig. 1

Additional functionalities of IIS 4.0 were used to upgrade the Intranet-based distant training center towards Internet usability. (Technologically IIS 4.0 was employed as web server.) Active Server Pages were used to provide the server-side processing. In the enhanced AKV version the client-server communications occur via socket-based system using TCP/IP. MSMQ is used to provide a quick response to the user by storing a message in an independent client for delivery to a remote queue. This protects the application from short-term network outages or traffic congestion, receiver over-capacity conditions, and connection windows. MTS provides the transactional integrity of the system. The local web application will send a message to an MSMQ Independent Client on the same machine. This message will then get transferred (eventually) to the destination queue at the appropriate Archimed distant training center. The queue processing is handled via some custom code in Visual Basic or Java.

The diagram in Fig. 1 illustrates example architecture of the enhanced AKV realization using IIS 4.0, ASP, MTS, MSMQ, and SQL Server 7.0. This extension is suitable for large-scale intensive data exchange, appropriate for larger corporative ODL environments. In this example, many of the server applications are clustered for fail-over.

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# ARCHIMED KNOWLEDGE VILLAGE – разработка и апробация

на разпределена среда за обучение

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## (Резюме)

Статията описва пилотна реализация на компютърна разпределена среда за обучение, разработена по международен проект. Средата е основана на съвременната метафора за “виртуален кампус” при организиране на среди на обучение и отчита модерните педагогически принципи за активно обучение. Накратко са разгледани виртуалните пространства на средата и поддържаните типове мултимедийни курсове, както и двата варианта на пилотната реализация (Интранет и Интернет-ориентирани). Обсъдени са резултатите от експерименталното приложение на средата.