Multimedia teaching for Siberian engineers

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Abstract — Siberian economics is based on extraction of natural sources traditionally. Multimedia teaching is very topical for Siberia that needs high-qualified engineers for industry. Multimedia teaching tools in information technologies of manufacturing are created under the state program “Joining of Science and High Education in Russia for 2002-2006”. They consists of: description of study course; study program; advice for self-access learning; manual with animated figures and color photos; labor works for simulation of manufacturing systems; tasks with advice; system of testing; problem-oriented simulator of Petri nets; bibliography; e-library with scanned texts, video, and WWW-sources. To show interaction of equipment during a work of a manufacturing system, the animated figures were developed using Macromedia Flash®. The first multimedia tool “Flexible Manufacturing Systems” is used for distance learning in the Kemerovo State University and the Kuzbass State Technical University with their distributed branches. New multimedia tools “Fundamentals of Robotics” with virtual reality and video, “Computer Automation in Industry”, “Information Systems for Automation” are developed with the help of students. In contrast of traditional manuals, multimedia tools open of new possibilities for education such as distance learning, individual sequence of studying, supplement of manual by own comments, rapid renovation of educational materials.

Index Terms — Multimedia, teaching tool, distance learning, simulation, animation, Petri nets, Internet-technologies.

INTRODUCTION
Siberia has about 3% of world population, 17% of world mineral reserves, and area that is much more than the area of Spain, Germany, France, Italy, and Great Britain together. Since the 17-th century Siberian economics is based on extraction of natural sources. Mostly traditional technologies are used in Siberian industry. Only 10.5% of all people in Siberia have high education whereas Russia has 16% such people. The problem is how to introduce high technologies in Siberian industry by improvement of education in Siberian universities.

DISTANCE LEARNING IN SIBERIAN UNIVERSITIES
New technologies of distance learning are developed in advanced Siberian universities, that were associated in “Siberian Open University” recently. Five universities have the institute of distance education. Last year the 9-th International Conference “New information technologies of education in universities” was organized by Kemerovo State University. This university is situated in Kuzbass – the largest industrial region of Siberia.

The problem of distance learning is very topical for Siberia because of:
• insufficient number of high-educated engineers stays in the way of Siberian industry development;
• high-qualified teachers have to waste 6-7 hours by car to leave for remote cities where universities organize their branches;
• high-qualified people live in the European part of Russia mostly and wouldn’t like to remove in Siberia;
• as a rule, people move in Siberian plants after a graduation from Siberian universities.

STATE PROGRAM “JOINING OF SCIENCE AND HIGH EDUCATION IN RUSSIA FOR 2002-2006”.

This program is aimed to improve a quality of high education by attraction of scientists for teaching in universities. About 160 Russian universities take part in the program. Our proposal “Education in Information Technologies of Manufacturing for Kuzbass” has won to be included in this program. We proposed to introduce the modern methodology of discrete event simulation and animation in universities, create multimedia teaching tools in computer automation, organize the branch of university department in information technology on the base of scientific institute to prepare talented students for scientific activity, cooperate with foreign universities with the aid of iNEER. Six study programs “Fundamentals of Robotics”, “Computer Automation of Manufacturing”, “Information Systems for Automation”, “Simulation and Animation of Manufacturing Systems”, “Modern Technologies of Automation”, “Systems and Devices of Automation” were developed and introduced in education. The main part of the project is to create multimedia teaching tools in modern information technologies for engineering education.
PREVIOUS WORKS

Idea of computer teaching has been advanced since 1993. At first the problem-oriented simulator of Petri nets was developed to simulate dynamics of flexible manufacturing systems for labor works in Kemerovo State University. Interaction between robot workcells, manipulator robots, transport robots, and automated warehouses was presented by movement of so called tokens through places and transitions of Petri net [1]. Making simulation experiments students compare various structures of flexible manufacturing systems, select equipment, and discover bottlenecks inside a technology. The sixth version of simulator NetStar 2.01 has user-friendly interface and easy-to-learn features (Figure 1).

Such experience is good base to use simulation methodology for improvement of actual technology after education. Then the system of computer access to each of 20 labor works was created. It consists of 5 questions about forthcoming labor work. Each of them has 5 possible answers and limited time to select a right answer. Sequence of both questions and answers is random. If the given number of right answers is achieved, access to simulator is permitted. A teacher can check efforts of any student to get access to each labor work.

In 1987-88 we have got NATO-Grant CRG OUTR 960628 “Simulation and Animation of Russian Coal Mines” to advance simulation methodology for design and modernization of coal mines. Specialized languages GPSS/H® and Proof Animation® (Wolverine Software Inc., USA) were bought for this project [2]. Proof Animation® was used in addition to the project to show interaction of equipment units inside the manual “Flexible Manufacturing Systems” for students. The first attempt to animate figures was very impressionable for teaching.

PECULIARITIES OF MULTIMEDIA TEACHING

Printed manuals need a long preparation to publishing and are backward the development of technology. Last years some teachers prepare traditional teaching materials in electronic form on CD-ROM. Sometimes such materials consist of hyperlinks, several levels of studying, and self-testing systems. Learning of mining engineers is used in USA, Greece and other countries [3, 4].

Dream of each student is to observe moving color figures, color photos and video directly in manual to accelerate an assimilation of study course. Rapid advance in informatics enables to realize it. Multimedia teaching tool must consist of full set of teaching materials such as study program for distance learning, advice for individual work, multimedia manual with hyperlinks, animated figures, and videos, interactive labor works, set of tasks with appropriate advice, glossary with used terminology, database of technical devices, questions to exams, bibliography from books, articles, and WWW-sources (Figure 2).

Any student can form the individual sequence of education and select a time for the studying of subject. However, he has to get the access to every labor work answering special questions. If his answers are right, the simulator will be open to start a labor work. Teacher can check the results of testing and solving of tasks. Multimedia teaching can be realized via Internet or using “case technology” [4]. We have selected the second way, because not all students have easy access to Internet.

The special requirements were based for multimedia study course:

- movement of any figure can be started by a reader directly in the text;
- all sections of a teaching tool must be shown on a screen during studying of any section;
- student can introduce and keep own comment to any place of multimedia tool;
- teacher can refresh any part of multimedia tool;
- multimedia teaching must be available for easy PC’s without using of a special software.

FIRST RESULTS AND THEIR APPLICATIONS

To animate figures in manual we tested packages SolidWorks®, 3D-Studio®, and MacromediaFlash®. The last one was selected because it is easy and needs less memory. Multimedia study course “Flexible Manufacturing Systems” consists of study program, multimedia manual with animated figures, 10 labor works in discrete event simulation with virtual technologies, 75 study exercises with advice, simulator NetStar, system of computer access to each labor works, multimedia handbook with color photos, and electronic library with scanned texts. Using menu on the initial page of teaching tool (Figure 3) a user can select any part of study course and form the individual sequency of education. There are 12 sections in the manual:

- principles of group technologies and flexible manufacturing;
- grouping of workpieces for flexible manufacturing;
- structures of flexible manufacturing systems;
- modeling of flexible manufacturing systems;
- current control of flexible manufacturing system;
- information exchange in flexible manufacturing system;
- automated warehouses;
- Just-In-Time manufacturing;
- CAD/CAM systems;
Computer integrated manufacturing;
Efficiency of flexible manufacturing;
Mechatronics in future manufacturing.

Special technology of distance learning was developed for this tool. There are hyperlinks inside the manual to explain some terms using glossary. The glossary consists of short dictionary with color photos, video and audio comment. Full multimedia tool needs 360 MB on CD-ROM. Before each labor work a student had to answer five questions for limited time. Testing of student’s efforts by a teacher is available.

STATE-OF-THE ART

Using this experience, we have been developing the multimedia manuals “Computer Automation for Industry”, “Information Systems for Automation”, and “Industrial Robotics”. About 100 photos and videos were collected on a CD-ROM to show examples of real equipment. Virtual labor work instead of real robotic system was created in 3D-space for the manual “Industrial Robotics” (Figure 4).

Using of multimedia teaching tools enables to refresh study materials according to current state, present color photos, videos and animated figures for teaching, form the individual sequence of education, and transfer study materials for autonomous education in university’s branches. Such opportunities were inaccessible for traditional education.

DEVELOPMENT OF MULTIMEDIA TEACHING

The next step is development of Internet-technologies for education, such as university’s Web-portal with opportunities for distance learning, ranged educational sources, schedule of classes, e-mailing between a teacher and students, video-conferences, and interactive games for education. Special software such as ToolBook II, Macromedia Director or Web-oriented net manuals in standard IMS (Instructional Management Systems) will be used.

CONCLUSIONS

The problem with improvement of engineering education is very topical for Siberian industry that is based on traditional extraction of natural sources. By comparison with printed teaching materials the multimedia teaching enables:

• to refresh teaching materials according to last advances in technologies;
• to introduce animated figures, color photos, and video with audio comment;
• to use virtual reality, training tools, and simulators without a real equipment;
• to use an individual sequence of education with own comments inside a teaching tool;
• to copy teaching tool for distance learning, universities branches, and external students quickly.

Recently the official methodology of distance learning in Russia was approved by the President of Russia [5]. There is the great potentiality for multimedia teaching in Siberian universities. As our experience shows, using multimedia teaching we can solve topical problems of high education in Siberia, such as shortage of high-qualified teachers and printed manuals in universities, long distance between university and its branches, current refreshing of manuals, and attractive presentation of study materials.

Since 1993 our multimedia teaching tools in modern computer automation are used in Kemerovo State University and Kuzbass State Technical University. Advanced students create some parts of multimedia tools during their degree works. Such activity enables them not only to create an useful teaching tool but also to study a subject much better.

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REFERENCES

FIGURE 1
PETRI NET AS AN INPUT OF THE SIMULATOR
FIGURE 2
SCHEME OF MULTIMEDIA TEACHING

Students

University Web-portal

Multimedia teaching

Study program

Access to labor works

Simulator

Animals

Methodology of learning

Teacher

Labor works

Text with hyperlinks

Manual

Tasks

Advice

Animated figures

Questions for exams

e-library

Photos

Questions for checking

Glossary

Videos
FIGURE 3
INITIAL PAGE OF THE MULTIMEDIA TEACHING TOOL

FIGURE 4
ANGULAR ROBOT IN VIRTUAL REALITY