MATERIALS SCIENCE VIRTUAL LABORATORY INNOVATORY DIDACTIC TOOL IN THE TEACHING OF MATERIAL ENGINEERING PERFORMED BY TRADITIONAL AND E-LEARNING METHODS

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Abstract: The purpose of this article is to describe the Material Science Virtual Laboratory, which is an open scientific, investigative, simulating and didactic medium helpful in the realization of the didactic and educational tasks from the field of material engineering in the Institute of Engineering Materials and Biomaterials of the Silesian University of Technology in Gliwice, Poland. The application possibilities of the virtual laboratory are practically unrestricted. It can be a base for any studies, course or training programme performed by traditional and e-learning methods. As the implementation example of the laboratory for the didactic and educational tasks several virtual devices, such as microscope or hardness tester are presented.

1. INTRODUCTION

The specific of passing on knowledge performed by the use of e-learning systems caused the creation of the new virtual reality. At present the process of gaining knowledge, skills and abilities takes place beyond class benches and laboratory workrooms - in the virtual reality. This process aided by telecommunication technologies, leads in the consequence to emerging of the virtual academical community and to the development of new building methodology of educational materials. Special case of such materials are the simulator programs of investigative equipment, that are simulating the work of real devices used for scientific, investigative and educational tasks on several technical universities (Stec,1996; Bidziński et al., 2004; Lau et al., 2003; Referowski et al., 2000; Dobrzański et al., 2006).

2. E-LEARNING SYSTEM AND ITS FORMS

E-learning (also called electronic or distance learning) is a method of leadership and education. It makes the learning procedures possible in any place, any time and at any speed. E-learning means aided didactics by use of personal computers connected to the Internet and permits teaching and graduating students without necessity of physical presence in lecture room.

The e-learning system is a purposely separated whole, composed from parts and connections between them, meaning, that it is an advisable composition (intentional by his creator), can realize aims in one or on many manners, does not have part isolated in relation to other of his elements, connections between parts and with whole (of system) rely familiar, that every part of system has to contribute to successes of whole.

E-learning systems are found as separating lectures from student in time and space for the greatest duration of lectures, identity of technology of remittance for teaching and studying persons, disengagement of communication between lecturers and students, individualization of programs of student occupations, high level of self-observation and self-control of progress of studies by the students themselves

An advantage of an e-learning system is this same repeatable quality of education process. There are no limitations, if goes for time, place and number of students. Estimations of results are made by the computer, always according to identical criterions (Wodecki, 2005; Zając, 2006; Dąbrowski, 2004; Piech, 2003; Krupa, 2004; Vermunt et al., 2004; Barraya et al., 1999; Cox et al., 1999).

E-learning can be realized in many various ways. Because of accessibility in the time, we distinguish the synchronic mode, that is called „education online" with use of suitable communication software making possible the contact in the real time with teacher and students, and the asynchronous mode, „own work" with use of forums, audio-visual recordings, e-books etc. (http://www.platforma.imiib.polsl.pl)

As an example of e-learning system, we can show the e-learning platform applied in The Institute of Engineering Materials and Biomaterials of the Silesian University of Technology in Gliwice (Fig. 1).

It offers the access for students and academical staff to the electronical didactic materials helpful in courses guided in the traditional way on the university. It is also the basis for material engineering e-learning courses performed into the Mechanical Technological Department (Dobrzański et al., 2006).

Another e-learning system applied in Institute is a Materials Science Virtual Laboratory, described in coming chapters.

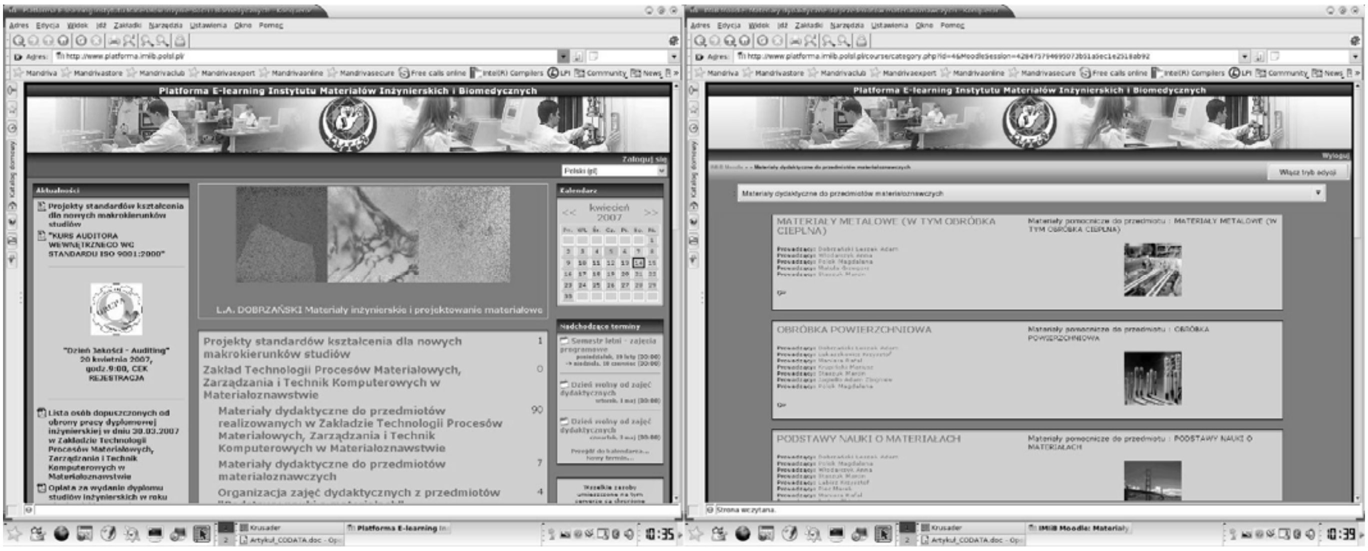

Fig. 1. E-learning Platform applied by the Institute of Materials and Biomaterials

3. VIRTUAL LABORATORY DESCRIPTION

Generally, virtual laboratory is an idea, that serves for facilitation of the work of students and engineers interested in acquiring skills and abilities from field of engineering materials This is a perfect environment to learn about investigations performed with the use of equipment, to which the students do not have access, or which they do not want to serve, because of inadequate knowledge on its working

In the virtual reality, the laboratory devices are replaced by corresponding to them computer programs created in different programming languages and technologies (e.g. Flash, Java, Delphi, C++). They are virtual reproductions of real equipment installed in a real laboratory. User has on his computer screen new possibility for realization of various defined tasks from given field answering to the given device. (Fig. 2) (Krupa, 2004, Vermunt et al., 2004; Barraya et al., 1000; Cox et al., 1999, Dobrzański and Honysz, 2007).

Fig. 2. The conception of the virtual laboratory - replacement of expensive equipment by the computer simulations in the virtual reality on the initial level of education and laboratory practices (Dobrzański and Honysz, 2007)

Material Science Virtual Laboratory is an open scientific, investigative, simulating and didactic medium helpful in the realization of the didactic and educational tasks from the field of material engineering in Institute of Engineering Materials and Biomaterials of the Silesian University of Technology in Gliwice, Poland (Fig. 3).

Virtual laboratory offers the access for students and academical staff to the electronical didactic materials helpful in courses guided in the traditional way on the university. It is also the basis for material engineering e-learning courses performed in the Mechanical Technological Department (Dobrzański and Honysz, 2007).

The possession of practically imperishable equipment will certainly encourage students to individual researches and experiments. Inexperienced users can affect experiments without threatening to their life or to health and without anxieties for the equipment damage caused by unsuitable use. Irregular service will end only with simulated irregular work of machine or with damages only on the computer screen. Then it suffices to restore the settings to the initial state and repeat the experiment with a new setup. Possible to the execution will be however only earlier prepared and conducted model experiments. The true investigative work is impossible to obtain (Dobrzański and Honysz, 2007).

The use possibilities of such virtual laboratory are practically unrestricted. Such laboratory can be a base for any studies, courses or training programmes performed by traditional and e-learning methods. Practically imperishable, cheap in exploitation and safe in usage virtual simulated scientific equipment encourage students and scientific workers to independent audits and experiments in situations, where the possibilities of their execution in the true investigative laboratory are restricted. During the work with the simulations users learn the functioning principle as well as the investigation and experiments guidance methodology of the simulated real device (Dobrzański and Honysz, 2007; Shen et al., 2003; Lee et al., 2001).

Several virtual workrooms are equipped with device simulations and didactic materials. Examples of virtual devices are presented below (Fig 4).

4. VALUE OF THE PROJECT IN THE WORLD EDUCATION

Rapid development of Internet and application of computers in more and more extensive areas of the life has caused that we become slowly the global informative society. The fact, that computers and the global communication net are in the present-day world indispensable, is undeniable. The use of computer and virtual reality became natural, without regard on this, if lessons were guided traditionally in class with benches and a table in an university building, or with use of e-learning methods (Honysz and Dobrzański, 2007).

The presented project of Materials Science Virtual Laboratory corresponds with the global tendency for expand the investigative and academic centres about the possibilities of training and experiments performance with use of the virtual reality, created to complement the work for persons interested in acquiring skills and abilities from field of materials science and for persons wanting to effect their investigations with use of equipment, to which they do not have access, or which they do not want to serve, because of inadequate knowledge on its working (Dobrzański and Honysz, 2007; Lee et al, 2001; Tadeusiewicz, 2002; Morbitzer, 2003; Siemienicki, 2002; Aebli, 1982).

Many virtual laboratory centres, related to the most various fields of life, already came into being all over then the world – www.virtuallaboratory.net, http://jhu.edu/~virtlab/, http://vlab.psnc.pl/modules/, http://www.math.uah.edu/stat/, www.home.agh.edu.pl/~vlsi/AI/, http://neon.chem.ox.ac.uk.

World investigations guided at universities proved, that the possibility for practicing the given task beyond the laboratory and beyond the control of the supervisor have positive influence on the student morale. They do not feel helpless and lost during the practice in the classes. The number of incidents and damages caused by their light-hearted behavior is a lot smaller than usually. Prepared students do not act recklessly in the situation, when the bad note is threatening. They know the behavior of equipment and know how to behave leading the investigations in the real world (Dobrzański and Honysz, 2007, Honysz and Dobrzański, 2007; Shen, 2003).

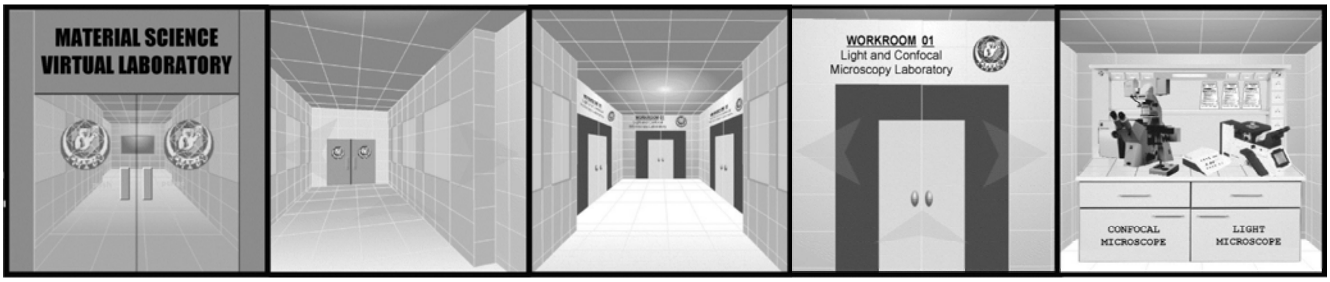

Fig. 3. Material science virtual laboratory of the Institute of Engineering Materials and Biomaterials, Gliwice, Poland, a) entrance, b) main corridor, c) workrooms, d) entrance door to virtual laboratory of light and confocal microscopy, e) inside the laboratory (Honysz and Dobrzański, 2007).

5. THE DEVELOPMENT OF MATERIAL SCIENCE VIRTUAL LABORATORY

Work at home with the use of computer is more and more popular. More of colleges and institutions are engaged in similar projects building their own virtual laboratories helping in different fields of knowledge, not only in material science. This makes the work more attractive and creates new possibilities for self-education for the students and employers. It expands also the interest for new fields of science.

From didactic point of view, virtual laboratory can be treated as a basic form of learning previous to work with the real equipment. Remote or e-learning students without exercises in a real laboratory should have their classes in the virtual reality as well. It could be also an exchange form of theoretical knowledge to practical competence.

Computer applications which simulate the work of real devices should be their possibly faithful imaging. Naturally, the simulation will never reach the full usability of the real equipment, but the simulator should describe the possibly largest quantity of function and the possibility of the original, particularly these, which are used in training and education. In a real device all functions are called out by use of the suitable levers or knobs, in simulated devices, by „clicking" on corresponding buttons, or by pressing an appropriate key on the keyboard. All buttons and switches must be placed in positions adequate to real effectors.

The fidelity of the simulation is very important in this case, because it has the cognitive character for students just getting to know the techniques of scientific investigations performed with use of the given device.

The economic aspects are also not to concealment. The virtual laboratory is inexpensive in maintenance and exploitation. Beyond the costs of starting, that are the costs of necessary computer system preparations and the costs of realization of virtual devices and virtual material samples to their service, there are only the costs of system running maintenance. While using the system, there is no need for preparing any material samples, any exploitative materials, sometimes extraordinarily expensive. The necessary technical reviews of these machines are not required and resetting machine to the initial state will liquidate all occurred damages.

The best virtual laboratory will never be as good as the modest and smallest real laboratory. Virtual and real technologies are complementary. The full principles of the machine guidance can be introduced only using the real device. Simulations have mostly bounded functionality. Present are only the basic function of the machine, which are necessary for realization of the chosen investigation and they were distinguished from the whole. The training experiments on virtual equipment are perfect for skills gathering which can be very useful later for operating this equipment in the reality (Dobrzański et al, 2006; Dobrzański and Honysz, 2007).

In the virtual laboratory are placed the virtual simulations of investigative equipment installed in the laboratories own by the Institute of Engineering Materials and Biomaterials, Silesian University of Technology, Gliwice, Poland. Except this the user will also find instructions and educational materials, necessary for execution of training experiments in the virtual reality, the description of real investigative equipment and scientific investigations guidance methodology, current information on subjects connected with the widely understood material science matter, multimediascientific help for better understanding of problems, educational animations, supervisory, examination tests and advises, thematic services, the scripts of the lesson and didactic presentations (Dobrzański and Honysz, 2007; Tadeusiewicz, 2002; Aebli, 1982; Siemieniecki, 2002).

Fig. 4. Examples of virtual devices placed in the virtual laboratory a) light microscope, b) confocal microscope, c) hardness tester, d) scratch-test machine, e) impact testing machine (Dobrzański and Honysz, 2007)

6. THE DEVELOPMENT OF MATERIAL SCIENCE VIRTUAL LABORATORY

The laboratory does not consist only of machines. Didactic helps are also very important for processes of active teaching. They raise the pictorial range of the methods applied by the teacher and they favour the realization of the collectivization postulates. The students use rich sets of information, which they require processing in the aim of their full understanding. In this way students are assimilating the knowledge through creating meanings, defining notions, creating logical structures, hierarchizing and valuing information (Dobrzański and Honysz).

Presented here (Fig. 5) interactive periodic table of the elements and the iron-carbon equilibrium diagram contains the compendium of knowledge on the presented subject and makes possible the cooperation with students by enabling the easy and immediate access to the necessary data. Only one mouse click on demanded element or structure is necessary for displaying of suitable description. The three-dimensional introductions of the elementary cells let help students in the understanding of the atomic building of engineer materials, electronic books and instruction to laboratory practices contains exclusively useful and objectively contents and passed on objectively devoid of the mediumistic hum.

7. SYSTEM REQUIREMENTS

To have the laboratory usage possibility indispensable is the PC/MAC class computer with the access to Internet and with web browser with Flash plug-in installed.

The minimum hardware configuration which assures the smooth work, is processor PentiumII 400MHz, 256MB of RAM memory and 100Mbps network card. The operating system should operate in the graphic user interface (GUI) with running TCP/IP and HTTP protocols. Every laboratory users posses its own login and, suitable for his rights, access password.

The laboratory was tested on several machines working under control of operating systems such as Windows 98/Me, Windows 2000/Xp/Vista, Mandriva Linux 2007/2008, Ubuntu Linux 7.10PL and FreeBSD 6.2. Browsers, used to the view laboratory content were Microsoft Internet Explorer 6/7, Firebox 2/3, Opera 9, Konqueror 3.5 and Epiphany 7.1. No difficulties were encountered in any case. The access to the system and his services was delivered without any problem.

8. CONCLUSIONS

The frames of this article allowed only for the very cursory presentation of the virtual laboratory as the computer aided didactic environment. However, this few examples show potential use possibilities of the virtual reality to scientific and educational aims. The interaction with simulation of the investigative device opens new possibilities in acquiring of knowledge and skill from the field of material engineering.

The virtual laboratory is a modern educational and accessible platform for all users. It delivers the knowledge not only to students, but also to teachers and other persons, who want to expand their knowledge with the functioning and operating methods of investigative equipment. The respective elements of the laboratory, built according to circumscribed in this article methodology, are the attractive introduction of the studied task and they can be applied directly at the university classes as the program basis of materials science projects, or as supplementary units of the teaching programme. In both cases the education process is richer about new possibilities of traditional and distance learning.

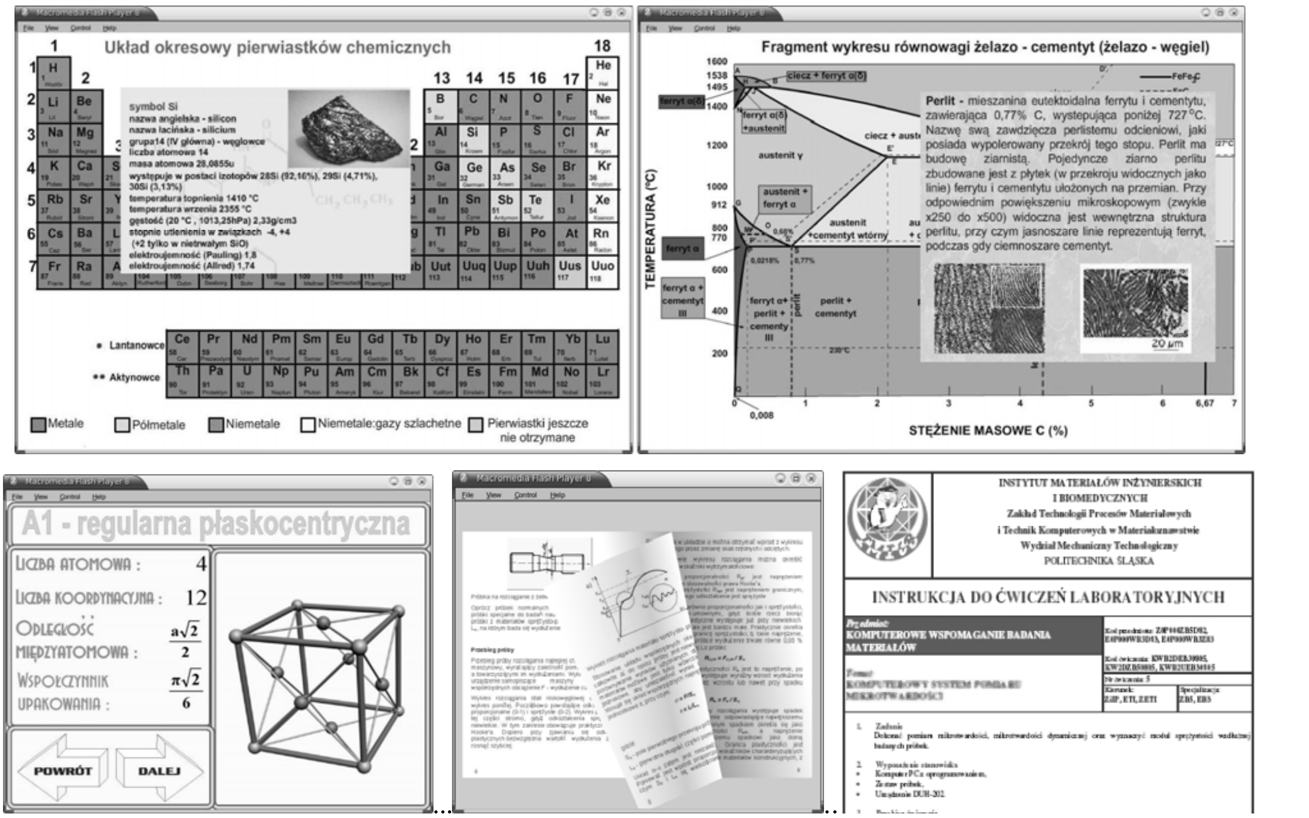

Fig. 5. Examples of different multimedia helps, a) interactive periodic table of the elements, b) the iron-carbon equilibrium diagram, c) three-dimensional presentation of metals crystallographic structure, d) electronic book on the subject of materials durability investigations, e) the fragment of the instruction to laboratory practices. (Dobrzański and Honysz, 2007)

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