



Building methodology of virtual laboratory posts for materials science virtual laboratory purposes

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ABSTRACT

Purpose: The purpose of this article is to describe the building methodology of virtual laboratory posts placed in Material Science Virtual Laboratory. Presented 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.

Design/methodology/approach: The use possibilities of the virtual laboratory posts are practically unrestricted. The laboratory can be a base for any studies, course or training programs performed by traditional and e-learning methods.

Findings: Possession of the equipment, that is practically imperishable, cheap in exploitation and safe in usage will certainly 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.

Research limitations/implications: The student during the work with the simulations will learn the functioning principle as well as the investigations and experiments guidance methodology of the simulated real device.

Practical implications: As the implementation example of the laboratory for the didactic and educational tasks the virtual simulations of investigative equipment are presented.

Originality/value: The presented project 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.

Keywords: Computer aided teaching; E-learning; Virtual laboratory; Training simulations

EDUCATION AND RESEARCH TRENDS IN MATERIALS SCIENCE AND ENGINEERING

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 take place beyond class benches and laboratory workrooms - into the virtual reality. This process, aided by telecommunication

technologies, guides in the consequence to emerging of the virtual academical community and to the development of the 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 [1-3].

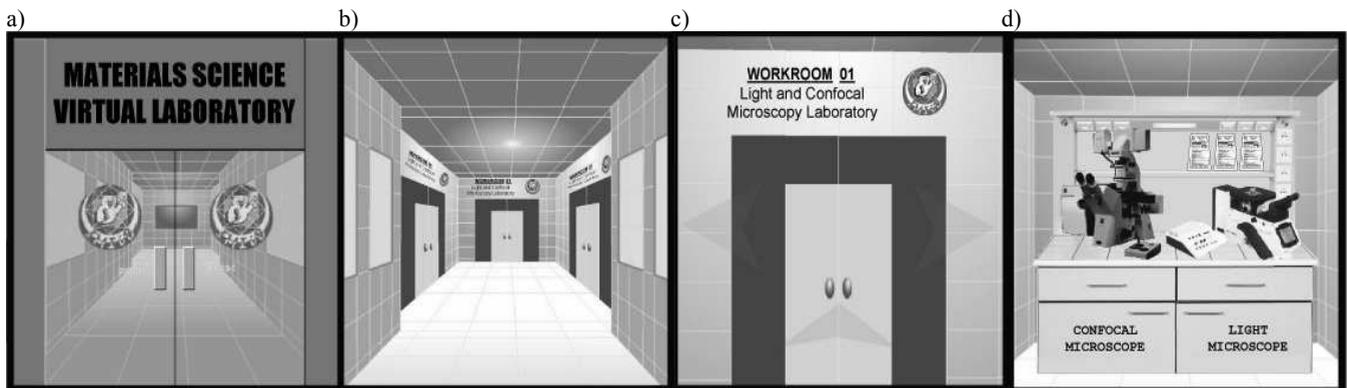


Fig. 1. Materials science virtual laboratory placed in the educational e-learning platform of the Institute of Engineering Materials and Biomaterials, Gliwice, Poland a) entrance, b) main corridor with workrooms, c) entrance door to virtual laboratory of light and confocal microscopy, d) inside the laboratory

2. Value of the project in the world education

The presented project corresponds with the global tendency for expand the investigative and academic centers about the possibilities of training and experiments performance with use of the virtual reality. Many of these centers abroad and in Poland already administers similar virtual laboratories used for the realization of their own aims and for use of new possibilities of education, which this laboratory offers. At many universities leaning across the virtual reality is the general form of knowledge transfer. [4-8]

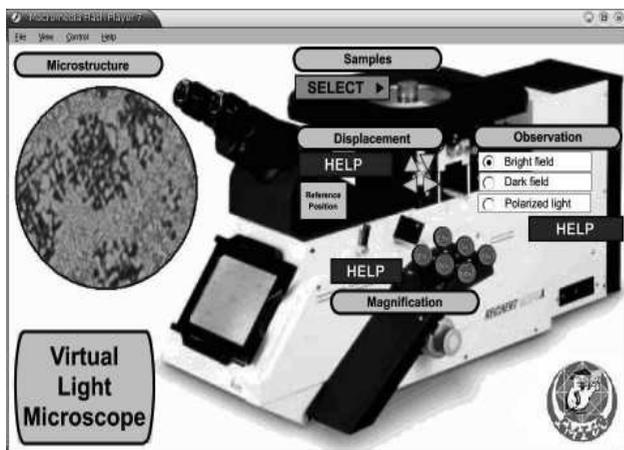


Fig. 2. Virtual simulation of light microscope. The loaded sample is ZIMn1.2 manganese cast iron

In Poland the works for application of virtual laboratory for didactic problems in the subject of material science were not undertaken yet. This project tries to fill this gap in the form of the methodology and lecture guidance performed with use of virtual equipment. [8]

3. Development methodology of material science virtual laboratory posts

Virtual laboratories are very dynamically developed environment for simulations, achieving knowledge and raising the skills. The creators of such laboratories are in most cases the investigative and academic centers and specialist technical firms using the virtual reality to projecting of their products and testing their properties before they will be directed to the serial production. Such form of the data collecting is widespread in Western Europe and United States of America. The systems of the computer aid CAD / CAM / CAMS are already generally well-known and used. This is the symptom of the active economic politics of enterprises aiming to raise the quality and reduce the costs of offered products (Fig. 1). [9-11]

3.1. Project and the content of the virtual laboratory

Material Science Virtual Laboratory is an idea, 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.

In the virtual reality, the real laboratory devices are replaced by corresponding to them computer programs created in different programming languages and technologies. They are virtual reproductions of real equipment installed in real laboratory. User on his computer screen have a unique possibility for realization of several defined tasks from given field answering to the given device. [12-14]

The main laboratory corridors are shown in (Fig. 1ab). Several workrooms equipped in virtual equipment together with the instructions of their use were constructed in the virtual reality. One of these is the virtual laboratory of light and confocal microscopy presented in (Figs. 1cd).

As examples of virtual machines used for realization of the didactic and educational tasks, figures of several device simulations are presented in (Figs. 2-6).



Fig. 3. Virtual simulation of hardness tester, presented is the panel serving for the choice of the testing method

In the virtual laboratory are placed the virtual simulations of investigative equipment installed in the laboratories own by Institute of Engineering Materials and Biomaterials, Silesian University of Technology. [14]

The educational e-learning platform of the Institute created in the October 2004 is used to the implementation of virtual laboratory for the material science purposes. This modern tool of the computer aid in distance and traditional learning, offers to the students the great possibility of active self-training methods granting access to scientific and educational supplies from the field of materials science. This platform makes possible the unbounded work in the laboratory through the internet for wide group of students, teachers and scientific staff from any place on the world. [15-17]

The languages of the network programming applied for the virtual laboratory creation makes possible the access to the laboratory worldwide, round the clock and without the regard on the configuration of the computer equipment, which users are operating. It doesn't have meaning neither the operating system installed on the computer, neither the internet browser used for displaying the laboratory content on the monitor screen.

The only requirement, which he has to be fulfilled, is the possession of PC class computer with the access to the global net, and the access code to the given device received from the laboratory supervisor. [12,17]

3.2. Limitations applied on the virtual laboratory content

The student should have the access to all contents which are indispensable for him to the realization of the given problem. Simultaneously, all secret information should be secured. The access to these informations should be granted only to students authorized to their receipt.

The system of personal accounts and passwords should come into being for controlling of the data flow among the participants of the given course. Student with use of his account has the access to the specific, designed for him section of resources and for his panel, which enabling the personalized work in the virtual reality. Systems of such type are called the content management systems (CMS) and they are delivered as a component of educational platforms. These systems are wide applied in e-learning and in traditional teaching.

The access to virtual scientific helps should be independent from time and the place of the student stay, that is why it shouldn't be engaged any limitations neither to the place of the access (e.g. only from the computers on the university), neither to the time of usage (e.g. only till the hours of the university work) [16,18,19]

Independence of the student work, in the asynchronous mode of teaching, from time and place, makes possible the almost continuous work 24h on the day. Individual problems designed by supervisors for realization can be taken independently for realization by students from the various pieces of the globe regardless from their current stay and at any time. This enlarges elasticity, productivity and availability. The student follows the project in time and place suitable for his day plan, not, how it takes place in the case of traditional classes, in terms and places thrown on by the university.

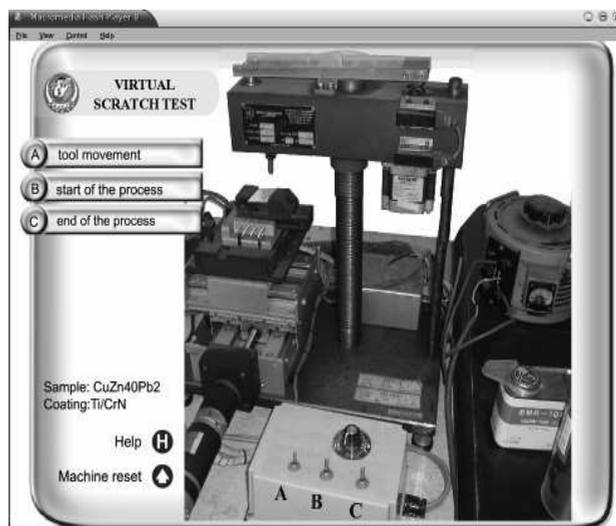


Fig. 4. Virtual simulation of scratch-test machine. Loaded sample is Ti/CrN coating on CuZn40Pb2 substrate obtained by the PVD method

The asynchronous mode of the work with lots of advantages carries also a lot of new threats. Differences are present in student's mentality and their predispositions to the work in the team. The teamwork of people, which are communicating with each other exclusively through electronic channels can be difficult because of the differences in the way of work of the various team members, and because of various communications with the external world.

The absence of direct physical supervision of the teacher over the realized by students project can also result in the formation of errors. The counteraction requires very meticulous defining and obeying of the communication principles, defining common notions and aims. Equal understanding and interpretation of shared data is the most important aspect of creating and functioning of virtual teams. [13,20]

3.3. Building methodology of virtual laboratory posts

Virtual devices are the special case of scientific helps, so they should fulfil all recommendations for to the building of electronic didactic materials and scientific helps.

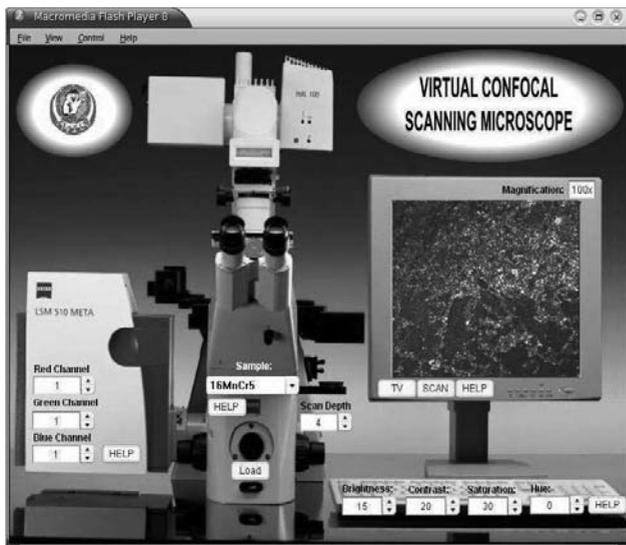


Fig. 5. Virtual simulation of confocal microscope, loaded is the sample of 16MnCr5 steel. magn.100x

The student during the work with the simulation should exactly understand the functioning principle as well as the investigations and experiments guidance methodology of the given device. Possession of this knowledge makes possible, that re-executing of the training experiments during the work in real conditions is easy and safe, without the necessity of continuous looking to the manual instruction. There is also no need to ask persons already trained in its service about every detail, because all are described in electronic manuals.

Presented simulations let the user acquaint with the basic possibilities of the simulated device. In real device all functions are called out by use of the suitable levers or knobs. In simulated machine, all this functions are accessible through gadgets on the monitor screen, by „clicking” on corresponding buttons, or by pressing appropriate key on the keyboard. All buttons and switches in the simulations are placed in positions adequate to real effectors in real machines.

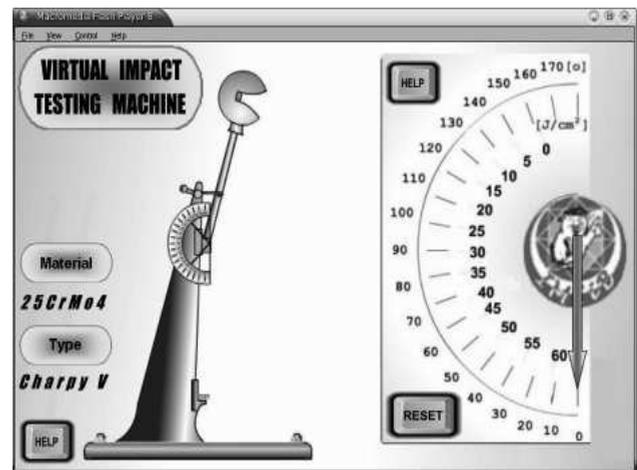


Fig. 6. Virtual simulation of the impact testing machine, loaded is the Charpy V sample of 25CrMo4 steel

It should be kept in mind, that even the best-programmed virtual laboratory will never replace even the modest real laboratory. These systems should not be treating as equivalent and one system should not be exchange on the second one. Virtual and real technologies are complementary to each other. Applied together offer more possibilities than applied independently from each other.

To use the laboratory necessary is only the PC class computer with the access to Internet. The languages of the network programming applied for the virtual laboratory creation should granted the access to the laboratory without the regard on the configuration of the computer equipment, which users operate, neither the operating system installed on the computer, neither also the Internet browser used for displaying the laboratory content on the monitor screen. [21-25]

3.4. Interactive didactic helps

The laboratory does not consist only from machines. Didactic helps are also very important for processes of active teaching. Presented here 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 necessary the data (Fig. 7). Only one mouse click is necessary on demanded element or structure for displaying of suitable description. [18,22]

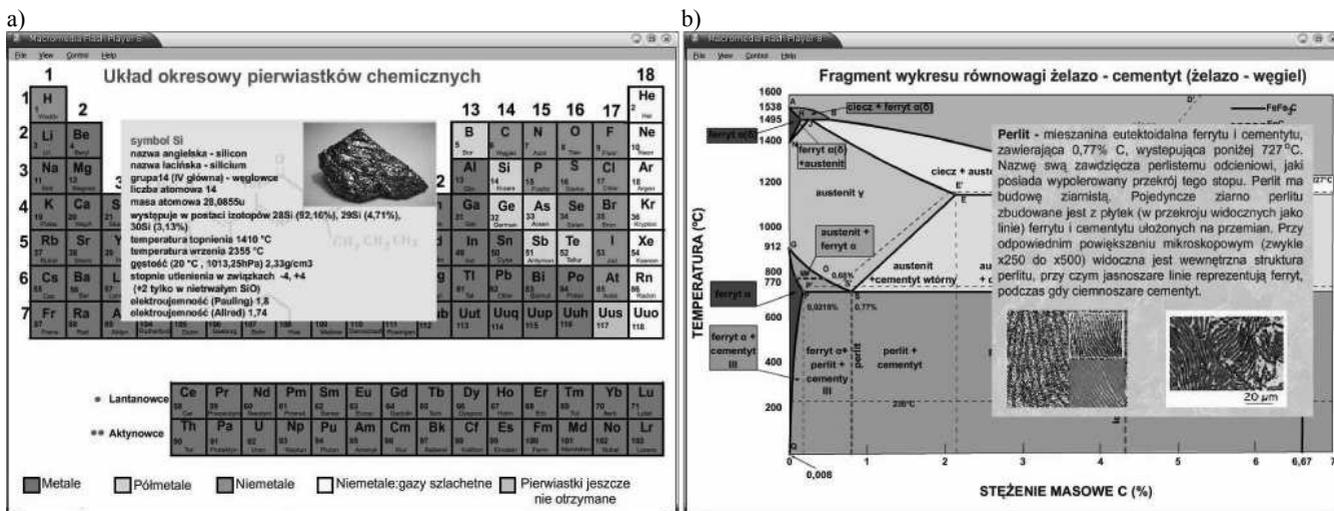


Fig. 7. Virtual didactic helps, a) interactive periodic table of the elements, b) the iron-carbon equilibrium diagram

3.5. Application of the virtual laboratory for material science purposes

The use possibilities of the virtual laboratory are practically unrestricted; it can be a base for any studies, course or training programme. It is assumed, that the project of the laboratory as fully multimedial. The participants of this laboratory can e.g. investigate training experiments from the definite field of material engineering, give questions, pass tests, contact with lecturers and the different users of the laboratory and obviously on participate in his design and content.

Possession of the equipment, that is practically imperishable, cheap in exploitation and easy in the use certainty will encourage students and scientific workers to independent audits and experiments in situations, where the possibilities of their execution in the true investigative laboratory will be limited because of the high material costs, difficult access to real equipment or the possible risk of his damage. [12,24-28]

4. Conclusions

The virtual laboratory is the modern educational and accessible platform for all users. It delivers the knowledge not only to students, but also to teachers and different persons, who wants 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.

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