An ODL system and Virtual Class for the electrical engineering sector

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Abstract: The rapid development of information and communication technologies (ICTs) and the move towards more knowledge-intensive, interdependent and internationalized societies created new challenges and opportunities for the design and delivery of education. This evolution also influenced the educational branches of life long training, continuing vocational training and distance training. This paper presents an e-training system which gives information about contemporary electrical installations simulating them as a virtual class. The presented material is organized into four separate courses because each one describes different features of electrical installations and has its own importance. The type of information provided, is both theoretical and practical. Moreover, this paper projects a market research on training needs of the electrical engineering sector across four EU countries. All the above, are implemented with new digital technology methods, using multimedia content management techniques and Open and Distance Learning (ODL) principles. Its main goal is to transfer knowledge to the electricians' workforce in order to achieve their adaptation to the transition from conventional installation technology to an intelligent one.

Key-Words: e-learning, ODL, virtual class, vocational training, simulation, electrical installations

1 Introduction

Computer aided training (CAT) started with CD-ROM applications. Although a CD-ROM has a large storage capacity and a great portability potential, its content is static and cannot be changed. The next step was to think about network solutions. These solutions were encouraged to be followed by the rapid development of the Internet. During the early days, the applications were simple with online courses comprised of various hyperlinked web pages which the learner advanced by clicking. The context was a simple quotation from printed books, being preventive for a learner to read. The collaboration between learners and teachers was taken place by e-mail with limited connection resources e.g. dial-up connections. Nowadays, this situation has dramatically improved with the advent of modern web-based technologies and broadband computer networks. As a result, the term e-learning arrived [1,2,3].

E-learning can be defined as the effective learning process created by combining digitally delivered content with (learning) support and services [20]. It requires a network which is working as a distribution system (for example an institutional intranet or the wider internet), but includes collaboration and interactivity among the users. Digital delivered content includes not only quoted texts, but also a wide range of other material including simulation experiments, illustrative images, video, and also email and other simple messages services which allow rapid information and guidance. Delivery refers to the use of telecommunication networks to allow high speed access to information. Finally, supportive services for e-learning can take several forms, ranging from pedagogical processes like explaining, tutoring and assessing, to less obvious processes such as efficient course administration or reservation of library books [4,5,7,9,17,24].

Open and Distance Learning (ODL) is a key subject in e-learning. It reflects both the fact that all or most of the teaching is conducted by someone removed in time and space from the learner, and that the mission aims to include greater dimensions of openness and flexibility, whether in terms of access, curriculum or other elements of structure [6,8]. Education, training and employment are not any more consecutive moments of life; in order to maintain their employability, individuals are urged to return to education and training at different stages of their working life making life long learning a reality

[18,19,,20,21]. When it comes to technical aspects, a simple ODL system maybe is not enough to cover the demands, due to their practical nature. Thus, the idea of virtual class is introduced. A virtual class transforms the provided vocational training into applied schemes. A typical virtual class uses the simulation process for the user in order to start experiments with the class's 'virtual' equipment as if he was in a real laboratory [10,11,25].

2   Abstract Level Description

This section contains two parts. The first one involves the searching of the appropriate specifications and principles which will be the backbone of the system, addressing ODL and Virtual Class issues. The second one contains the case study of the presented system, applying the above principles.

2.1 ODL and Virtual Class issues

In order to design the whole system, a set of principles had to be taken into consideration. About cultivating an ODL environment, a certain area of studies to be taught is selected together with the type of target group that these programmes or courses appeal to. Moving on, the type of educational institution/organization which is providing the ODL and the group of people who will develop, prepare and guide the courses sessions is a crucial parameter. Above all, there should be a study of economic, societal and technical requirements, placing the framework for the next phase of the virtual class modulation.

An organized virtual class should combine its features with the offered vocational training. A simulation planning of certain technical processes should take place in order to present the core of each case study without exaggerating, providing spherical information in every topic of interest. It is essential for the class to have a user friendly interface, having interoperability along many platforms.

2.2 System structure

Having consolidated the principles of the previous section the next step was to design the system structure according to them. It is depicted in Figure 1. The design's flow chart consists of the following steps:
- In the first step, there is a choice of the scientific area to be described and the type of the correspondent learners. At this point

electrical installations and the electricians' branch are selected respectively.
- The second step includes the information providers. These are the institutions that provide the ODL either giving technical information or developing the system (a bundle of institutions and companies), and the development and preparation of these courses by a team of experienced engineers/teachers
- Moreover, a thorough study takes place about the aforementioned requirements of this work. Therefore, the crucial decision was to divide the system into four main parts: A course about how the content is presented and three pure technical courses. This division made for the reason that these activities, although in the same field are operationally different. Then, it is more effective for them to adapt to a virtual class environment separately producing improved results for vocational training schemes and simulation processes.
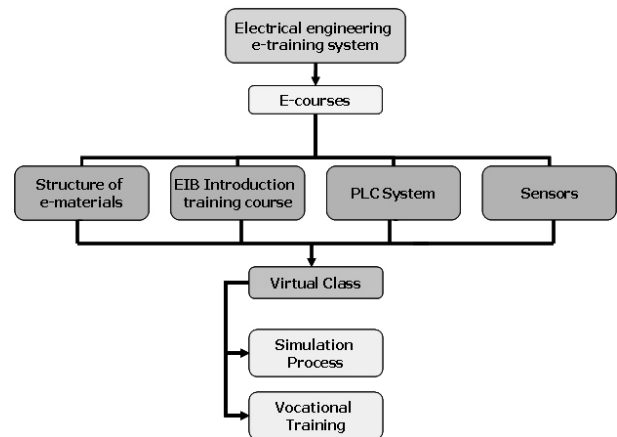

Fig.1 – System Structure

3   System Analysis

This system's opening page is depicted in Figure 2, has a simple but functional structure. It shows Thales who discovered "hlektron". It was the first observed material having electrostatic behaviour, attracting other physical objects. At this point, the user-visitor has the option to choose one of the next options:

- State of the Art
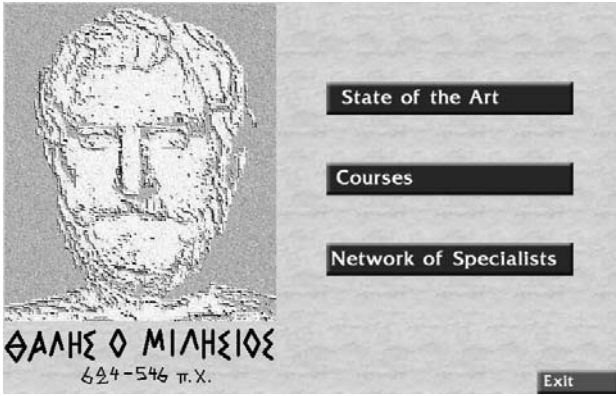- Courses
- Network of Specialists

Fig.2 – System's opening page

Following the first option (State of the Art) projects a market research on training needs of electrical engineering and installations sector in Greece, Cyprus, Norway and Sweden. It is depicted in Figure 3.
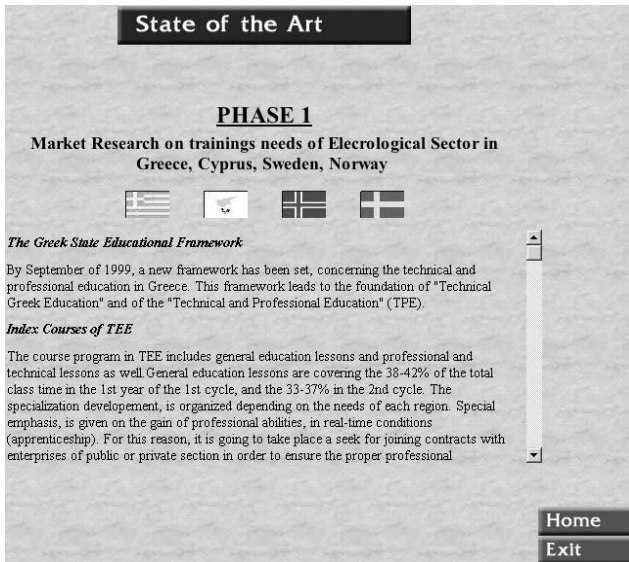

Fig.3 – Market research on training needs

The next option (Courses) is the core of this system. It contains four main parts. The first is the structure of e-materials which analyzes how the technical content is organized. Every part is divided into small subject chapters, containing clearly determined goals in every unit. It contains advice about how it should be studied with representative examples and studies and self-tests as well as the correct answers and discussion about possible mistakes. The entire above have explanatory titles and subtitles. In the end, all chapters include

The second part (EIB Introduction training course) describes an alternative way of electrical installations via an EIB bus. It begins with a simulation of a conventional installation (Figure 4) and moves on with an overview of EIB bus technology hierarchy (Figure 5). Someone can easily observe that in the left side of the screen the user can navigate over the various sections of each course. As a result he can proceed to the chapter of his interest without having to pass from the previous ones. On the right side of the screen the content of each chapter is presented whether it is vocational training or simulation.
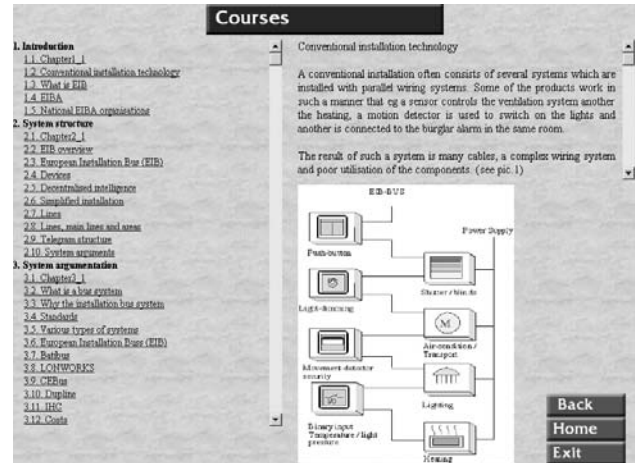

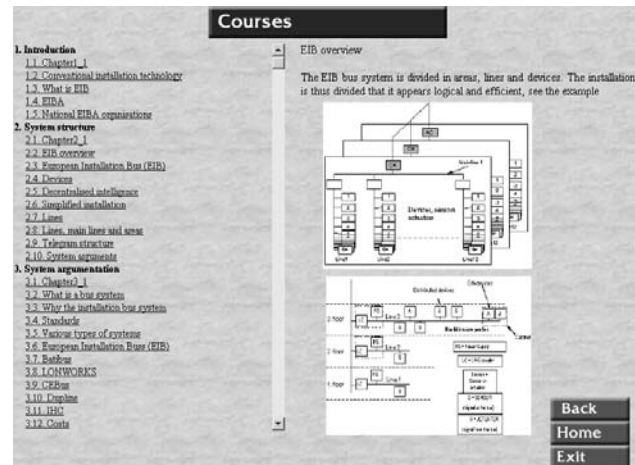Fig.4 – Conventional installation technology simulation

Fig.5 – EIB bus technology hierarchy

Great focus is given on the connection of electrical devices to the EIB bus system with the help of relays and connection boxes (Figure 6). These are useful for mounting on ceilings, in channels etc. They have binary inputs and outputs. They also can be utilized for coupling/dimming of light and chatters regulation. Here the technician learns how to make the exact connections as if he was in a training class to an EIB bus in order to apply them in the future to more complicated installations.
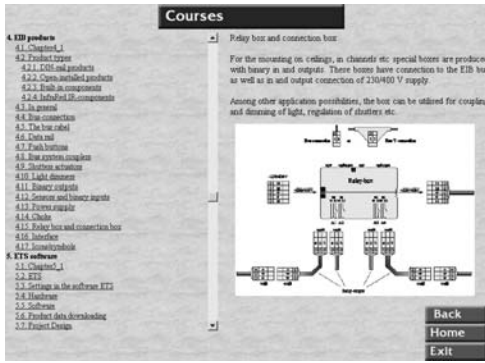
Fig.6 – Relays and Connection boxes

A significant change in planning and designing electrical installations via an EIB bus is the ETS software. This software can communicate with the rest of the system through only a twisted pair-cable. Here is presented an installation design with the help of ETS software, a guide for every technician (Figure 7).
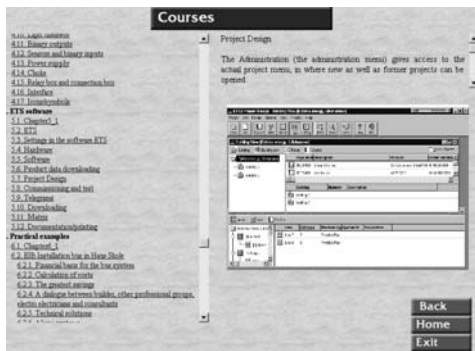

Fig.7 – ETS software

The third part of Courses option is PLC (Programmable Logical Controllers) systems. PLC's are systems that control motors, cylinders etc. receiving several signals from sensors and switches. In Figure 8 a simulation of a lift system is depicted. This is a virtual laboratory (class) showing the moves of this lift through questions and answers depending on each question requirements. The lift operation is simulated with logical expressions by the help of PLC's.
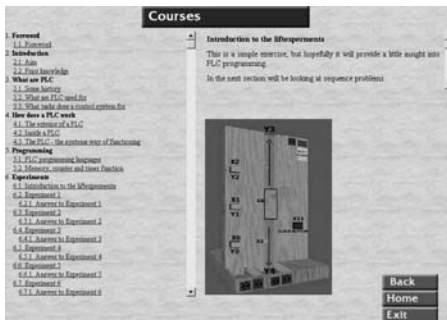

Fig.8 – Lift simulation

The answers about the various lift operations are given in a form of a software environment simulating a PLC operation (Figure 9). With that simulator a PLC's internal memory can be programmed and tested before the procedure and construction of the lift system achieving the best results and covering all the operational specifications.
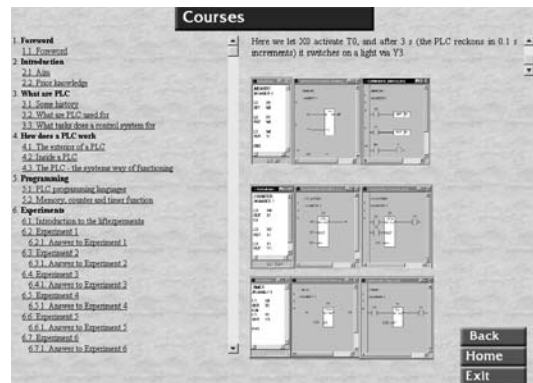

Fig. 9 – PLC memory programming

The final part of Courses option contains the wide area of sensors. Sensors are devices which observe, detect and convert information signals into voltage or current intensity. Therefore, they imitate (in a way) the human senses. In figure 10 various sensors application can be seen and its operation principle as well.

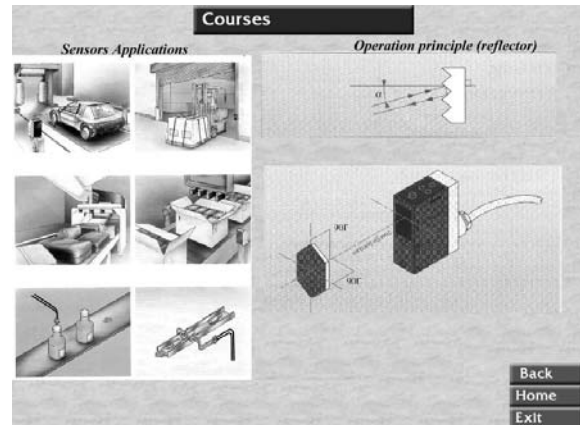Fig. 10 – Sensors application and operation principle

An interesting chapter of sensors part is fiber optics photocells technology. Here, the user-visitor can learn about the applications of fiber optics (optical transmission systems like LAN/MAN networks). Because of the complexities of fiber optics installations, special vocational training is given in the form of right/wrong examples (Figure 11).
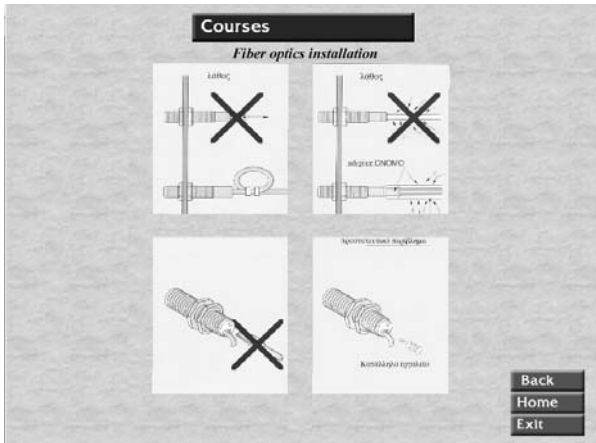
Fig.11 – Fiber optics installation technology

The third option, Network of Specialists, contains the continuous phases towards the finish of the system and the distinctive roles of scientists, technicians and producers of products, included in the electrical engineering scientific area. This networks job is to inform all the categories involved in the area (electricians, students etc.) about new demands or products creating collaboration between electricians and production-industry.

4 Benefits

The described ODL system in this paper has various benefits for the evolution of information society and for the electrician's branch.

ODL provides better access and flexibility for a learner because he can combine it with his occupation, adapting it to his needs. Furthermore, the ODL concept is learner-centred giving him the capability to increase his level of learning with an interactive way [13,14]. On-demand availability enables learners to complete training conveniently without having to comply with a specific schedule. A learner also, can follow his own pace according to his current availability without stress making his experience more satisfactory [15,23]. For employers, ODL offers cost effective professional development in the workplace, allows upgrading of employees' skills with increased productivity [7,16]. Moreover, vocational training planning is essential because it is the vehicle to meet the various e-training requirements (societal, economic and technical), allowing to foresee the future demands [12]. To sum up, a big opportunity is given to people with limited access to the traditional education types, for example disabled people and people in rural or remote areas.

As far as the content of the educational material is concerned, the electricians' branch becomes multiply benefited. Such systems mean reduced training time, and increased portability of training. Besides, this system supports with an easy and friendly way education and training in the form of life long and continuing education and training. Moreover, it is directed towards the aim of training in electrical engineering (science, modern products and technology) which is the community of electricians, engineers and students. Furthermore, the creation of a human network of scientists, technicians and producers is beneficial. This network is undertaking the role of the information circulator among industry, electricians and students. It informs the students/electricians via particular actions for new products, availability, prices etc. and bears the feedback from electricians to industry. Finally, the technicians who were skilled in a certain technical domain which starts to decline or become saturated in the market (conventional installations), have the chance to work with in a totally new environment (EIB bus systems). As a consequence, their transition to the new status becomes as smooth as possible, they upgrade their know-how and they do not turn up unemployed [22].

5 Conclusions

In the analysis carried out throughout this paper, the numerous advantages of the system that supports virtual class and ODL services became clear. This system can give to a user-visitor the capability to navigate through the course about electrical installation technology with the assistance of vocational training and simulation (virtual class) methods.

Nowadays, a great challenge exists in the field of e-learning and particularly e-training. The development of such systems is demanding. They must fulfill both pedagogical and infrastructure criteria. An up-to-date e-training system should function technically without problems across all users, having clearly explicit pedagogical design principles closely to learners' needs and qualifications. The teaching faculty should be specialized connecting the training courses with enterprises needs and changing requirements in the labour market. In addition, it must have all the necessary infrastructure parameters like sufficient hardware and software resources, connection with high speed computer networks and should be regularly upgrade or maintained.

E-training is a dynamic and creative field. Virtual classes are centers for creativity and imagination. Exploiting them, they turn into innovation catalysts, leading to a better society accomplishing the scheme 'Information for All'.

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