A virtual lab and e-training system for natural gas technicians

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Abstract: Information and Communication Technology (ICT) brought a wave of change in such a way that many human activities are being conducted with its catalytic contribution. This evolution inevitably could not leave the learning and education field unaffected. As a result, the term e-learning is used. This paper presents an e-training system which gives information about the installation and maintenance of natural gas networks for domestic and professional use simulating them as a virtual laboratory. It contains an adequate amount of material about natural gas technology. This material is equally theoretical as well as practical, combining text, sound and image. It also gives the picture of the Greek natural gas market and national distribution grid as it is operating so far. All the above, are implemented with new digital information methods, using multimedia content management features, vocational training techniques and Open and Distance Learning (ODL) principles. Its main purpose is to convey knowledge to the technicians' workforce in order to achieve their adaptation to the transition from conventional energy sources to alternative ones.

Key-Words: e-learning, ODL, virtual lab, vocational training, simulation, natural gas

1 Introduction

Computer based training (CBT) started with CD-ROM applications. Although a CD-ROM has a large storage capacity, its content is static and unchangeable. The obvious next step was to think about network solutions. These solutions were enhanced by the development of the Internet. The early days, the applications were simple with online courses comprised of various hyperlinked web pages which the learner advanced by clicking. The cooperation between learners or teachers was accomplished by e-mail with limited resources e.g. dial-up connections. Nowadays, the previous status has dramatically improved with the advent of modern web-based technologies and broadband computer networks. Consequently, the term e-learning came to existence [1,2,3].

E-learning can be characterized as networked access to digital learning materials and communication systems to deliver and support learning. Explaining the above in further detail, networking implies both a distribution system (especially when linked to institutional intranets and the wider internet) but also includes collaboration and interactivity. Digital learning materials mean not only texts, but also a wide range of other materials including simulations, images, sound and video, and also email and other simple messages which allow rapid and tailored information and guidance. Delivery typically refers to the use of telecommunication networks to allow rapid transfer of information. Finally, support for learning can take a wide variety of forms, ranging from didactic processes such as explaining, tutoring and assessing, to less obvious processes such as efficient course administration, reservation of library books and the processing of awards [4,8,11,19,20].

Particularly, Open and Distance Learning (ODL) is a key subject in e-learning. ODL emerged as a second chance approach to education and training. It can produce results of a better quality than conventional teaching having features like individualization, internationalization and flexibility [6]. Contrary to skepticism, the European Union has funded many projects concerning ODL starting to shape a new, firm policy framework [5,9]. ODL systems must be always planned with certain case studies and principles according to the desired needs, goals and perspectives of the target group that appeal to [10].

When it comes to technical aspects, a simple ODL system maybe is not enough to cover the demands. Thus, the idea of virtual laboratories is introduced. This idea is bringing the user/visitor straight to the

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core of a technical application as if he/she was in a real laboratory. A typical virtual laboratory tool usually proposes a simulation allowing distance interaction with the laboratory instruments [12,13].

2 Abstract Level Description

This section contains two parts. The first deals with the specifications and principles for designing an e-training system addressing ODL and Virtual Lab issues. The second deals with the description of the system structure applying the ideas of the first section.

2.1 ODL and Virtual Lab issues

In order to design the whole system, a variety of specifications and principles had to be taken into consideration. The most important ones are mentioned in the list below:

- Area of studies to be taught
- Type of target group that these programmes/ courses appeal to
- Type of educational institution or organization which is providing the ODL
- Who developed the ODL programmes/ courses
- Who prepared the courses to be taught
- Study of economic, societal and technical requirements
- Combination of vocational training and virtual lab features
- Adequate simulation planning of certain technical processes in order to cover as more case studies as possible

2.2 System structure

Having realized the parameters of the previous section the next step was to design the system structure which is depicted in Figure 1. The design flow procedure 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 natural gas and the technicians' 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 an experienced engineer of a natural gas distribution company
- Moving on, a thorough study takes place about the aforementioned requirements of this work. Therefore, the crucial decision was to divide the system into two parts: The installation part and the maintenance part. 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 laboratory environment separately producing improved results for vocational training schemes and simulation processes.

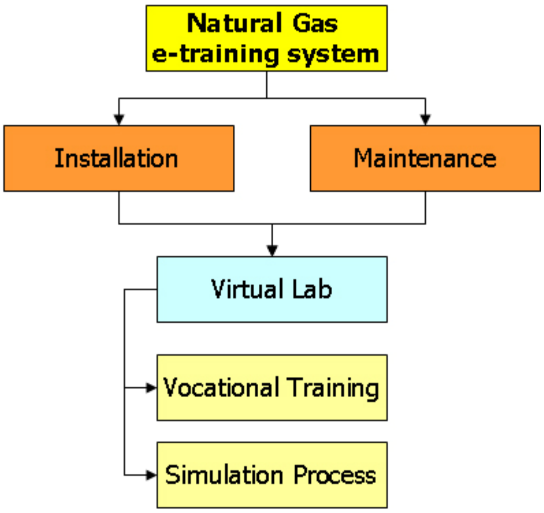

Fig.1 – System Structure

3 System Analysis

This system's opening page (Figure 2) has a functional structure so that the visitor can easily navigate throughout the various presented options.

Fig.2 – Natural gas maintenance opening page

The opening page for natural gas installations has the same structure. The two categories, although having identical a major part of the content, they differ in the simulation process. Actually, they act as two independent subsystems.

At this point, the user-visitor has the option to choose one of the next options:

- General Information
- Technical Guide
- Practical Advice
- Useful Addresses
- Training programmes

Following the first option, a menu giving information about natural gas appears. This menu contains subjects such as the Greek natural gas grid, the natural gas grid in the region of Attica (this is where Athens, the Greek capital, belongs), the natural gas's chemical composition and attributes, its applications and its impact on the environment. Here vocational training is giving about all the above subjects. An example is depicted in Figure 3 along with a simulation of Greece (Figure 4) and Attica grids.

Fig.3 – Natural gas applications

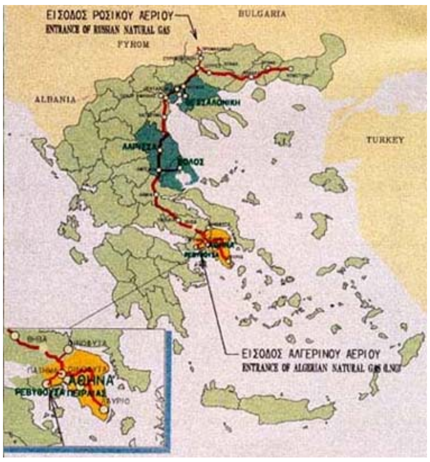

Fig.4 – Natural gas grid simulation

Getting back to main menu, the technical guide option is described. It consists of the technical instruction about installation and buildings with operating pressure 0 – 50 mbar. This instruction was published by the Technical Chamber of Greece (TCG). TEE provides all the specifications about gas installations/maintenance from the beginning to the end of a construction (Figure 5).

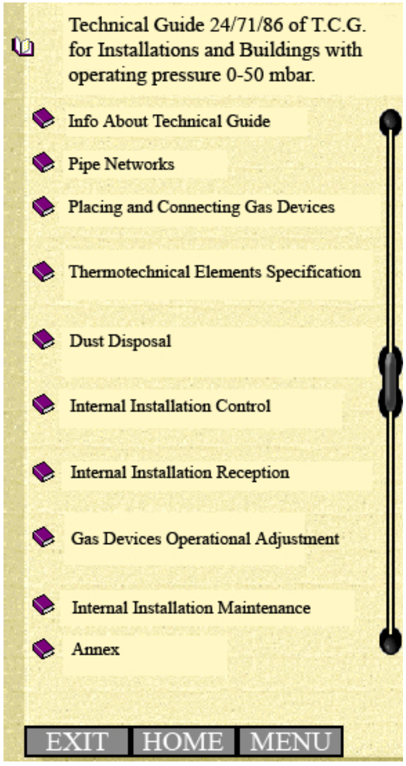

Fig.5 – Technical guide menu

This guide also provides in its annex the necessary symbols of natural gas technical drawings in order for a technician to design or recognize them and their operability/connectivity to a more complicated network (Figure 6).

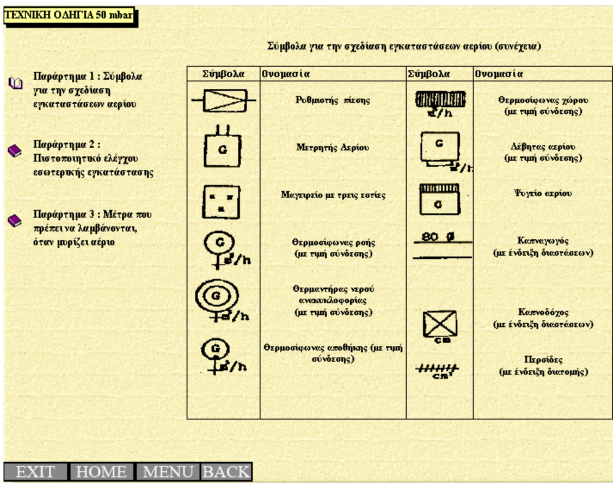

Fig.6 – Natural gas technical drawing symbols

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The next option is the Practical Advice section. In this section, the use of natural gas is analyzed adopting virtual laboratory techniques. It is divided into three parts. The first one describes -with the combination of vocational training and simulation- the devices using natural gas for cooking purposes. It is focused on the connection between them and the building's network. The second one describes the devices which produce hot water for washing purposes (Figure 7).

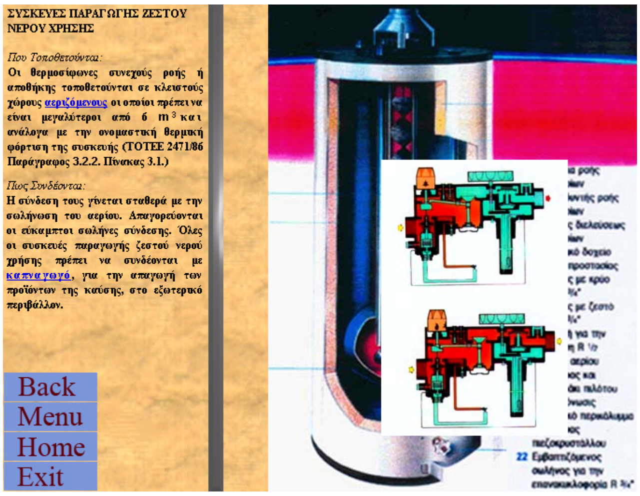

Fig.7 – Characteristics of a water-heater using natural gas

In the third one respectively, the devices which produce hot water for heating purposes are described (Figure 8).

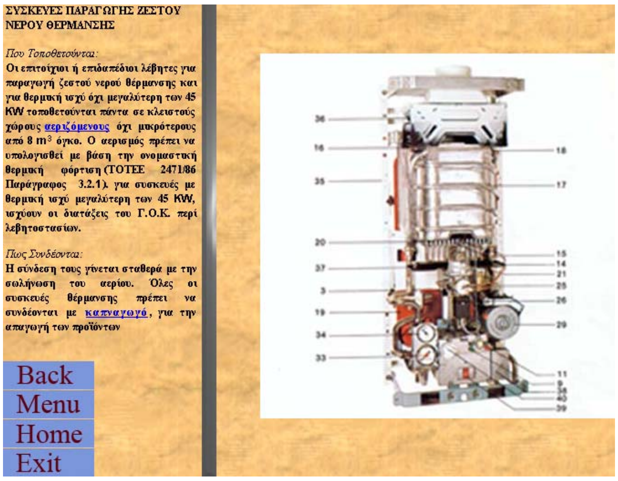

Fig.8 – Characteristics of a boiler using natural gas

Moving on, the next step of navigation includes useful postal addresses, telephone and fax numbers of natural gas installation and distribution companies. These companies belong to the public or private sector (Figure 9). The vast majority of them are Greek.

Fig. 9 – Addresses of natural gas installation and distribution companies

The next option from the main menu is the training programmes (Figure 10) held about natural gas technology. These are two separate seminars held simultaneously for installing/maintain a natural gas installation. These seminars were funded by the EU 'Adapt' project with the collaboration of the Gas Distribution Company of Attica (EDA). The goal of these seminars was to give a further support to this system developed by skilled scientists and engineers. It contains all the thematic sections concerning natural gas and a last section of practice in special formed places.

Fig. 10 – Training programme about natural gas

Finally, a complete natural gas installation in a typical residence is simulated as a virtual lab (in the natural gas installation page), following the phases of distribution from the city grid, the supply point, the internal distribution pipes and consumption/dust elimination devices (Figure 11). Here, the gas flow at any of the previous mentioned phases is illustrated with different colours. Clicking on each arrow someone can watch the gas's flow at each phase sparkling indicating its difference from the rest. Simultaneously, at the left side of the screen useful advice can be seen for each phase, according to the aforementioned Technical Guide by the Technical Chamber of Greece.

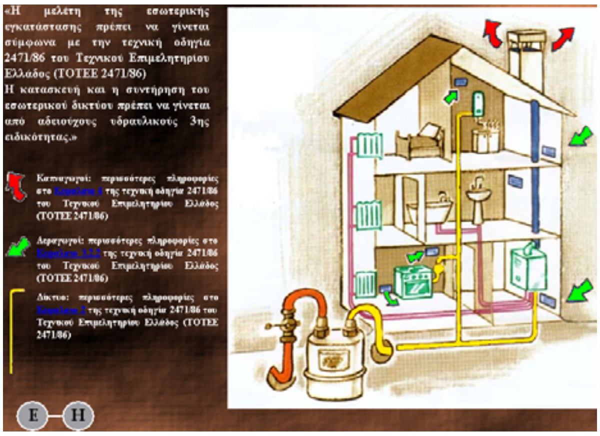

Fig.11 – Complete natural gas's installation simulation

4 Benefits

The described e-training system in this paper has various benefits for the evolution of information society and for the technician's branch.

On the one hand, ODL provides better access and flexibility for a learner combining it with his/her work [16]. Furthermore, the ODL idea is focused on the learner giving him the potential to have higher quality of learning and an increased level of interactivity [15]. On-demand availability enables learners to complete training conveniently at off-hours or from home. Self-pacing for slow or quick learners also, reduces stress and increases satisfaction [17]. For employers, ODL offers cost effective professional development in the workplace, allows upgrading of employees' skills with increased productivity [7,18]. 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 [14]. Lastly, a big opportunity is given to people with limited access to the traditional education/training types, for example disabled people.

On the other hand, the technicians' branch becomes multiply benefited. Such systems mean reduced training time, and increased portability of training. Besides, knowledge is conveyed to several categories related with natural gas. These are, technicians involved in installation and maintenance of natural gas systems, engineers and designers of such systems and even people who want to learn about their domestic installation in order to take caution measures in case of an emergency. Finally, the labor workers who were skilled in a certain technical domain which starts to decline or become saturated in the market (conventional energy sources), have the chance to work with in a totally new environment (alternative energy sources). As a consequence, their transition to the new status becomes as smooth as possible, they upgrade their know-how process and they do not turn up unemployed.

5 Conclusions

In the thorough analysis carried out throughout this paper, the numerous advantages of the system that supports virtual lab and e-training services became clear. This system can give to a user-visitor the capability to navigate through the main features of natural gas technology by using vocational training and simulation methods, exploring places that he cannot physically visit.

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 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 appropriate to learner type, needs and context. In addition, it must have all the necessary infrastructure parameters like sufficient hardware and software resources, high speed connectivity, regular maintenance/upgrade operations and specialized faculty.

E-training is dynamic and creative at its core. Virtual laboratories are centers for creativity. Exploiting them, they turn into powerful catalysts for innovation, leading to a better society with equal chances to access knowledge and information.

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