E-LEARNING IN DIGITAL ELECTRONICS

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This paper outlines the design and implementation of a Web based interactive e-learning tools in the field of Digital electronics. It covers structure of the trainers, approaches and technologies used in their development. All tr@iners are modular in concept and can be easily adapted to specific requirements by the developed authoring tool. They apply "learning by doing" pedagogical model with extensive use of interactive simulators. The design philosophy of the e-Trainers is based on latest state-of-the-art software technology. All products are Internet accessible, platform independent, and ensure multylanguage support. They conform to the AICC and SCORM standards and are compatible with most LMSs.

1. INTRODUCTION

Technical competence is the prerequisite for the success in any industry. The challenges abound:

- The rapid growth in the number of skills required;
- The complexity of knowledge which needs to be mastered, and
- The short life-cycle of information

Thus universities are looking for ways:

- To enhance their classical learning concepts
- To provide better results within a lower budget.

The Internet has enormous power to improve the educational process. By using the Internet, education can be personalized to each user, so that each student is given a targeted set of materials based on his or her specific educational goals and previous achievements. The net effect of all of this is that education is becoming increasingly targeted to the individual; it is going to be integrated more completely into our daily lives, generating a process of lifelong learning, and it is going to happen in real time.

Web-based education is a vital aspect of today's Information Society. The engineering process of learning systems is a complex task that incorporates organizational, administrative, instructional, and technological risks. Different approaches have been proposed by the scientific society and various innovative implementations exist in applied research in order to counter the complexity and achieve quality in offered tools and services [1]. To this end, well-defined approaches to the creation and sequencing of content-based, student-centered learning activities were developed, but many problems also arise.

In the field of e-learning there are so many different suppliers and so many

different systems. It is a problem that is common to many areas of technology. And in e-learning, as in other areas, the solution that offers most hope is the establishment and adoption of standards. In the case of e-learning the standard that has emerged as the most widely accepted over the last year is SCORM (Sharable Content Object Reference Model).

During the past few years, the reusability of educational content has been one of the main issues in the learning objects economy. The ultimate goal is to structure learning scenarios that are separated from the learning resources. Thus, learning resources can be reused within different scenarios and scenarios can also be reused when populated with different resources [2].

E-learning, is using the special capabilities of the Internet as a delivery method to reinvent the way that people learn. Technology is a tool; by itself, it cannot teach anything. The human element is a critical component of the educational process. The Internet is such a powerful medium that it is going to change the face of education. Whether that change is for good or ill depends on the talents and motivations of the people implementing it. The key is to create a set of tools that can be used most effectively to leverage the teacher's time and energy, so that the teacher spends the most time doing those things that add the most value to the learning process.

This paper outlines the design and implementation of a Web based interactive e-learning tools in the field of Digital electronics, which fulfill requirements for reusability and adaptability to any educational concept, provide for language independence, conform to the highest development AICC (Aviation Industry CBT Committee) and SCORM standards and are compatible with all major Learning Management Systems (LMSs).

2. DESIGN PHYLOSOPHY OF THE E-TRAINERS

One can think of the e-learning as having three many components: Courseware – the e-learning programs themselves; authoring software – the programs that are used to create courseware; Learning Management Systems (LMSs) and Virtual Learning Environments (VLEs) – these are the systems that manage the e-learning.

Courseware in proposed tools covers main topics in every digital circuit's curriculum – logic gates, flip-flops, combinational circuits, both asynchronous and synchronous sequential circuits, analog to digital and digital to analog converters and microcontrollers. Digital representation using binary codes, Boolean algebraic laws and rules, the design and implementation of combinational and sequential logic circuits, basic and advanced digital applications are also covered. Extensive use of a software-based interactive animations and simulations provide support for the theory concepts.

The design philosophy of the Web based e-Trainers is based on latest state-of-the-art software technology. All software is designed based on an open architecture and an open system concept to enable future system expansion. Only standard Web

technologies like XML, HTML, Java and Flash are used for all products. Therefore no additional plugins has to be installed neither on the server nor on the client.

All tr@iners are modular in concept and can therefore be easily adapted to specific requirements of any curricula or training format by the developed authoring tool. The interactive learning materials are designed to:

- Allow learning at any time and any place;
- Assist with "virtual tutor" by guidance and feedback of student actions;
- Provide easy integration in any language;
- Ensure platform independence and LMS compatibility, and
- Permit easy restructuring of the sequence and/or content.

2.1 Structure of the Trainers

All trainers have a common structure, which includes:

- Introduction
- Learning Objectives
- Prerequisites
- Entry Evaluation Tests
- Learning Section
- Practice Section
- Final Tests

Introduction aims to introduce learners to the topic and to motivate them to learn.

Learning objectives emphasizes learning outcomes. They state what the learners should know or to be able to do at the end of a learning activity. Training programs have objectives that are clear and have measurable content and performance.

Prerequisites state the preliminary knowledge, which learner should already have for successfully finishing the e-trainer. These are check during the interactive entry evaluation tests.

Learning section is dedicated to introduce new knowledge and to serve as a media for obtaining comprehension on the processes, devices and circuits.

Practice section gives an opportunity to practice what have already learn to obtain skills and abilities to apply knowledge, to solve problems, to analyze facts in order to create new product.

Through the interactive cognitive *final tests* is verified learner's knowledge, level of comprehension and ability to apply topics discussed in e-trainers.

3. CONTENT DEVELOPMENT

The main goal in tr@iners development is to increase student motivation to learn; to enhance understanding of logic elements and circuits; and to create ability to apply already learnt topics. To achieve these goals we apply "learning by doing" model with extensive use of interactive simulators designed for pedagogical purposes to cope with the increasing demand of e-learning for feed back and "virtual teachers" guidance.

Content development is based on Instructional Design [3] and follows Bloom's taxonomy [4] in cognitive domain. A content-performance matrix, proposed by Merrill [3] is used to identify optimal ways to present content, practice skills, and test knowledge. Performance refers to the three types of performance possible: remember, use (apply) or find (create a new instance). Content refers to four kinds of knowledge: facts, concepts, procedures, and principles. Developed interactive learning materials cover main Bloom's categories: knowledge, comprehension, application, analysis and synthesis.

Knowledge of terminology, facts, ways and means of dealing with specifics is obtained by intensive use of animations, interaction with objects, devices, equations interpreting rules and laws etc. Figure 1 shows some examples, which explore learning by doing approach, with funny and game-like context.

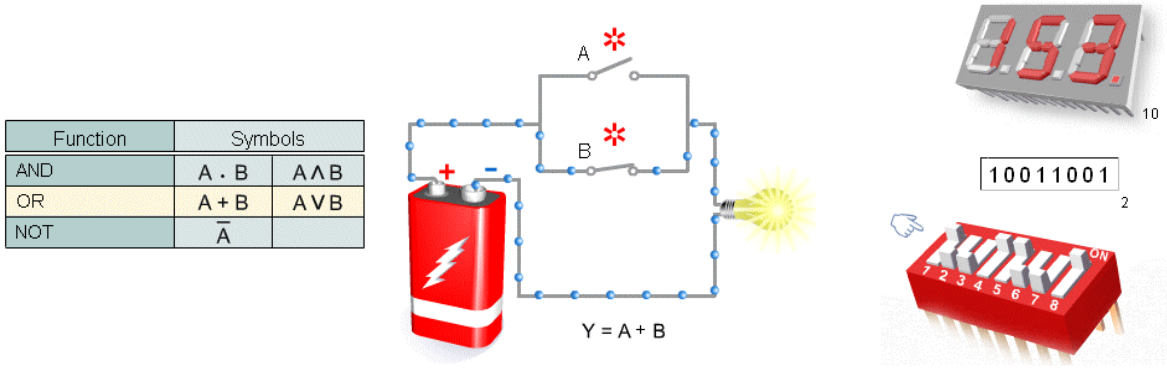

Fig. 1 Knowledge items for OR gate operation and binary/decimal number representation

Comprehension is connected with understanding the meaning of informational materials. It is checked by drag and drop options, arrangement of a system, filling in the form, choosing from drop-down list, as illustrated in Figure 2, etc.

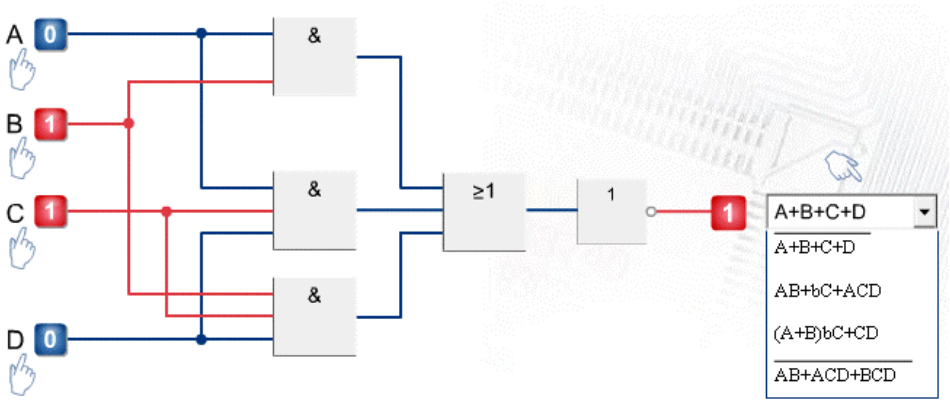

Fig. 2 Example item, illustrating comprehension ability (circuit versus logic expression)

Application means the ability to use of previously learned information in new and concrete situations, as well as to solve problems. To stimulate such ability the learner is forced to choose appropriate logic element or functional block to obtain given logic function, to arrange system with pre-defined system behavior, to discover faulty component, etc.

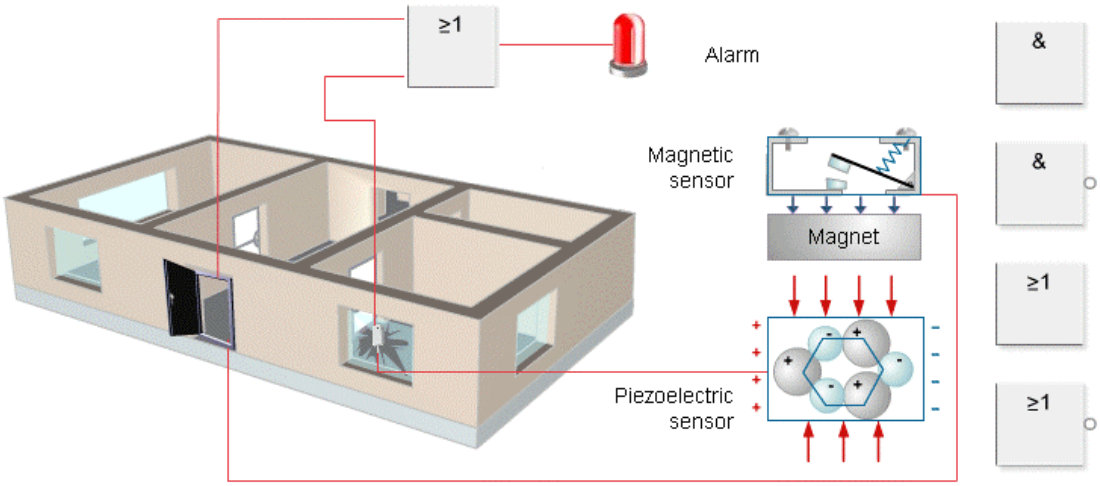

Fig. 3 Example item for checking application ability (intrusion alarm system)

Analysis cover the breaking down of informational materials into their component parts, examining such information to develop divergent conclusions by identifying motives or causes, making inferences, or finding evidence to support generalizations. Special developed event-driven logic simulator is dedicated to serve analysis tasks in the trainers.

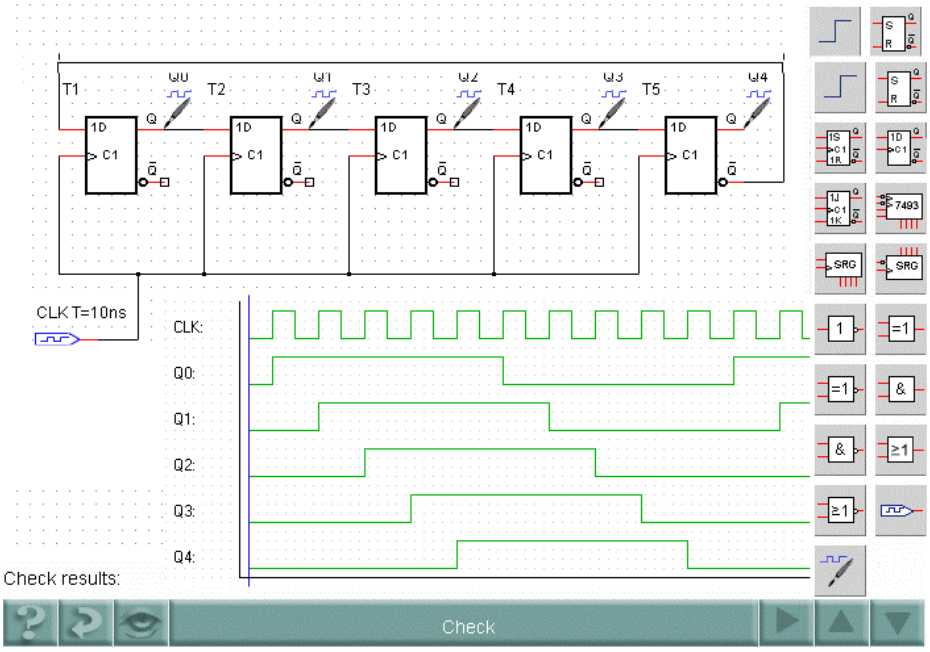

Fig. 4 Example item, stimulating analyzisis of circuit operation

Synthesis means creatively applying prior knowledge and skills to produce a new or original whole. These tasks include special design problems – to synthesize simple calculator from a functional blocks, to design system with defined behavior, to realize such system with corresponding standard integrated circuit, etc. (Fig. 5).

All above mentioned didactical approaches need rich and meaningful feedback during guided practice and student training. Developed Web based programs provide effective feedback and use it to develop the learner's ability to self-diagnose their problems and eventually correct errors without prompts.

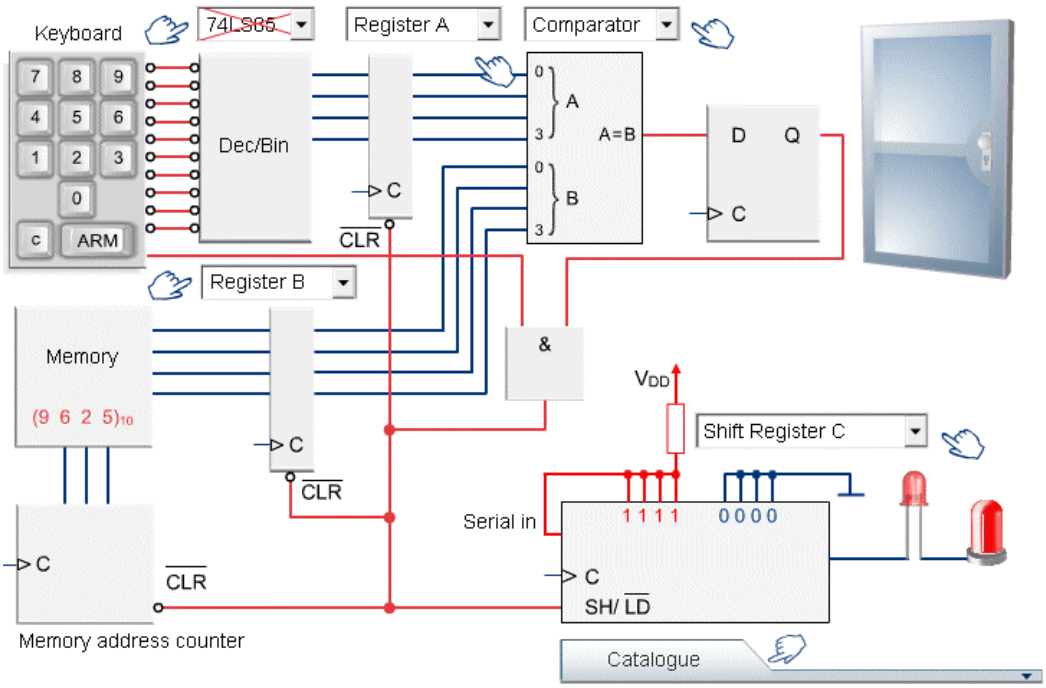

Fig. 5 Item, stimulating synthesis (security alarm system)

4. CONCLUSION

The paper considers developed state-of-the-art e-tr@iners in the field of Digital Electronics, which overcome the tedium of traditional training materials by embracing action-based learning concepts and learning by doing approach with intensive use of interactive animations and simulations. Developed e-tr@iners use Java, XML, Macromedia Flash and the Web to create a network-enabled, student-centered learning environment, which provide individual learning path, depth and duration at any time and place. All products have a modular approach allowing easy integration into any training format and are easy adaptable to any language including Arabian, Tai, Vietnam Ian, Greece, and others with exotic character sets. The trainers are AICC and SCORM compliant and are compatible with all major LMSs.

The effective use of technology in education helps improve the talents and abilities of individual students. Skillful use of technology supports the development of process skills such as flexibility, adaptability, critical thinking, problem solving and collaboration that are essential for success in the rapidly evolving economy.

4. REFERENCES

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