Action-Based Learning System for Teaching Digital Electronics and Test

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Abstract: The Internet and multimedia open new possibilities for learning methods. We want to present a learning method uses so-called *living pictures.* On one hand teachers can show more complex examples and immediate demonstrate the influence of changing parameters by using computer simulated living pictures in their lessons. On the other hand students can use the same simulations on their home computer, if the living pictures are available on the Internet. We demonstrate an example of a living picture, dealing with digital electronics and test.

1. INTRODUCTION

Traditional teaching methods either start by explaining a theory and showing some examples or giving an example to introduce a theory. However one of the both methods is chosen and fixed by the teacher independently of what is best for most of the students. The students mostly get some accompanying materials such as scripts, books etc and make some own notes. After listening to a lecture they can consult only their notes and try to solve some problems by using the new learned method as good as they remember. Mostly there is not enough time for lots of examples during a lecture and the students' notes include some errors. To correct these errors and to give some more examples the students usually replicate the subject of the lesson at home and during an exercise. How can computers, connected to the Internet, be used to make this learning process more effective? What kinds of software modules are required? How can the same software be used in several phases of the learning process? To answer these questions we'd like

to present an action-based learning system realized in the project DILDIS carried out in cooperation between TU Ilmenau and TU Tallinn.

2. METHOD

The following figure 1 shows the four phases of the learning process supported by the education system: listening, replication, examination and practice phase. For each phase there exists a special application service adapted to the learning process, which allows different views and actions using the same interactive module. Thus the education system supports the action-based training.

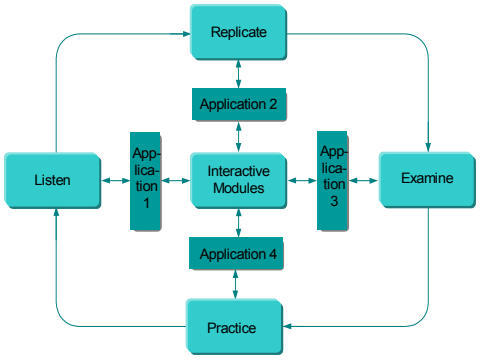

Figure 1. [Phases of the learning process]

Action based training via internet names a new teaching concept where the learning process is characterized by several features like computer aided learning and teaching, offering a set of tools to inspect the subject, access to multiple learning modules, a big reservoir of examples and the possibility to generate new ones, focus on correct solutions, easy action and reaction (click and watch) by using "*living pictures*", the possibility of distance learning, multilingual descriptions, individual depth and duration, learning by doing, funny and game-like context. This concept offers teachers and students the possibility of free acting in the learning process. Core of that concept are some JAVA-applets (the interactive modules) running on any browser connected to the Internet. We call these applets "***living pictures***" and explain it as follows:

Given a tricky, quite complicated situation of the learning subject in a graphical form on the computer. The graphic has to be self-explanatory and involving interaction possibilities. By using interaction possibilities the students can generate examples that are interesting enough to encourage own

experiments but not too complicated for learning. They can produce input stimuli and watch the reactions. In reaction of the inputs a *simulation component* starts, executing the method that has to be taught, and presenting its results using a *visualization component*. Thus the students immediately get a correct reaction of their inputs. In that phase it is important that there is a simple interface and no assessments of the students' inputs occur. They can use it like a game: they act and the system reacts by using a yet unknown method (that one, that should be learned). In addition to the simulation component there is also an *explanation component*, describing the unknown method step by step, using the actual chosen or generated example.

Comparing this method with traditional learning methods using books and notes, taken during a lecture, the learning process becomes more effective. During the same time the number of examples that can be inspected is higher and the students loose no time in going wrong ways because of wrong notes they made. They can always be sure that they get the right results. The game-like character of the *living pictures* raises the students' curiosity and encourages them to do some own experiments and examples. The same software described above can support several phases of the learning process as written in [1]. In difference to the case of self study described above, the same modules can also be used during the replication and the examine phase and during a lecture (in the listening phase). In that case the teacher can immediately generate examples that can answer students' questions by showing changes caused by teachers inputs. The teacher can also use some prepared examples to show characteristic effects and specialties. The use case "Practice" requires the tool features of the modules, such as export/import components and connections to professional used tools.

3. EXAMPLE

In the following figure, a *living picture*, dealing with the fault simulation in digital circuits is represented. The *living picture* includes a graphic of a circuit with the facility to insert all possible faults and to watch how they change the circuits behavior at different input patterns or how they can be detected by test patterns.

The program is written in Java 2. It can be run via network, using standard browsers like Netscape and Internet Explorer with Java 1.2 runtime plug-in, or with Java 2 applet viewer. The work window consists of three main parts as shown in figure 2:

- vector insertion panel,
- view panel for design schematics and
- view panel for data tables and waveforms of simulated test patterns.

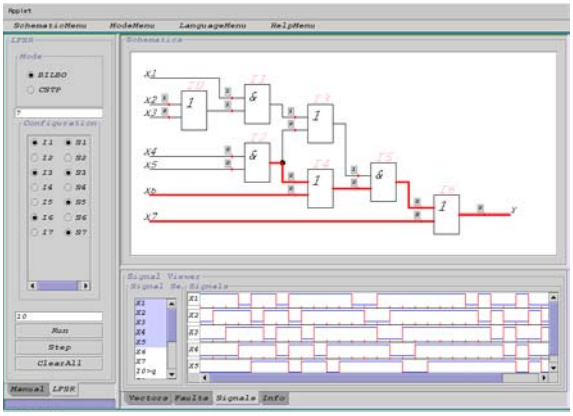

Figure 2. [Screenshot]

The following topics of the course "Digital Electronics and Test" are supported by this program: fault simulation, test generation, testability analysis and design of built-in self-test architectures. The key problems of these topics can be taught and learned using the program on different examples. After the theoretical investigation of these topics, a laboratory work follows with more complex designs, where the design software (Cadence, Synopsys or Xilinx), and diagnostic software Turbo-Tester [2,3] is used.

4. CONCLUSIONS

By the use of web-based media we achieve: presentation of course material independent of place and time, individual learning according to the students‘ own needs, quick cross-referencing by hyperlinked texts, new forms of communication between teachers and students (chat, joint editing), up-to-date course material.

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