Computer Based Technical Training: Students Designing for Students

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Abstract *— As an initiative to produce low-cost / low-time Computer Base Training (CBT) material for the education of Chip Design, we introduce our multimedia reference model and our multimedia lab. The reference model enables the cost efficient production, where the multimedia lab creates the environment for the production of CBTs to motivate the learning of students. The resulting CBTs out of the lab are reused in education. An experiment described here, gives an impression about the quality of our CBTs.*

Index Terms — CBT, multimedia, chip design, reference model.

INTRODUCTION

Design of computer-based training material (CBT), though popular and useful, can be too expensive for normal technical university departments. However, such institutions have large potential of support, namely from their own students

We discovered at most of our students the will to work with CBTs. At the same time we were interested in tutorials, based on our subjects. The idea was born to organize a lab, in which the production of CBT was offered, with our subjects as contents. The resulting CBTs could be reused in education, if the quality was acceptable.

Over the years we have optimized the production techniques and increased the quality of our CBTs. We would like to introduce our multimedia lab, our multimedia reference model and an experiment for evaluation in the following sections.

OUR MULTIMEDIA LAB

For five years, we offer a *multimedia lab*. Teams of three students are developing a CBT on a given topic in chip design. Within 12 weeks, they pass the phases C*oncept*, *Scripting*, *Implementation*, and *Evaluation*.

Our lab takes place during summer terms. At that point, the students have already completed the winter term, with a lecture of chip design basics. Also, during the second part of the winter term, candidates for the multimedia lab are taught in Authorware, which is our preferred authoring multimedia tool. Figure 1 shows the curriculum for the VLSI education.

During the winter term introduction and summer term lab, the students are coached by two graduate students and a professor's assistant. This coaching team can supervise max. 15 students, thus 5 groups. If the number of students grows, more coaches will be needed to ensure quality. The coaches monitor the work and have to ensure their feasibility. They give hints, advise and show solutions for complex problems. The graduate students are chosen from teams, which previously mastered the multimedia lab.

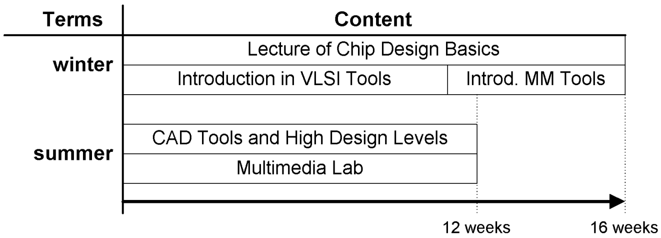

FIGURE. 1
SCHEDULE FOR THE VLSI EDUCATON

The multimedia lab starts with the Concept phase. In order to limit the task, each team gets one topic out of the chip design. According to this, the students are creating a concept within one week, which consists of giving a short description for each section. The results are controlled and evaluated by the professor's assistant.

Teams passing the Concept phase, are handed out a copy of our script master. This is a word file, providing the script design.

During the Scripting a script is written. This includes structuring of the sections out of the Concept phase further into pages and page groups. All spoken sentences are formulated and a description for each page is written down. Optional, for each page a sketch is drawn, which shows a screenshot. During scripting, we don't ask our students, to formulate exact screen layouts. We encountered, that during implementation ideas develop. In this sense, also small deviations from the script, under control of the coaches are quite accepted.

Besides the script, an implementation schedule is set up. It gives the students a feeling of the scale of work they have to master. In addition, this schedule helps the coaches to determine if a group is working in time.

The script is evaluated again by the professor's assistant. Only groups passing the Scripting phase start with the implementation. The Scripting phase takes two weeks.

During Implementation, which takes seven weeks, the CBTs are written in Authorware. The teams start the implementation on basis of our reference model, which is described in the next section.

After five weeks, a draft is delivered. This is evaluated by the professor's assistant and checked to match the

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scripting. Detecting errors in time is important as it protects students from discouraging rework.

Finally, the Evaluation phase starts and lasts two weeks. For evaluation purposes, the CBTs are exchanged among the teams. Each team must review the others CBTs critically, note errors and specify advantages and disadvantages. We were skeptical whether the students would be critical. However, they work very seriously and make constructive suggestions. All suggestions are returned to the teams and final cleaning and debugging starts.

Figure 2 shows the phases and their duration. The 12 weeks are given as the duration of a semester. An extended version of the phase definition can be found in [1].

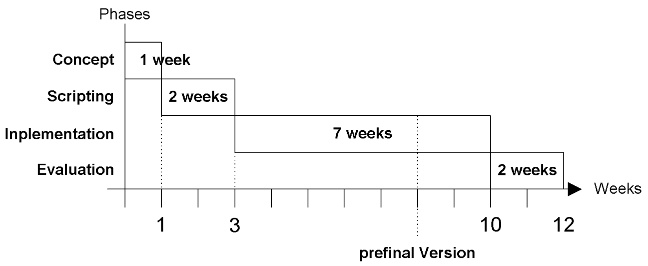

FIGURE. 2
TIME SCHEDULE FOR THE MULTIMEDIA LAB

This partnership of already trained students designing CBTs for prospective students, is by no means a one-way exploitation of low-cost student power. Rather, in designing CBTs, students become teachers thus expanding their knowledge. We discovered that the aim to build a CBT motivates the students to research the subject and develop ideas to formulate the given facts within the CBTs.

THE MULTIMEDIA REFERENCE MODEL

CBT development has three main aspects: *navigation*, *presentation*, and *technical contents*. Navigation includes features such as next page, next section, skip, link, bookmarks, list of contents etc. Presentation deals with the way, knowledge is presented, which multimedia techniques are best-suited, didactical aspects, which type of questioning and much more. It strongly depends on the technical contents to be presented. Often, active multimedia with a high degree of interaction is meaningful; other topics are better presented in a more passive movie style.

Since navigation and related functions are similar in most CBTs, we developed a *reference model* (RM) as a skeleton-like core, to be used as a frame for CBT design. By starting from the RM, the student CBT designers are relieved of time-consuming and error-prone routine work, they gain time to concentrate on presentation and technical contents. Figure 3 shows the relative lead, if one starts with the RM.

We introduce the concept of *low-cost* and *low-time* searching for ways to produce CBTs for chip design with a reasonable amount of man power and time. The idea behind the RM is to support the low-cost / low-time production of CBTs.

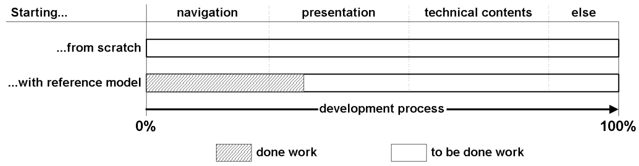

FIGURE. 3
DEVELOPMENT PROCESS WITH AND WITHOUT THE REFERENCE MODEL

A CBT based on the RM is called *Modul*. Modules consist of *Sections*. Sections consist of *Pages* and *Page Groups*. Modules can be combined into *Systems*. Figure 4 shows the Modul structure, where Figure 5 shows two Systems A and B; build out of the according *Modul Pool*, containing CBTs with different levels.

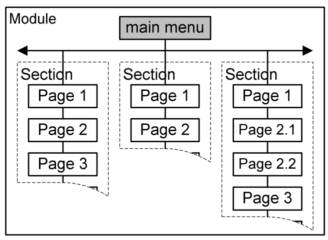

FIGURE. 4
THE STRUCTURE OF A MODULE BUILD WITH THE REFERENCE MODEL

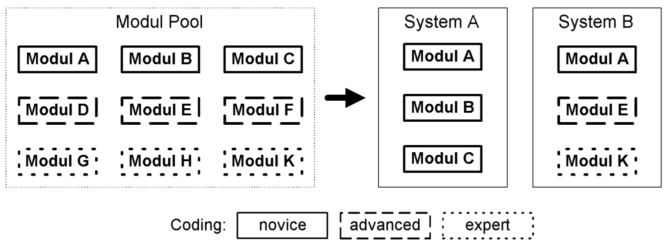

FIGURE. 5
TWO SYSTEMS BUILD WITH MODULES OUT OF THE MODULE POOL

A team can develop a Module and start with the development of the next Module. A Module can be used as soon it gets finished. There is no need to wait for all Modules to be finished. With this advantage, existing Systems can easily be extended, or outdated Modules can be replaced. Also, teams can develop Modules in parallel and combine them afterwards. This supports building new projects in a short period of time.

In addition, this modularity supports the idea of user adapted solutions as shown in Figure 5. The Module Pool contains CBTs with different levels; these can be combined to build the best suiting System for the user. In the future, we would like to automatically determine the level and lead the user to the best suiting CBT.

The RM provides many built in functions, such as automatically generated contents list, a login dialog, individual bookmarks, a history list – which works like a back button of a browser, the complete navigation function set – next page, previous page, as well as, a pause button and a skip button. The pause button stops and reruns dynamic presentations. The skip button jumps to the end of a dynamic build page, which is often necessary when a user wants to skip already known content, otherwise the CBT can become boring and disturb the rate of learning.

To support the use of the RM, we developed some multimedia introductions, based on the RM. The first is called *Reference Model Starter Kit in Detail (RID)*[2] and explains the advantages and shows how to use the reference model. The second is called *Introduction to the Reference Model (VDR)*[3] and explains the concept behind the RM. To support our students and explain to them what is important during development, we produced a third called *Recommendations for CBT Designers (DE)*[4]. This explains aspects like contrast, limitation of used fonts, color usage and sound recording – basics each CBT designer needs.By using these three CBTs we try to support the development process and coaching of students. Also, these CBTs are considered implementation examples.

AN EXPERIMENT FOR EVALUATION OF CBTS

For an even better evaluation, we performed an experiment on a class of 60 students and a special chapter in chip design, *logic synthesis* [2,3]. The students were divided into three classes: class B was taught the conventional way (classroom plus text book); class A *in addition* received a logic synthesis CBT, while class C had to get along *only* with the CBT. Table I shows the distribution of the teaching materials.

TABLE I
DISTRIBUTION OF THE TEACHING MATERIALS

Class	Text Book	Lecture	CBT
A	x	x	x
B	x	x	–
C	–	–	x

We informed the participating students about or experiment and asked them to study as they would usually do, with the only difference to record the time they spent learning with one of those given materials. At the end, an intensive test was conducted to measure learning progress of classes A to C.

Along with the learning materials a questionnaire was handed out. This questionnaire gave us some information about the background.

Some of the points out of the questionnaire were:

- Did you learn continuously over time, or only once before the test?
- Have you used both materials (text book and CBT) or just preferred one of both (Class A only)?
- Write down the time you used one of those materials.

To avoid manipulation and to get realistic answers, we decided to execute the experiment anonymously. Only the group name had to be indicated and a given random unique number for each participant. This decision turned out to be correct later, as we noticed to have 80% feedback. 20% of the results were not usable because of missing group name, or absent students during the test, or having *had no time to learn* answers. The students accepted this anonymous experiment. Also, as the experiment was voluntary, we promised that we would use the results only for research purposes and not to manipulate their grades.

Our prognosis

We were convinced about the quality of our CBTs. Our estimations were:

- Since class A could use all materials, they should achieve the best result.
- Class B and C should achieve equal results which would be an indicator that teaching alone with our CBTs, can be sufficient.
- If C would be last, this could show lack of quality. Then A has to be considered, as they would have all materials.
- If A and C would be better than B, there must be a positive influence of using our CBTs.
- If B is significantly better than A and C, though we must reconsider the use of CBTs.
- If A and B are significantly better than C, though obviously the use and the quality of our CBT is to reconsider

The Analysis

First, we must admit that we were astonished by the results. In this experiment an experienced professor and his script were challenged by CBTs developed by students.

The best results were achieved by Class B followed by Class A and finally Class C. The professor won the challenge. But in detail the differences were not very significant. Figure 6 shows the attained results of the test by percentage. As one can see all three Classes are very close to each other.

Looking on Figure 7 gives us a different view. Class C spent an average of 2,76h studying prior to the test. Where A and B spent almost twice as much time, with 5,82h for A and 5,84 for B. Figure 8 shows the average efficiency. For one hour learning time, C reached in average 6,24 points, where A has only 3,14 and B has 3,17 points. Obviously learning with the CBT was more effective.

[2] Available only in german language, *Refmod. Starter Kit im Detail*.
[3] Available only in german language, *Vorstellung des Referenzmodells*.
[4] Available only in german language, *Designer Empfehlungen*.

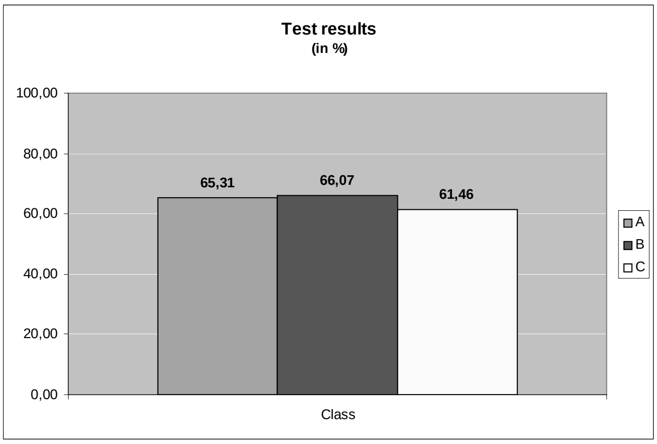

FIGURE. 6
TEST RESULTS, CLASS B IS THE BEST,
BUT THE DIFFERENCES ARE NOT SIGNIFICANT

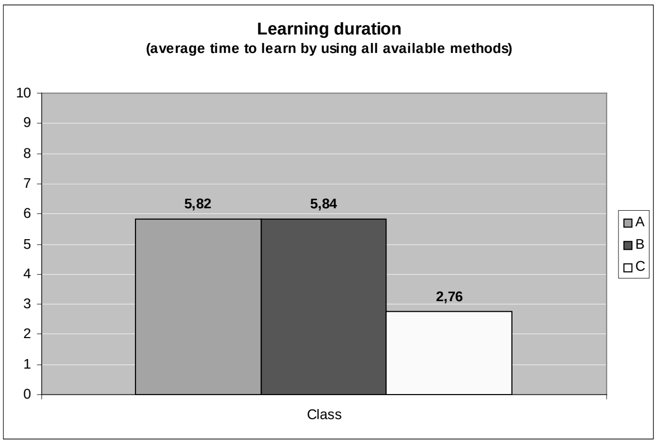

FIGURE. 7
CLASS A AND B HAD SPEND THE MOST TIME TO LEARN

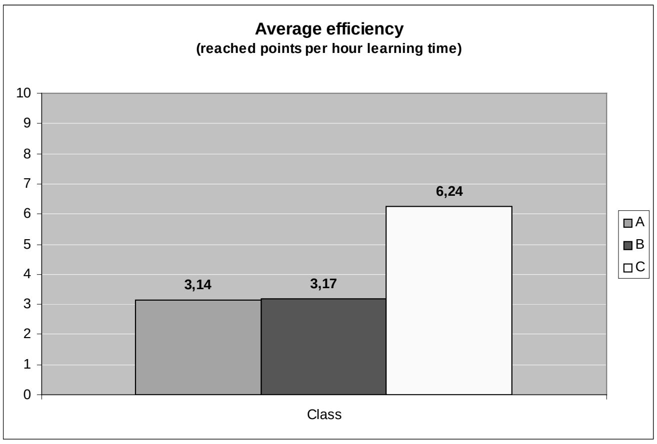

FIGURE. 8
CLASS C HAD LEARNED MOST EFFECTIVE,
FOR EACH LEARNING HOURE THEY REACHED 6,24 POINTS

Also, we found that most of the students studied right before the test, and not continuously like they should have. This was true for all Classes.

It is remarkable that A, although had all the material, did spent almost as much time as B, why? After analyzing the questionnaire we found, that most of A has used only one method, either textbook or CBT. The answer for the *why* was, that they couldn't afford to invest more time, because of other lectures. Well this might change if the students are interested in better grades for their diploma, whereas the results out of this experiment don't count as a grade.

Finally, the diagram in Figure 9 gives us feedback about best-presented content by the CBT. These results are used to further develop out our CBTs.

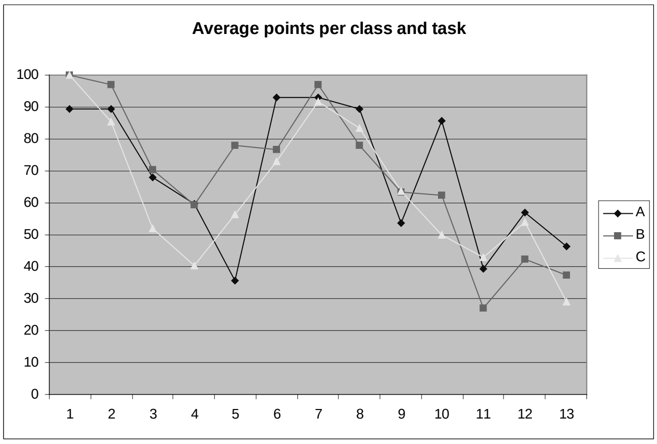

FIGURE. 9
TASK 11 WAS OBVIOUSLY BETTER DESCRIBED IN THE CBT,
AS WITH THE CLASSICAL METHODS

Conclusion

We wanted to determine if we are on the right track. If the results had strongly differed, then we would have known that our low-cost / low-time production is not feasible. However, the results proved to us that low-cost / low-time production for universities is realistic with efficient results. Further, we would like to stress that we see the multimedia education only in conjunction with the classical teaching methods. The time is not ripe yet to leave the education only to the computers.

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