Application of Digital Circuits' Simulation in Academic Exercise Classes-Methodology Issues and Results.

Ginka Marinova[1], Nikolay Kostov[2], Slava Yordanova[3]

Abstract: **The authors present results of their own experience in introducing circuit simulation in training students on Digital Electronics. All facts and conclusions are based on the academic practice at the Department of Computer Sciences and Technologies at the Technical University of Varna. Analysis and recommendations from practice are presented in the specific context of the contemporary social environment and perception of the students in respect of their engineering studies. Brief comparative figures from in-university survey illustrate basic arguments of the authors in favor of the methodology.**

Keywords: **education, circuits' simulation, methodology.**

I. Introduction

Academic training in more fundamentally oriented disciplines like Digital Electronics is to an extent conservative. This is due first to the nature of the subject and secondly to certain methodology reasons. An essential part of the academic community (including authors) still considers that the ideal exercising on Digital Electronics should be hands-on. In fact, just 10 years ago, this was the only methodological approach and the results were pretty satisfactory – most of the students obtained a very good knowledge and experience in understanding and working with basic digital electronics and digital devices. This in turn produced quite highly qualified electronic engineers, which was and perhaps is still appreciated by the companies and the universities. The methodology for this type of academic exercises was almost perfect in respect of the final results sought – the students worked with real stuff, the performance of the examined circuitry was visible, an excellent feeling of the circuit's operation was cultivated with the young people. There is a single disadvantage to this approach however in the context of the contemporary expectations for the higher education – it is resourceful, in terms of both funds and time. Unfortunately, modern technical universities may not afford neglecting such factor. This is because the presently accepted three level educational structure limits the available time for training the students (for the BSc level the Bulgarian regulations cut the maximum number of academic hours to less than 3000) and also due to the fact of changed structures of the study plans for electronics and computer oriented courses. The interests and perception of the students changed too – they are keener on working with virtual environment. Perhaps there is some fashionable point in this new attitude.

[3]Slava Yordanova is with the Faculty of Computer science and Technology, Studentska 1 9010 Varna, Bulgaria
E-mail: slava_y@abv.bg

Whatever the reasons for the changes in the academic reality are however, the need for changing the approach and the methodology in teaching this particular subject is obvious.

II. Didactic and Social Basis of Contemporary Higher Education

Education is a bilateral process. From a social point of view it might be looked at as a special kind of deal between the students as customers and the university as provider of the educational services. It is well known from general practice that there is no successful deal where both sides are not satisfied. Students have certain pre-biased expectations for the way they will receive the professional knowledge they have come for at the university. The academic staff of the university has certain expectations for the level of perception the students show in respect of the knowledge transferred to them. If both sides do not receive some minimum satisfaction from what they expect from each other, they will be at least unhappy and at most totally disappointed and consequently might break the deal. If such scenario occurs both sides will lose – time and money. To avoid it the changes in the exercises' technology discussed here were introduced.

III. State of the Art

The main arguments for the lecturing staff to break the status-quo were:

- intensify the exercise work for the Digital Electronics discipline in general;
- increase possibilities for the students to work independently;
- make control procedures more efficient in terms of time and comprehensiveness;
- Change the attitude of the students to positive (as much as it can be) for a work they generally dislike.

Before we proceed with discussion on the specific details and outputs from the working experience at the Department of Computer Sciences and Technologies of the Technical University of Varna perhaps it would have been useful for more in-depth understanding of the issues discussed to reveal in general terms the academic picture within this specific subject. Why specific?

First, because the attitude of the average student, changed significantly towards material sciences during the last decade. The idea of the classical electronic engineer dealing with sensible and real stuff has moved aside to be exchanged for the image of the new computer man, controlling a powerful tool like the modern PC, which existence and abilities are

given for granted and always in obedient service to this same specialist. A survey made amongst the second year students studying for computer specialists at the Technical University of Varna showed that less than 5% see their future as directly related to work with hardware, just about 7% study the Digital Electronics discipline with pleasure (unlike other software disciplines), about 90% describe discipline as difficult, about 50% consider it useless within their expectations for the knowledge content of the course they study. To be fair we should note that this survey was made when still classical approach was used in carrying out exercise classes. That is the students assembled during the 3-hour exercise certain circuit, examined its behavior and discussed with the teacher all problems during the work and other questions they might have from the lectures. The average success rate from this type of organization of the academic work did not exceed 20-30% within the normal study hours. What was interesting as well was that no matter how intelligent the students were (judged against their results in other disciplines) they almost always ran against time deficit in completing prescribed exercise program. Secondly, new technologies in studying and development of electronic circuits made it possible to move away from the classic exercises on one side and get closer to the actual picture of the students' interests on the other. In fact, a chance appeared to exploit the natural positive attitude of the contemporary generation to the electronic games and the technologies that support them. This opportunity became even more reasonable in the light of the continuous and drastic fall in prices of the latest simulation products. The market situation changed so significantly, that some companies announced free use for earlier versions of their simulation products.

IV. Organizational and Technological Issues of Implementation

Based on the accumulated experience and considering the newly emerging opportunities in terms of technological support, it was decided to change the above-described pattern of work. That was to move away from predominantly didactic approach to a more flexible one in terms of communications with the students and perhaps as well more focused on the independent work of the students. For the purpose, a simple to learn and work with version of the simulation program Electronic Workbench was chosen. No significant changes in the topics of the planned exercises were made and these were kept as close as possible to the old set. The reason was that no essential changes in the study plan of the discipline are foreseen for the next few years (it has just been re-worked in the context of the modernized study plan for the computer course as a whole). The lectures and the exercise instructions were combined in one textbook. The idea was to make it easier for the students to consult with the lectures' content when preparing for an exercise class. The methodological approach for the organization of the exercises was changed to implement completely independent work of the student on the topic of the exercise, done in advance to the scheduled classes. To facilitate the preparation for the exercises extended consultations were introduced, increasing the total consultation time available to the students by more than 50%. When deciding on the new approach, certain fears for unavailability of PCs to the students were present. These appeared to be completely groundless first because we have underestimated the private access to modern computers and secondly because in the mean time the university increased significantly the number of PCs freely available to the students through the library. On the other hand, the chosen type of simulation software had so small requirements in respect of the hardware, that practically the students could run it from everywhere and on any platform. To reduce further obstacles for independent work, lectures, exercises' content and the installation source of the simulation program were loaded on an Internet accessible platform so that students can have access to these 24 hours. In addition, a discussion forum was opened in the Internet, where everyone can put questions and get answers within the next day. The structure of the exercises' assignments was changed to become more descriptive in respect of what has to be done and what should be expected as a result. The requirements for the presentation of the exercise's results were simplified, while the focus was put on the conclusions. That was achieved with an introduction of guiding questions at the end of each exercise description. Answering these the students acquire in-depth understanding of the essence of the exercise topic and hence improved ability to apply the quazi-practical experience obtained during work with the simulation program.

V. Assessment Results

As mentioned earlier the basic content of the exercises was not changed essentially when changing the methodology of the training. This allowed for good comparison for the level of successiveness of the students before and after the change. The assessment was made implementing two methods – an interview to reveal the changes in the personal attitude of the students and comparative study of the actual results from the presentation of the exercise data sheets and the formal tests. The interview results pointed to improved attitude towards the discipline in general. People considering it difficult dropped from 90% to 70%. The improvement is even better regarding the exercise classes. The percentage of students approving the applied methodology increased from 20% to 80%. This significant increase directly confirms the correctness of the new approach and encouraged authors to proceed with its improvement. However even after the introduction of the simulation training, still about half of the students consider the discipline useless within their course program. This should be considered serious signal in respect of the general planning of the education for the computer specialists' courses. Perhaps part of these perception problems have their roots in the philosophy and concept for educating universal specialists rather than narrowly profiled. As long as such fundamental changes in the educational program are impossible for the moment, we should rather concentrate on the increasing of the attractiveness of the less attractive disciplines like Digital Electronics.

Interesting figures from the test results on this discipline

were observed when successiveness of the students was compared before and after the change of the exercise classes' methodology. These can be seen from the table below (average figures shown):

TABLE I
SUCCESSIVENESS RESULTS

Test Parameter	Before	After
General successiveness rate	30%	35%
Results for exercises	20%	53%
Results from content tests	35%	40%

It is obvious (and it should have been expected) that most effect was achieved on the exercise part of the training. The lower effect on the other parameters can be explained with fundamental reasons arising from general misbalances in the overall study plan as outlaid earlier.

Another interesting side effect was observed in connection with the methodological survey conducted. Unfortunately, it could not be measured quantitatively and has more orientation nature to guide academic staff in future developments. This is a substantial increase in the wish of the students to experiment with various options of the simulated circuits, up to the point to apply absurd values or modes of operation. This effect was unexpected even for the authors when designing the curriculum of the exercises. We may explain it to an extent with the play component existing in the simulation procedure. As mentioned earlier the new generation of students has a passionate attitude to computer games and systems. This naturally based attitude should be in authors' opinion exploited further to attempt creation of genuine interest to subjects, which principally are difficult and boring for the students.

VI. CONCLUSIONS

Introduction of circuit simulation in the exercise methodology for the discipline Digital Electronics in no way can substitute work with real circuits. In this respect, it should be looked at as an alternative to the classical exercise classes. Perhaps it is the most easiest way to induce a genuine interest with the contemporary students to this generally difficult and hard to pass discipline. Improvements in the methodology of teaching should be sought in direction of proper arrangement of exercise topics as well as in comprehensiveness of circuits' studies performed by the students. In situations when reduction of contact hours discipline's study plan is foreseen, this methodology approach may be used to preserve still good level of learning at much saved time to academic staff.

REFERENCES

[1] S. Jordanova, V. Donev Digital Electronic Circuits, Technical University of Varna, 2005

[2] U. Tietze, Ch. Schenk Halbleiter-Schaltungstechnik, Springer Verlag, Berlin, 1980

[3] Electronics Workbench v.5.12 – Users' guide, Interactive Image Technologies©, 1996