

COMPILATION AND UTILIZATION OF COMPUTER PROGRAMS IN THE EDUCATION OF ELECTRIC CIRCUITS AND SIGNALS

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Abstract

Paper deals with the general questions cohered with the utilization of computers in the teaching process of electrical engineering, electronics, circuit and signal theory. The commonly applicable methods of computer programs compilation and utilization are evaluated on the basis of general didactic principles and authors experience.

Introduction

Nowadays, computer programs are utilized practically on all schools in numerous forms and intensity. As regards the faculties of electrical engineering, both professional and “self-compiled” programs are used in the teaching process. Comparing for instance programs developed on the Department of Theoretical Electrical and Experimental Engineering FEI VUT Brno, Department of Circuit Theory ČVUT Praha, and the Department of Theoretical Electrical Engineering ZČU Plzeň, we can differentiate three different conceptions of didactic programs [1]. The first category represents relative simple and compact executable programs (VUT Brno). Students cannot utilize source files. Let us call utilization of such programs as “input-output“. Concerning the conception of ZČU Plzeň, the program is prepared as the Pascal source file. Before compilation, students have to modify one part of the source file to input individual data of simulated problem. The third approach (ČVUT Praha) uses the special system MVK (Mini Vision Klassic) that helps the student to create individual applications. According to the authors of MVK, main idea of this system is to enable implementation of the mathematical algorithm for solution of the technical problem [2].

For the computer teaching utilization on the Department of Electrical Engineering VA Brno, the combination of concepts mentioned above is utilized.

Existing dissension how to use computers optimally in various teaching forms indicates the difficulty of given problem. The extensive and permanent discussion is recommended. In this contribution, some personal opinions will be presented as a result of practical teaching experiences in VA and VUT Brno.

Basic questions

In the course of time, teacher engaging in the updating of his subject has to reply to following and many similar questions:

- When it is /is not advantageous to use computer in the teaching process?
- How to proceed to gain maximal didactic effect from the utilization of computer? What to avoid not to weaken idly this effect?
- Which type of program to use in given phase and form of teaching process? What about their properties and the way of their utilization?
- Which properties of the operational system would be optimal for the teaching purposes? Which of the operational systems established in our universities approximates closely this ideal?

Answers

It is very difficult to find such answers that more teachers solving similar didactic problems would agree without exceptions. From my experience, the principally different opinions can even exist among the colleagues from the same department. As a result, not only different universities, but also more departments of the same faculty and sometimes the heads of related subjects choose its own way.

The state described above indicates the complexity of the problem. No universal reply to the aforementioned questions exists, as well as the system of questions that solution would reduce all specific pedagogical problems of all schools. On the contrary, solution would be optimized to the specific conditions of given school, teaching subject, student level, and taking other aspects into account, for instance the relations to other teaching subjects of the school program.

Nevertheless, all could be in the agreement that basic didactic principles have not be violated by all pedagogical activities. Computer utilization is not the exception. From the period of J.A. Komenský, these principles were revised insignificantly [3], omitting the “party-spirited” didactic principle, forced here by the communist theorists. Because of the increased possibilities of our pedagogical influence due to computers, we shall try to concrete these “sempiternal” principles to the nowadays condition which not even Komenský could anticipate. Although Komenský could not predict invention of personal computer as a powerful didactic tool, his didactic principles can help us for example to select suitable computer operational system for education.

The realist is aware of the discrepancy of our schools between the ideal model of the education to fulfil all didactic principles and the material and the financial possibilities of the schools and the students [4].

Fundamental didactic principles [3], [5] and their utilization to the computer supported education

- Principle of the goal-seeking
- Principle of the systematic and succession
- Principle of the adequate influence
- Principle of the object teaching
- Principle of the activity and creativity
- Principle of the emotionality

The principle of the goal-seeking advises to build detail plan of the updating of teaching subject including the explicit aim of the computerization. Respecting this principle, we avoid typical abuse as “computerization at any price”.

The principle of the systematic and succession declares the requirement to compile such well-ordered and substantiated system of the subject matter that enables its acquirement in the logical order, and also the requirement of the systematic teacher’s influence and student’s work. Komenský summaries this idea as follows: „If you teach something, be everything that follows as the aim, and everything that proceed, be as the resource to reach the aim“ [3].

This principle can be easily violated during the application of analyzing and simulation programs to the subjects like “Basics of EE” and “Circuit Theory”. According to my experience, utilization of such programs has required effect only when the students have basic knowledge about the function of analyzed circuit and elements. Without the physical observation of simulated phenomena, the teaching unit at the computer laboratory becomes the waste of time. In addition, such negative phenomenon is promoted when the student unconditionally takes the simulation results without the possibility/ability (and later without the willingness) to check the result by own consideration. That stands to reason then the student’s physical opinion can be unfolded also using the computer but by means of special programs.

The principle of systematic and succession has also to do with the often question which CAD/CAE programs are the best for the successive and gradual work during the study. The answer would be searched, taking account of

the principle of the adequate influence: it is not reasonable to train beginners to the exacting professional software. Alternatively, we begin to use programs that are simple for students with minimum knowledge about the simulation rules, mathematical models of semiconductors, etc. On this stage, we can use “self-compiled” programs that include – in contrast to the professional ones- necessary didactic elements. The principle of adequate influence recommends keeping basic pedagogical rule: from easy to difficult, from known to unknown, for concrete to abstract. Teachers

agree on the requirement of simple tender of the developed programs [1]. However, I think that the meaning of the term “simple tender” modifies in time – today’s generation has less problems with the same program than the previous one. This is true on the assumption of user friendly, logical and intuitive tendering. Illogical and unforeseeable program responses have to be excluded.

As a consequence of the principles of goal-seeking, systematic and succession and the adequate influence, following recommendation can be given:

During the first semesters the student gains basic theoretical knowledge of the electrical engineering and his physical opinion is built in the experimental and the computer labs. Starting from the second year, he meets professional programs that then utilizes for the work in the related technical subjects until the final diploma project.

The principle of object teaching offers some advice which properties would have the developed computer programs and how to use them during the teaching. Komenský considered this principle as the “golden rule” of didactic. Given principle associates two rules [6]: 1. To get out of the student’s sensuality and permanently occupy it (i.e. direct opinion) and to utilize his hitherto notions and experience (i.e. indirect opinion), 2. To improve his looking and imagination abilities simultaneously (his receptivity, observation and the fantasy). Then the “golden rule” can be utilized on higher possible level.

It is well-known that the bud of knowledge arises by the repeated irritation of the cortex through the receptors. According to the Komenský, the memory effect is more effective by the simultaneously activation of more receptors. The efficacy of given receptors to the memory effect is as follows: hearing 10%-20%, sight 30%-40%, and their combination 50%-70% [7] (given values are strongly individual). Computer offers much image information. During the teaching unit, where the computer simulator is used for the study of electrical phenomena inside the circuits, the teacher’s influence is important (explanation role, hearing influence). In the signal laboratory, use of the soundblaster PC card could be rewarding. Using the ingenious script of the laboratory exercise, the teaching of the spectral analysis and relation themes can be finished by the unprecedented pedagogical success.

From the point of view of the object teaching, that is why I prefer computer utilization in the experimental (not classical computer) laboratory as a part of working place.

On the other hand, our effort to improve objective teaching can meet some psycho-physiological and didactic limitations due to great feasibility of today’s multimedia. Saturating of the receptors by the excessive amount of information causes the efficiency of the teaching. In addition, it is proved that the excessive objectivity often suppresses the independent thought and the creativity. That is way the compilation of good didactic programs can be serious problem even for experienced schoolmasters.

The memory and learning process supported by the computer is raised considerably, if the student ascertains that: 1. he got the upper hand of the computer in this sense that the computer serves to him and he does not serve to computer, 2. he is able to use computer to solve technical problem individually, 3. from the computer/program he can gain replies to questions that appear during the problem solution (and to practice learning) 4. he wants to learn, because it is exciting. In other words, the student behaves as the active subject.

The principle of the activity and creativity.

The activity, creativity and independence belong to the internal forces of students that enable them to learn prescribed matter deeply with the utilization of creativity. However, it is necessary to motivate, or to put it in a better way, to force student to this style of work [8]. Computer utilization can be efficient tool of such “compulsion”. Teacher’s role is here the principal. If the teacher to the remembering directs the student, then his activity is concentrated to the noncreative area. However, if the teacher requires explanation and the problem analysis, then the thought activity dominates and the creativity is expressed as the independent searching and solution. Then the computer can be used as an excellent tool for student’s needs.

As known, from certain average value of IQ, the correlation between the intelligence and the creativity does not exist [7]. The ability to solve problems in creative way – one of most valuable student’s possession – can be increased by special didactic methods [9], [10]. In the area of computer

supported teaching of electrical subject, the most efficient methods are as follows: Formulation of questions and motivation to produce ideas. Computer can help to practice these activities.

Problem solution starts from a question. The success depends considerably on the formulation of the question. Via the questions, student is attracted to the solution. Indeed, putting the question is a great art. Students often do not understand what the teacher asks about. Ideally, students should be able to put questions as the way to understand the essence of solved problem.

It should be noted that the ability to put correct questions is useful for the individual work with the computer simulation software. The simulation of electric circuit is the chain of the simulator's replies (results of the given analysis) to the set of questions (analysis requirements) with the aim to study circuit behavior under various conditions.

Putting questions is partially dependent on the motivation to produce ideas. Common teaching procedures suppress students to put questions and to produce own ideas. Computer can motivate thoughtful students to use own ways, which are not prescribed. Nevertheless (or it can be reason why) the student tries them. These didactic rules assert especially during the teaching in the experimental labs and students work continuously on the individual projects.

The principle of emotionality. According to Komenský, „Without bright mood, the disgusting or ugliness appears, true bane of the teaching“ [3]. Occasionally, I remember this sentence, walking near the typical computer room of some “electrical department”. Through the open door, I catch a frowning and stooping student that starkly examines something on the screen. The stillness inside the room is sometimes disturbed by the student's repercussion to some unexpected program action. We must hope that it is not a dreadful image of the nightfall of electronics in our universities.

Let us leave classical computer rooms to the training of word processors and spreadsheets. Do not tear our students off the world of real phenomena. Let us prefer interesting work in the modern experimental laboratories, where the personal computer performs its own function as one of more systems in the chain of the data collection, processing, and evaluation, with the possibility of coexistence of the real experiments and computer simulation.

Computer programs and the applied operational system may not evoke the „disgusting or ugliness“, as warns Komenský. Windows type operational systems, often reprobated in some schools, offer the outstanding didactic possibilities. Windows 95 is not well serviceable due to its vulnerability: the incompetent student's action may cause computer malfunction. OS Linux and Windows NT have better stability. The last mentioned operational system seems to be the perspective for supporting the teaching process in future. However, only on the assumption of adequate financial grants to our educational system.

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