General Description of a Multimedia Package for assembling an Electric Circuit

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INTRODUCTION

The purpose of this essay is to present an overview of a multimedia package for teaching Electric Engineering undergraduates how to assemble an electric circuit. This package is part of an Electric Circuits II Course which is being developed in its web-base version by a multidisciplinary team at the Pontifícia Universidade Católica in Rio de Janeiro, Brazil. The points mentioned herein to serve as a basis for a multimedia package that could fulfill this purpose have been taken from both the recommended readings and the BBS discussions relating to block 3. Reports from interviews as well as discussions by students, professor, and instructors involved in a real laboratory activities, were also taken into account. This essay does not pretend to present a complete project of the multimedia package for teaching the assembling of an electric circuit. The idea is for it to serve as a basis for guiding the development of this project by students who are frequenting the last year of Electric Engineering and Communication courses. These students should present an end-of-course assignment whose objective is this multimedia package.

WHY A MULTIMEDIA PACKAGE ?

This part will attempt to show how the idea of a multimedia package designed for welding changed into a multimedia package for learning how to assemble an electric circuit, and what resources were used to back the decisions taken.

At present students learn how to assemble an electrical circuit scheme in a real laboratory environment, with the assistance of instructors. One of the stages of assembling an electric circuit is fixing the components on a board by soldering with tin. The original idea was to conceive a multimedia package to teach soldering as may be read in Adelaide's posted message describing this program < adelaide-l msg #194>. However, listening to the students (potential program users) it was realized that there wasn't enough motivation for them to use a multimedia program to learn soldering. Their argument was first that soldering per se made no sense for an engineering student. It only becomes meaningful when students are developing a project which uses solder, for example the assembly of an electric circuit. Secondly, because the best way to learn how to weld is to hold the soldering iron and do the job yourself. Multimedia could not be as efficient for teaching actual welding. For these reasons the soldering multimedia program was broadened into a multimedia program for assembling an electric circuit scheme.

In addition a consensus was reached with the students about the real purpose of the program, that is, that the program was not to replace teaching in a real laboratory but

that it was rather to serve as a guide for the virtual preparation of the student before he/she began to carry out their experiments in a real laboratory.

In Davies and Crowther's paper(1996a) we can find arguments to justify this decision. They say: "Multimedia technology offers the opportunity to simulate reality and therefore can facilitate experiential learning. Through video and sound, a real-life scenario can be conveyed and then the interactive and non-linear access capabilities of multimedia can be enable the student to explore the situation as if for real". But also they say "… the complexity of a real life situation can never be replicated with total accuracy… the social implications must also be considered. Students may become proficient in interacting with a computer, but less able to interact with real people."

One other resource used for understanding the selected program was an analysis of Multimedia strengths and weaknesses. Stephen Slater < Stephen-s msgs # 20 and # 24> presents a synthesis of the advantages and disadvantages of multimedia. This synthesis helped to identify, inter alia, the benefits which the electric circuit program can draw from multimedia: it enables information to be conveyed in different forms in the same environment, large volumes of material to be organized and stored, a mix of media for explaining ideas, and interactivity.

Finally, the checklist offered by Laurillard (1993a) was taken as a basis for evaluating to what extent the chosen multimedia program was improving students' learning. Through it the following issues were discussed: Why would a computer be used (and not other media) for distance teaching the assembly of an electric circuit? Is the possibility of random (as against linear) access really important for the student to learn how to assemble an electric circuit? Is it possible to improve students learning by the fact that they can interact with the computer, by selecting their own options and getting feedback from the chosen options? Do students need access to large quantities of data that can be delivered most efficiently via electronic storage?

After discussing these issues one came to the conclusion that the decision to make a multimedia package for assembling an electric circuit was the correct one.

SELECTING INTERACTIVE MULTIMEDIA

The decision to use an educational multimedia package implies, on one hand, understanding what multimedia is, and on the other, understanding how multimedia can contribute to improve an educational process.

There are countless definitions of multimedia and two tendencies may be distinguished. One that associate multimedia to the computer, and the other which defends the idea that multimedia predates the computer era. This essay is based on the latter tendency and uses as a reference the following definition by Patricia Reynolds < Pat-r msg #51>: "Multimedia is the combination of sight, sound and sensation in the many forms through contemporary innovative technology". This means that even before the existence of the computer, the program for assembling an electric circuit could be developed within the Multimedia conception via the combination of means such as a video accompanied with printed text. However, only with the advent of the computer can this program be made by multimedia with interactivity included.

As important as to understand what multimedia is, is to understand how multimedia can be used in a teaching-learning process, ranging from one extreme that focus on teaching (Instructivism) to the other extreme that focus on learning (Constructivism). The choice of approach is of a fundamental importance because the definition of the structure and of the instructional design for the multimedia program depends on it.

MM PACKAGE FOR ASSEMBLING AN ELECTRIC CIRCUIT

This portion of the essay aims at providing a global vision of what a MM educational program for assembling an electric circuit should be. Its aim is to identify the students' learning difficulties and the learning objectives, justify the selection of media resources, provide an explanation of the chosen structural approaches, describe the interactive activities of the program, and finally, present an idea of multimedia design.

Learning Difficulties

At present teaching how to assemble an electric circuit is carried out in a real laboratory to groups of 10 to 12 students, assisted by an instructor, for three hours a week. Generally, seven stages are identified in assembling an electric circuit: 1) the instructor draws the circuit diagram on a blackboard and with this as a basis the students assemble the circuit on a protoboard (a board for provisional connections); 2) guided by the instructor students draw on paper the paths, taking into account the size of the components (resistors, capacitors, etc) and the distance between terminals; 3) the students place the paper with the drawing on a copper board (board for permanent connections) and, following the drawing, make holes on the islets through which the component terminals are passed; 4) guided by the instructor, students will first trace the path on the copper board in pencil and, after correcting it, trace it in pen for the printed circuit; 5) aided by the instructor, the students bathe the boards in a specific solution; 6) the students lean the board on a support and position the component; 7) the students fix the components to the board with tin solder.

As described above two sorts of problems justify the development of a multimedia package. First the relationship of students/instructor/equipment involved in the individual learning process, and second, difficulties inherent to the process of assembling an electric circuit.

Although the laboratory has enough materials available, the equipment, the instruments and, principally the attention of the instructor, are shared by the students. If the instructor is not on the alert, some students (generally those who show better performance) will monopolize his/her attention, the use of the instruments and the equipment. As a result those students who are slower or more introverted will shy away from asking the instructor to clarify their doubts for fear of revealing themselves and 'disrupting' the class. In these cases, in order to go on with the work, these students generally resort to asking colleagues with the same difficulties, and together attempt to find the correct procedure by trial and error. Beside the waste of material and the likelihood of damaging the instruments, the final results of the projects reflect a lack or insufficiency of learning by the students.

Matthew Stratfold < Matthew msg #235> raises two questions which could help identify learning difficulties: "Is there something that learners always have difficulty that an

interactive exercise might help with?" "Is there something that is always difficult to teach using other methods that multimedia can do better?" On the strength of these questions the most frequent difficulties related to the process of assembling an electric circuit were identified: the students have difficulty in associating the theory learned in a classroom with the procedures learned in a laboratory, and generally assemble the circuit in a mechanical fashion without understanding the rationale behind it; in the above mentioned stage 1, students frequently connect the component terminals to the power points the wrong way because they don't quite understand how the protoboard works.

Learning Objectives

The objectives of a multimedia package for assembling electric circuits are:

- To help students realize the meaning of assembling an electric circuit by associating the practical procedures with the pertinent theory.

- To give students the opportunity to understand how a protoboard works (e.g. points with identical and different power, matrix of points, barring), and how these functions should be used when assembling a circuit.

- To help the students prevent having accidents while welding.

Selection of media

The selection of media for a multimedia educational program is not a trivial thing and should not be over-simplified. According to Durdbridge (1997a) there is no recipe capable of teaching the selection of media arising from its effects for different situations. Much less is there a single response to the question 'which medium teaches best?' That depends on the circumstances, she says: "Different media cannot be weighed against each other by reference solely to their effects, as if these were cut off form other factors."(pp 3/10). "... We cannot I think, design a Multimedia program with a mix and match of these components and assume they will remain the phenomena we once knew and loved in another context, i.e. that they will function in the same way."(pp 9/10).

By virtue of what has been stated above, as well as of the statements made by Adelaide Lukowiecki and Brian Joyce messages on the use of sounds < Adelaide-l msg # 247 and Brian-j msg # 266>, the learning objectives of the program for assembling an electric circuit were the focus for the selection of media, viz:

To help students associate practice with theory.

Text ⇨ to present equations for first order circuits;

Sound (speech) ⇨ to explain how the equations apply to the project;

Animated graphics ⇨ to demonstrate diagrams for assembling relays.

To help students discover the functions of a protoboard by assembling a circuit

Fixed image (photo) ⇨ to demonstrate protoboard matrixes with power points. With a mouse the student will explore the matrix to find out the points of equal power;

Student-controlled image movements (photos of the different components) ⇨ to enable students to test different ways of connecting the components to points of different power on the protoboard. Boyle (1998a) referring to VirCom says: “The learner carries out a virtual assembly operation by moving and positioning objects with the mouse. This process culminates at the end of a learning block when the user carries out a full virtual assembly of the component. The user picks up each object in turn with the mouse and assembles it the right position” (pp 166).

Non-student-controlled image movements (digital videos or animated graphics) ⇨ to illustrate a short-circuit (explosion effect) or an open circuit (nothing happens or a component may explode) when the student makes the wrong connection, or illustrate the desired result when the student makes the right connection;

Sound (special sounds effects) ⇨ associated with image movement to cause impact on the student.

To help students avoid accidents while welding

Digital video ⇨ to demonstrate the right and wrong procedures in the act of welding, e.g. environment, clothes, and handling of soldering iron.

For sure, this selection as well as the mix of media, can be changed while developing the package. However, some of the principles pointed out by Boyle (1998b) in chapter 12 should be maintained. These are:

- Unnecessary time based effects should not be imposed on the user;
- Flipping pictures to create an animation effect is very inefficient in computer resources;
- The speech segments should be short, manageable, integrated and complementary to text;
- The sound of music should comply with the copyright;
- The user should have as much control as possible over the audio and video (initiate, pause, repeat, and interrupt);

Structural Approach

The contents of the multimedia program can be organized in countless ways, ranging from Linear structures (compelling students to follow a predetermined path to get to their destination) to Network structures (enabling students to choose their own paths to get to their destination). From an educational perspective, the first case would place emphasis on Teaching while the latter would focus on Learning. Among these countless ways there is a structure named ‘Tree’ or ‘Branching Structure’ upon which the multimedia package for the assembly of an electric circuit should be based. Boyle (1998c) also referring to Structured learning presents three areas of work on tutorial learning:

Intelligent Tutoring Systems (ITS), Guided discovery learning environments, and Adaptive hypermedia and intelligent assistants. The first approach develops intelligent software to emulate a human teacher, that is, the computer as a tutor that teaches. The second approach switches from intelligent software to intelligent learners, that is, the contents are structured in ways that help students to discover knowledge. Finally, the third synthesizes the first two approaches building in intelligent software within learner centered environments, that is, adaptive assistance is provided under learner control. The most appropriate category under the multimedia program for assembling an electric circuit is the Guided discovery learning.

Interactivity

The Interactivity concept is very flexible and can be seen as an open system (exchanges among people) or a closed system (action-reaction-new action). Durbridge (1997b) says that "the concept has become so open to interpretation and exemplification that it has lost its critical edge." Analyzing discussions on Interaction and Multimedia, she shows how the concept has been used to sell computer technologies. Within an academic scope, the 'learning by doing' and 'by being active' discourse is used as if it were Interactivity (with no reference to Reciprocity which, according to Durbridge is a key aspect of interaction) to sell the myth that interaction is, per se, a 'good thing' and that multimedia offers the best opportunities for interaction. Within an industrial scope, interactive games have sold the illusion that a person is active within a real three-dimensional space. Interactivity then becomes the 'thing' responsible for selling games. This way the commercial appeal of the potential offered by the computer for interaction seems to support the academic debate on activity-interactivity in learning, and vice-versa. Durbridge also raises the question that the observable effects of an interaction between a person and a computer (switching on, mouse manipulation, keyboard work versus a screen lights up, symbols and noises appear), are not sufficient to explain a learning and subject-matter interactions. She says: "The crucial but invisible influences upon human action … are thus sandwiched between visible actions and visible effects on a screen" (pp. 6/18).

Davies and Crowther (1996b) say that learning occurs when the student is actively engaged with the subject matter concerned , and that that may be attained through interactivities such as questions, exercises, and discussions. They also say that multimedia is an important technology in this context because it offers the means by which the desired learning activity is performed (different problems can be posed for different students) and for the student to receive online feedback to enable him/her to assess his/her progress. But having said this, they also alert one to the limitations of multimedia "Just because the student provides an answer to a problem does not necessarily mean that any thought, let alone the desired thought, has gone into the response given." "However, it is important to recognize the limitations of multimedia for assessing students' abilities…"

In the case of the assembly of an electric circuit, questions and exercises are properly applied. Questions are pertinent for addressing the learning objectives (i.e. associating a practice with the theory and for preventing welding accidents) while Exercises that simulate laboratory practices are pertinent for addressing the second objective (i.e. assembly of a circuit on a protoboard). However, any of these forms, should encourage students to make decisions, supply feedback which will enable them to reflect on what they have done as well as change their decisions, in a way that will enable them to learn

from their mistakes. A good parameter for guiding the development of program is offered by Laurillard (1993b).

Multimedia Design

Boyle (1998d) points to two fundamental paradigms for educational multimedia design: Constructivism and Context. “The central tenet (of Constuctivism) is that knowledge of the world is constructed by the individual. The person through interacting with the world constructs, tests and refines cognitive representations to make sense of the world. Learning rather than instruction becomes the focal issue.”(pp71). In a simplistic way Context could be understood as an association of three important axes for interactive multimedia: content of the information to be conveyed, the aesthetic framework for this information, and Interactivity since the user is an active participant.

The design of a multimedia package for assembling an electric circuit should reflect the above mentioned paradigms so as to motivate the students and enable them to control the situation. The program should then: “1) provide a content list to facilitate access at any time to all material available; 2) allow access to all parts of program at all times; 3) offer a default rout through the material; 4) allow students to sequence and select/construct their own task goal, and to generate the learning experiences they feel they need; 5) provide a statement of objectives, so that students know what counts as achieving the topic goal; 6) state clear task goals, so that students know when they have achieved the aim of the learning task; and 7) give an indication of the amount of material in each section so that students can plan and pace their work.” (Laurillard, 1993c).

Working on assembly of a circuit on a protoboard. By understanding how this protoboard functions (the second objective of the program) a student could, for example, begin by choosing the project he/she desires to develop (emergency light, alarm, etc). Afterwards he/she would choose the functions, i.e the aim of the project and its application (house, car, etc). Finally, he/she would choose the level of difficulty in which he/she wishes to learn. As a result one student’s experience will be different from that of another that has chosen otherwise. On the strength of the different choices, the location of the different power points on the protoboard and the value of the components for assembling the circuit will vary. This means that the one option made in different circunstances will produce different results, allowing the student to understanding that the correct decision made for situation A may be incorrect for situation B. For the activity of assembling the circuit per se, the program should offer a toolbox complete with measuring tools and different-size components so that the student can choose the components and move them with the mouse to the power points, test the connections, check the results by means of feedback, and try new components and/or new connecting points.

CONCLUSION

A multimedia package for learning how to assemble an electric circuit should serve as a guide to help students carry out their experiences in a real laboratory but not to substitute face-to-face teaching in an actual laboratory. Some procedures made in a laboratory for learning by experimentation are so successful that no other media could replace them so efficiently.

Purporting to offer a guideline this essay attempts to show some of the important principles that should be observed in developing a multimedia package for learning how to assemble an electric circuit. With regards to the Structure of the program the option for guided learning (not imposed or completely free) denotes the belief that environments for teaching-learning should at least be controlled to ensure that the student does not loose his/her way and that the learning objectives are attained. The selection of the media associated with the learning objectives also attempts to guarantee that the pedagogical factor is as relevant to the program as the technological factor, i.e., special effects should serve to encourage students to learn, and not distract their attention from that which is really important. Finally, with regards to the Interaction aspect, the essay tries to draw attention to the risk that the program might be diverted by some myths, thereby proposing that checks be made at each stage of its development to make sure that it offers opportunities for students to reflect on.

In sum, this essay attempts to pass on the idea that Multimedia is not a good thing in and by itself as it has been bandied about but rather that depends on the context in which it is used. Within the scope of education, multimedia should be used as a learning resource but never as a technology that has arrived to address all the old problems of the teaching-learning process.

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