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EVEA: A Virtual Space of Analog Electronics and its Applications

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Abstract: The use of a multimedia environment for analog electronics has been introduced in some courses of the Castelldefels School of Technology. The use of animations and quizzes help to save explanation time without loss of generality. The spared time is then dedicated to active problem solving at classroom. Positive acceptance of both students and professors opens the doors to further improvements of the environment.

Key-Words: - Multimedia learning, analog electronics, animations, applets.

1 Introduction

Learning is an individual process. Studies concerning the way engineering students learn show that their learning mechanisms can be grouped on different blocks [1]: students learn better through active than passive methodologies (67 % vs. 33 %); they prefer data and examples (57 %) rather than theoretical approaches (43 %); they understand better visual explanations (69 %) than only listening (31 %); and finally, they usually prefer a bottom-up approach (72 %) rather than a top-down one (28 %). These results allows for two conclusions: first, students' learning preferences are rather diverse, and second, they are biased towards active learning and visual examples. In this frame, professor methodologies must be diverse enough to favor that most of the students be able to learn successfully. Besides, in the context of the European Higher Education Area (EHEA), where student-centered education is a goal, the organization of the syllabus and the teaching methodologies must consider this diversity in order to achieve the success of the whole class.

A possible methodology is to introduce multimedia material as a learning aid tool at classroom. From previous experiences [2, 3], savings in lecture time of about 48 % or even 80 % [2] can be achieved when compared to a classical professor-centered methodology. There are more advantages that the use of multimedia [3-12] has: the acceptation of this material is usually higher because the students learn more easily and achieve a deeper understanding of the subject; different learning styles are covered [13]; an additional bibliographic source is given to the students, considering that students do not check the literature often [14]; it creates a motivating and dynamic environment; students can learn at their own pace and learning is constructive and interactive, stimulating imagination and creation.

Our purpose with this contribution is to define and evaluate the multimedia environment *EVEA* (Virtual Space on Analog Electronics) [15], at the same time remarking the implications it has in some courses of analog electronics.

2 Context of Analog Electronics

The experience has taken place at the Castelldefels School of Technology (EPSC). The involved engineering degrees are: Communications Engineering (3 years –bachelor– and 2 years –master) and Aeronautical engineering (3 years–bachelor). 40 students per class and highly innovative teaching methods are assets of the school [16]. Classrooms with mobile desks and video projectors are available.

While analog electronics bibliography is vast and its bases for an electronic engineering degree are well established, this is not the final goal in communication and aeronautical engineering, although they are quite relevant. Three courses on analog electronics have been involved in *EVEA* project:

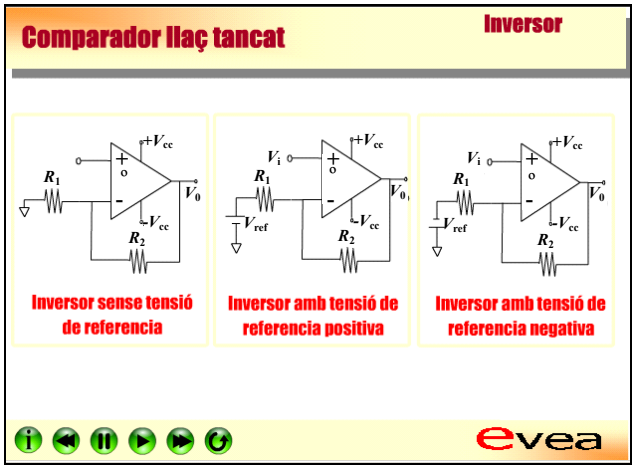
- *Components and Circuits* (1st semester – 4.5 ECTS)
- *Electronics Laboratory* (2nd semester – 6 ECTS)
- *Electronic Systems* (3rd semester – 4.5 ECTS).

This work will focus mostly on the *Electronics Laboratory* course. It is a semester-based course (28 lecture hours and 42 lab hours), and four main topics are discussed: i) amplification, ii) digital to analog and analog to digital converters, iii) comparators and timers and iv) power sources. Reference bibliography is [17, 18].

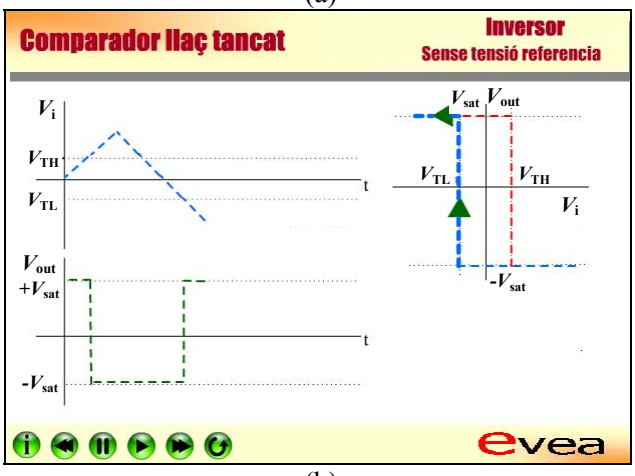
Prior statistics showed that those students working weekly achieved a 100 % success while in other cases the average reduced down to 20 %. Hence, continuous learning is critical for the success on the course. The need to have students motivated to work on a week-to-week basis has proven to be an essential issue to achieve satisfactory results in this course.

3 The EVEA project: description

The EVEA project consists of a virtual environment for multimedia material, devised as a teaching aid of analog electronics in different engineering degrees [Suecia]. This environment consists of animations, applets, interactive tests and a virtual lab.
Animations were generated with Macromedia Flash© and conform a comprehensive bibliographic material for different courses.



(a)



(b)

Fig. 1*. Animation windows from EVEA. (a) Cover of Hysteresis Comparators (b) examples of the comparator response to a triangular input signal. The animation allow a step-by-step evolution of the transfer characteristics as a function of input voltage.*

Applets were programmed with JAVA to illustrate the behavior of electronic circuits. The main difference with Flash animations is that applets allow modifying circuit parameters, so that the response under different conditions can be studied.
Students will have the opportunity to manipulate components' values (resistances, capacitors, supplies, etc.) and observe its influence on the output. Its goal is to verify theoretical basis.

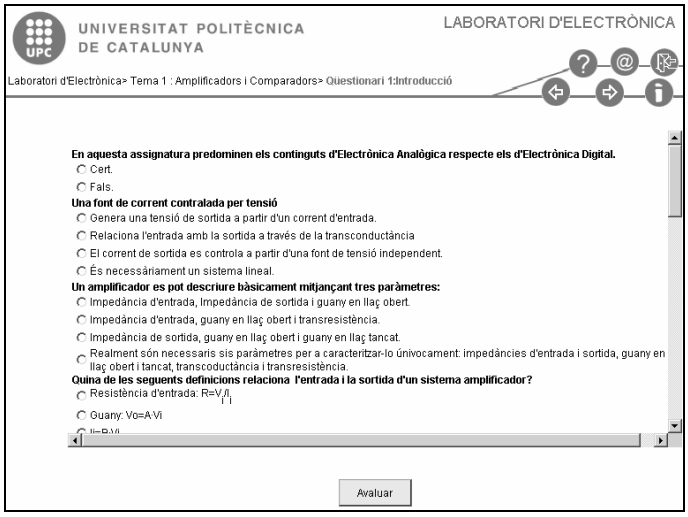


Fig. 2. Multiple choice quiz. At the bottom, the evaluation button allows sending the solution to the professor via email.

Interactive quizzes were generated with EasyProf©, proposing questions via internet in order to prepare next lectures and evaluate the degree understanding of the course. Moreover, a solution for the students is automatically generated along with a report which is sent via e-mail to the professor.

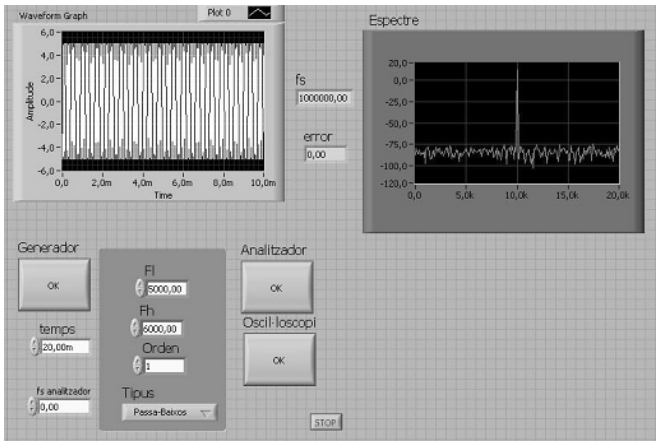


Fig. 3 Virtual lab window, showing the oscilloscope and the spectrum analyzer.

Virtual Lab: This is a collection of lab instruments programmed on LabVIEW® [19], embedded on a virtual lab environment. The instruments are: digital

multimeter, function generator, spectrum analyzer and oscilloscope, which mimic the front panels of the actual instruments, at the same time providing full functionality. Additionally, different modules simulating actual circuits, like passive filters or op amp based voltage amplifiers have also been developed, so that virtual hands-on experiments can be carried out. In the case of op amps, the modules developed simulates a big deal of the practical behavior of the op amp, like PSRR and CMRR. Its goal is to let the students train themselves with the virtual lab instruments in a safe way before entering the real lab.

An average estimation of the time needed to generate this material would be around 2500 h, and about 200 h per each Flash animation covering a single topic (comparators, for instance).

4 EVEA application: animations and tests.

The introduction of these animations in the development of the course implied reorganization both of the lecture structure and students' interactions in the class. Two methods applied on the classroom are described here. The material is available at the intranet for the students in both cases.

4.1. Professor guide

The material has been used in three semesters and four groups. Multimedia animations have been used as a support for classical class. However, several advantages come out. First of all, a great amount of material can be explained in a short time, like those courses based on PowerPoint slides. Under these circumstances, being lecture time a constant (2 hours), the subject is presented in one hour, while the saved hour time is dedicated to hands-on study of problems derived from the theory just learned. Thus, while one hour students hold a passive learning, the other hour is completely devoted to problem analysis, implying an active participation of students and better consolidation of knowledge.

A second advantage is that animations simplify and better illustrate dynamic circuit behaviors. For instance, the explanation of 555 timers through animations highly simplifies professor explanation and improves students understanding since dynamic and animated functions of these devices are illustrated on the screen.

4.2 Group Work: Animations and Virtual Laboratory.

A completely different approach was considered in the group work. Students were divided in groups of three or four people and provided with one laptop, having access to the multimedia animations. The professor plans the class via a well-defined script Students are let free to learn the course material with the help of the guide, the animations and the professor who, wandering around the class can solve individual doubts that arise. The first time that animations were introduced in these conditions, results were not completely satisfactory. The radical change in the methodology required an adaptation process for both the students and professors to get used to working in this new frame so that new tests must be carried out to refine its application.

4.3- The quizzes.

Tests were the first developed tools, with different purposes. First of all, a feedback tool was intended to be given to the students, so they could know their course tracking. Moreover, it was also intended to be a tool for a prior preparation of the lecture: that is, tests had to be solved before the class in order to prepare the material and after the class to settle knowledge. However, tests were only solved in the case that their assessment implied a final mark. Being voluntary, students were not resolving them.

5 Results of EVEA

5.1 Students balance

To evaluate the benefits of these tools, a survey was distributed among the students. 25 people per course answered it, allowing for some preliminary statistics. The results showed a positive balance, as shown in Table 1 for the course *Electronics Laboratory*.

The survey of the first course considers the use of two strategies: professor's presentation and group work. In the second course, only professor presentation was introduced. The group work at class required an excessive control of course and was not completely accepted by the students. In the second course, only the professor approach was considered. In this case, students' opinion shifts to a more positive balance. The group strategy show controversial results. Students agree with the group interaction but contrarily, their opinion on the class evolution is not as positive as the professor balance, probably due to the active and effort required in this method and to be the first approach of the method [20].

Concerning the material itself, students considered that animations were clear in appearance and able to describe satisfactory the topics presented. They also manifested their interest to use it outside the classroom along with the desire that these methodologies could be extended to further courses.

Results evidence the diversity of students learning preferences. Hence, the introduction of additional methods to help the learning process is needed in each session. Curiously, the percentages are quite similar to those given in [1], irrespective of the country, culture and education model.

	Pro 1st	Against 1st	Pro 2nd	Against 2nd
Descriptive enough?	83%	7%	100%	0%
Extend to more subjects?	61%	24%	90%	5%
Good learning tool?	65%	20%	95%	0
More time on this material?	40%	34%	50%	28%
Use outside classroom?	67%	11%	90%	5%

Table 1. Comparison between first and second semesters survey recording students opinions.

5.2 Professor's balance

From the point of view of the professorate, the interest for the multimedia material has become evident, not only as a valuable tool to facilitate class explanations, but also as a way of applying diverse methodologies without syllabus' reduction, at the same time introducing additional strategies to center the learning process around the students, which are basically focused on the resolution of problems at class and in reduced groups.

On the other hand, the use of a detailed guide for self learning workgroup on a laptop and in the classroom has been tested. However, this methodology involves a drastic change in the course development, so that the difficulties involved in the method are criticized by the students, as shown in Table 1. Anyway, it is expected that this methodology can be progressively implemented in next semesters.

5.3 Coordination

The sequential structure of different subjects of analog electronics in the global syllabus implies a correctly sequencing the subjects to facilitate students' learning. Thus, it was advisable to establish a coherent coordination between the different courses involved. The generation of EVEA, a comprehensive database of topics dealing with analog electronics, helps to make the learning process more global. The benefits of EVEA as a coordinating tool have also been assessed.

6 Conclusion

A multimedia environment covering analog electronic courses, EVEA, has been developed, with the purpose of promoting active learning. First results of its application and performance in two semesters have been presented. Active participation of students has been enhanced, implicating a better understanding of both the theoretical and practical learning, what has been achieved by devoting more time to complementary exercises in the saved time using multimedia tools.

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