SHIVA: A HYPERMEDIA SYSTEM FOR ELECTRONICS LEARNING

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Abstract — *Shiva is a hypermedia system to improve Electronics teaching and learning processes using hypertext, multimedia, PSPICE simulation, a virtual laboratory and real modules combined with virtual instrumentation. It has been designed with criteria of space optimization and may be used by professors at the classroom as well as by students at home.*

Index Terms — *Hypermedia, simulation, virtual instrumentation.*

INTRODUCTION

Present Electronics computer aided learning systems only use hypermedia and they are not useful for teaching electronic circuit design. Shiva is an original electronics learning system including a set of tools:

- Hypermedia lessons divided into theory and exercises including solutions and simulations. This tool is combined with a glossary, a short Electronics history and the biographies of the most famous scientists and engineers related with the development of Electronics.
- Real modules combined with virtual instrumentation facilities to improve fundamental concepts and design learning (Figure 1).
- A virtual laboratory.
- Other tools:
- Complementary exercises.
- Reverse engineering.
- Data searching.

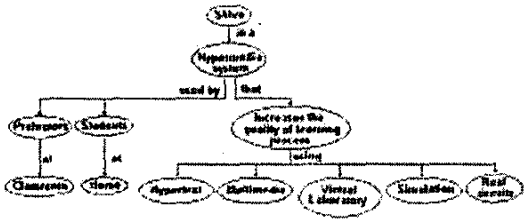

Figure 1. Shiva general structure.

The Shiva system requires a personal computer, a sound card, a CD player, a data acquisition card connected inside the PC, a general interface module containing the power supplies, and the real experimentation modules.

Shiva may be used as a professor support during the teaching process, using mainly simulations and real modules. Occasionally texts may be linked with the glossary and/or the history and biographies to reinforce some ideas.

Students may use the system at home during the learning process. They can read lessons and/or listen to the spoken comments, simulate the circuits under study, solve exercises and use the virtual laboratory.

LESSONS

Shiva is at present specialized in Analog Electronics learning. Lessons are divided into theory and exercises (Figure 2). Theory uses text files, spoken comments, simulations, manufacturers' documents and real circuits. Exercises follow a similar structure with text, solution, answer checking, real circuits and simulation.

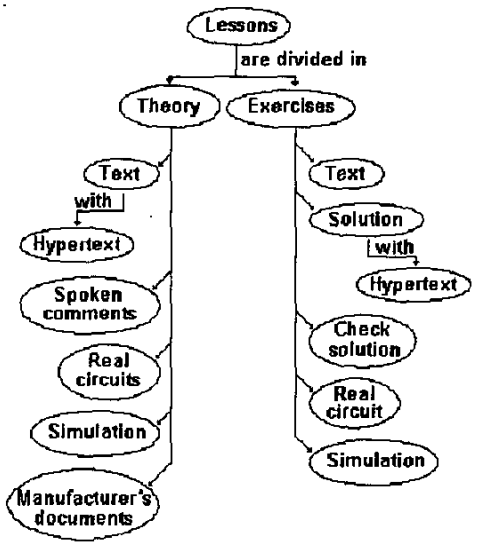

Figure 2. Lessons conceptual map.

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Lessons, exercises and solutions are under HTML format. The main advantage of HTML files is the hyperlink utility (Figure3).

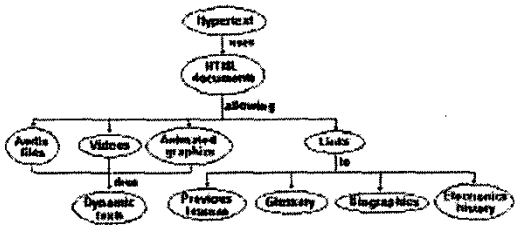

Figure 3. Conceptual map of Shiva hypertext.

By means of hyperlinks the student can go back to previous lessons to review forgotten concepts, or to display some additional information to reinforce his knowledge. At the same time, HTML files are useful to display animated graphics drawing complex circuits step by step, explaining each one. Shiva includes a glossary with the most common used words on electronics. By means of hyperlinks the student can access to the glossary as well as to the biographies of the most famous scientific and engineers related with Electronics development.

SPOKEN COMMENTS

The "Spoken comments" included in the lesson show a "like" cassette player (Figure 4). Including spoken comments, the students can listen to the abstract of the theoretical part. These abstracts show the most important concepts of the theory. They can be used at the beginning or at the end of a every lesson.

When using it at the beginning, Shiva points the attention of the student on important concepts. When used at the end, the students test their knowledge.

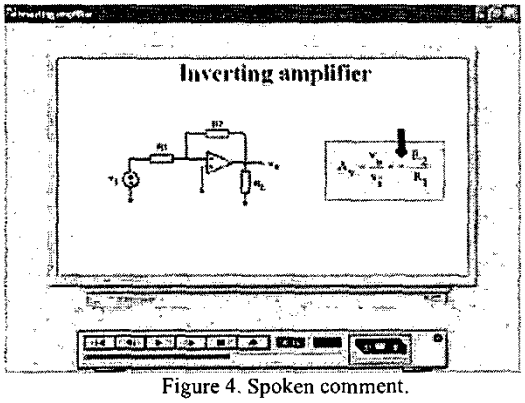

Figure 4. Spoken comment.

REAL MODULES AND VIRTUAL INSTRUMENTATION

Real modules (Figure 5) are cards containing circuits to be analysed. The available modules introduce different analog electronic circuits including potentiometers, switches and push buttons to change the appropriate circuit parameters (Figure 6): input voltage, reference voltage, feedback resistors, etc.

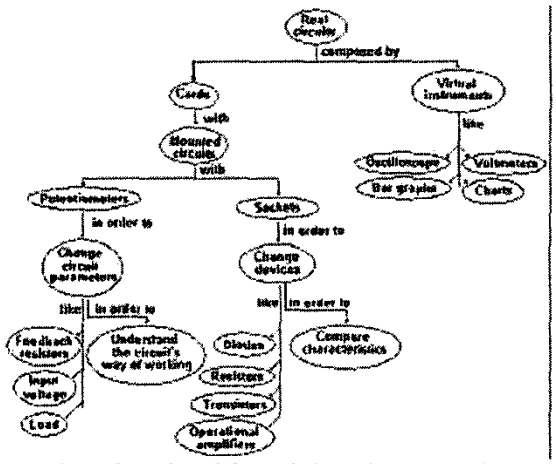

Figure 5. Real modules and virtual instrumentation conceptual map.

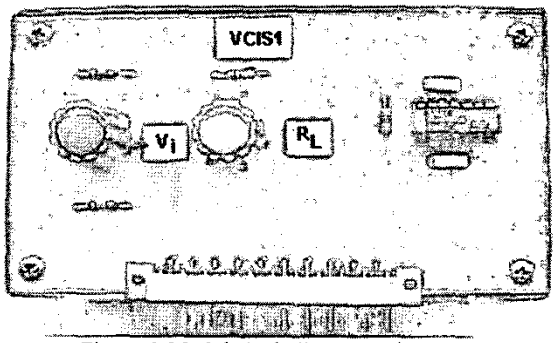

Figure 6. Module including potentiometers.

Many modules are equipped with sockets to be able to change the type of operational amplifier being used (Figure 7). In this way it is possible to compare the behaviour of the same device produced by different manufacturers and/ or of different devices. The professor can use this utility at the classroom reinforcing, in that way, the understanding of some parameters, as for example the input bias current.

Combining virtual instrumentation with overhead projectors the professor can bring the laboratory to the classroom (Figure 8).

Obviously, Shiva does not replace the laboratory, but introduces experiments at the same time that the professor is teaching a new electronic concept or circuit. Our experience is that students really enjoy using the modules at the classroom.

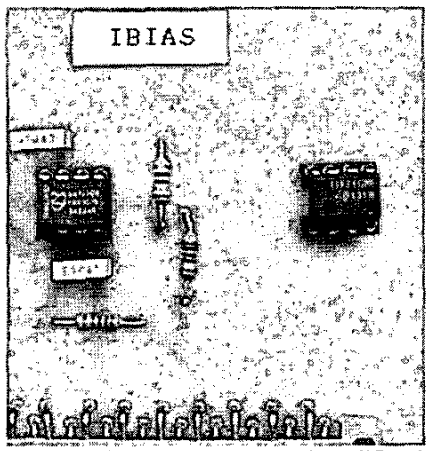

Figure 7.Card using two operational amplifiers in order to compare input bias current

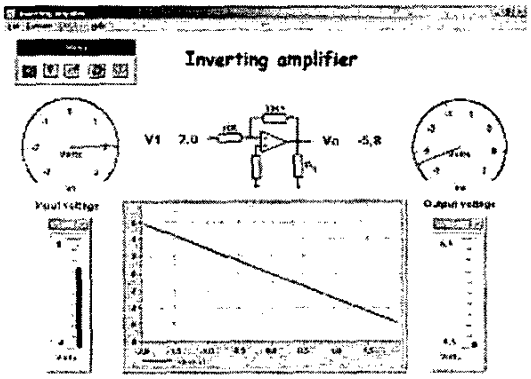

Figure 8. Screen showing virtual instrumentation for an inverting amplifier circuit with voltmeters, bar graphs and chart.

SIMULATION

Simulation is a powerful tool both for the professor at classroom and as a cheap alternative to practical experimentation for the student at home. Shiva uses MSIM evaluation version (Figure 9), a free version of PSPICE. In spite of the limitations of this free version, it is possible to simulate the most important circuits.

At the same time, students can learn by using the most popular electronics simulator with pre-prepared circuits and also modify them, step-by-step.

Using simulation the possibility to destroy an electronic device, a very common situation when the student begins, is avoided. Simulation gives the opportunity to use "software" instruments like oscilloscopes and voltmeters at home with a very low cost.

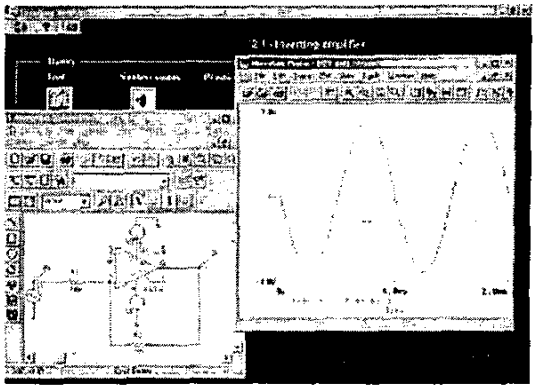

Figure 9. Pspice simulation.

Simulation plays a relevant role when solving exercises (Figure 10). When the student gives a wrong answer, Shiva generates the PSpice sch file and simulates the wrong circuit. The idea is that the student could check his wrong answer and then compare it with the good one, in such a way that he can learn from his own mistakes.

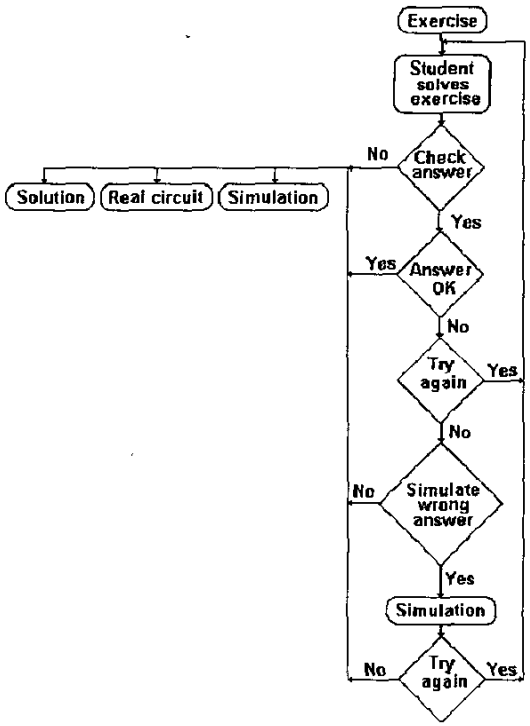

Figure 10. Flow diagram of simulation when solving exercises.

VIRTUAL LABORATORY

The virtual laboratory is a hypermedia system to be used between the lessons and the practical work in the laboratory in order to:

- Facilitate that the student learns circuits mounting using protoboards before he goes to the laboratory (Figure 11).
- Teach the student the most common analog circuits fails in the laboratory such as:
  - -Short-circuited or open circuit passive devices.
  - -Out of order solid-state devices.
  - -Uncorrected values of resistors and/or capacitors.
- Protoboards with failed contacts.
- Let the student to come back to theoretical lessons using hypermedia links.
- Let the student to consult manufacturer documents.

Figure 12 shows the block diagram of the virtual laboratory composed by three main blocks:

- The workbench area
- The data module.
- The complementary resources

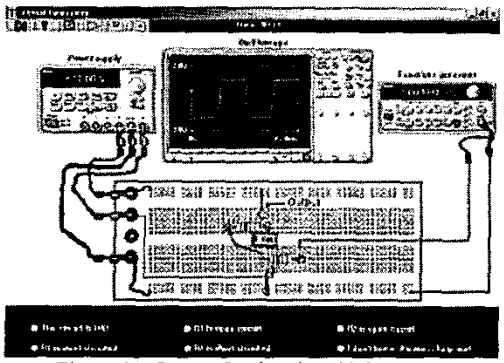

Figure 11. Screen for the virtual laboratory.

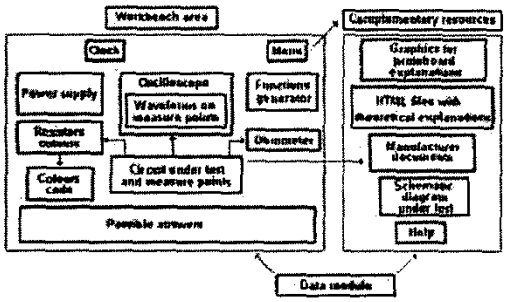

Figure 12. Block diagram of the virtual laboratory hypermedia system.

The main screen shows, among others, the following items:

- A power supply
- An oscilloscope, where the waveforms may be shown
- A function generator
- A protoboard where the circuit is mounted showing the way to optimise the devices placement and interconnections. The circuit can be out of order.
- Red circles. Clicking on them the oscilloscope shows the waveform at the selected point.
- Resistor colour code, and an ohmmeter (Figure 13).
- An area where possible circuit fails are indicated.

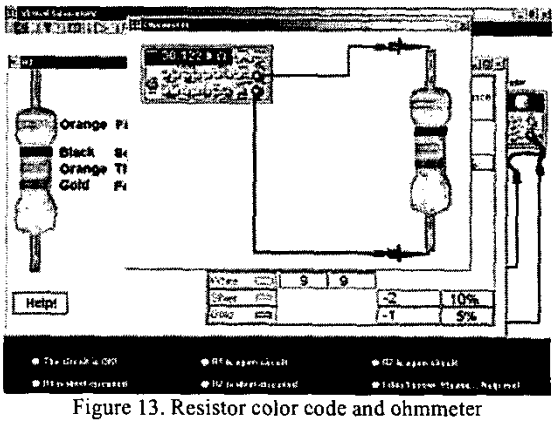

Figure 13. Resistor color code and ohmmeter

Among others complementary resources are composed of:

- Hyperlinks to theoretical lessons (Figure 6), in such a way that the student relates theoretical explanations and practical works. From the theoretical lessons, the students can link to a glossary containing 800 words of common use in electronics, to the biographies of 68 scientist and engineers that have participated on electronics' development, and can navigate through the history of electronics in the passed 20th century. The students can listen, among others, J.J. Thompson speaking about the electron (Figure 15) or they can watch 21 videos explaining electronics' concepts.
- Hyperlinks to manufacturer's documents in order that the student learns to interpret them. (Figure 14)

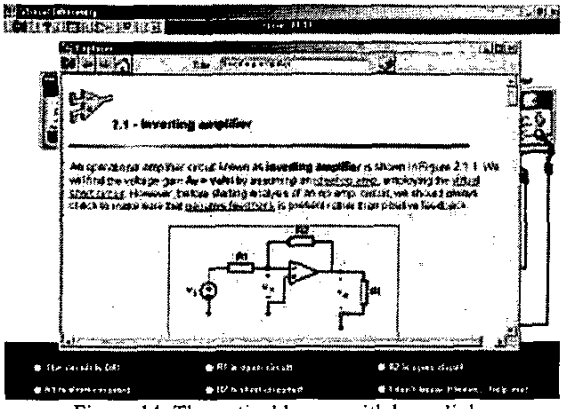

Figure 14. Theoretical lesson with hyperlinks.

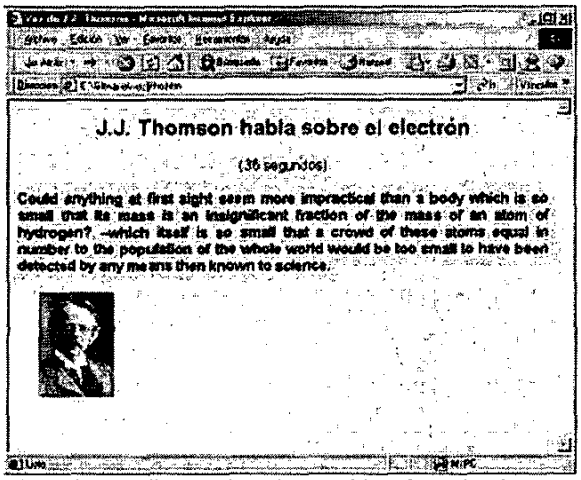

Figure 15. J.J. Thomson' s voice speaking about the electron.

The Data module is a small file including the information (graphics, devices values, links, questions and answers) related to the practice. It is about 95 Kbytes long and it may be downloaded from Internet giving a great flexibility to the tool. Data are compressed using a special format to prevent the students from searching inside the solutions.

OTHER TOOLS

To reinforce the learning process, Shiva includes other tools, like:

- A random exercises generator reinforcing the student knowledge (Figure 16).

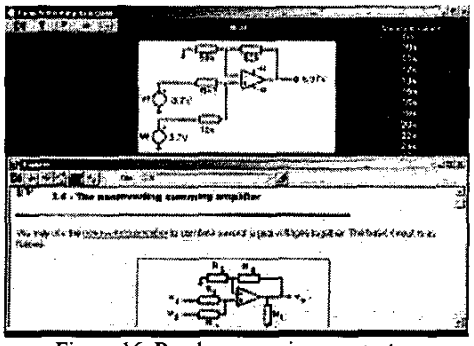

Figure 16. Random exercises generator.

- Tests to check the student knowledge.
- A reverse engineering tool, which is a game where the student plays detecting the circuits under his "hands" (Figure 17).

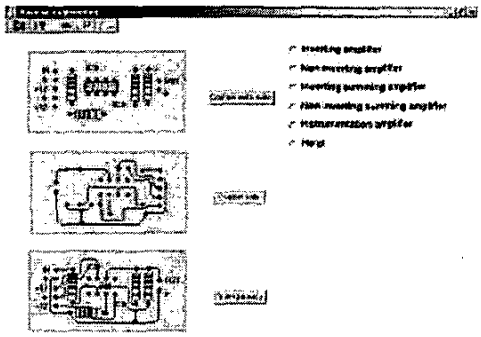

Figure 17. Reverse engineering.

- "Searching data". Where the student is asked to search specific data on manufacturers' documents. The idea is to teach them how to do it with help screens (Figure 18).

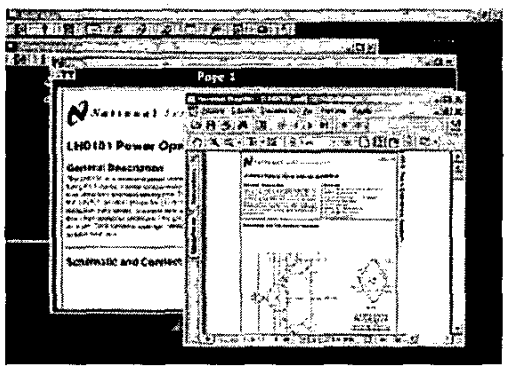

Figure 18. "Searching data" with manufacturer documents and help screens.

- Internet connection for data searching
- Net meeting
- E-mail connection with professors.

CONCLUSIONS

Combining hypermedia with real circuits and simulation, we can improve Electronics education. Shiva is a computer aided learning system being experimented during the last four years with Spanish, German and Greek students (University of the Basque Country, Fachhoschule Wilhemshaven and TEI Kavala). All of them admitted that Shiva is a useful tool for Electronics learning. At present (course 2001-2002), 32 students use the Spanish version of the Shiva system at the E.U.I.T.I. SS. (University of the Basque Country).
The students use the whole Shiva system (including a data acquisition card and the set of modules) at the Faculty and a reduced version of the system (without the data acquisition card and the modules) at home.