

## **AC 2009-70: PODCAST TUTORIALS ON PSPICE AND LAB-IN-A-BOX**

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# Podcast Tutorials on PSpice and Lab-in-a-Box

## Abstract

An approach has been developed to provide students with 24-hour access to multimedia tutorials from a department website using a readily available means to distribution – podcasts. Tutorials have been developed to cover select topics in PSpice as well as to address issues commonly encountered when using the hardware and the software oscilloscope used in an introductory circuits lab course, which is not taught in the traditional classroom laboratory environment. The advantage of podcasts is that students can view the tutorials while their computers are running the oscilloscope program, enabling real-time instructional support as they work on their labs while on or off campus. The podcasts are a mixture of still images and screen shots imported into a Powerpoint presentation with an audio track added. Currently, tutorials are compatible with three platforms: iPod nano, iPod Classic, and the iPod Touch. An explanation of the techniques applied during the development of the tutorials and a brief review of the current tutorials are provided.

## Introduction

A project known as Lab-in-a-Box (LiaB) was developed at Virginia Tech as one of the outcomes of a department-level reform of the Electrical and Computer Engineering (ECE) Department, addressing a need that was identified through student and employer surveys for concrete examples of fundamental concepts in electrical engineering.<sup>1</sup> LiaB is a set of ‘hands-on’ exercises in which students design, build, and test at home various d.c. and a.c. circuits using an inexpensive electronics kit, digital multimeter, and a software oscilloscope.<sup>2</sup> Thus, LiaB does not require significant resources to implement. The inclusion of LiaB in our ECE curriculum has received overwhelmingly positive comments from the students as well as from faculty members who have adopted the kits for projects in upper division courses, which traditionally have been lecture-based with no lab component. LiaB has also been adopted by three community colleges in Virginia including Virginia Western Community College.

Despite the overwhelming success of LiaB, we still find that even the best students are often uncertain of their abilities to properly perform experimental work. One of the goals in our effort to develop multimedia learning materials is to instill self-confidence and improve self-reliance in the students when, for the first time in their engineering careers, they construct a circuit with physical components rather than symbolic parts in PSpice and determine the voltage drops and currents in the circuit by direct measurement rather than by plugging values into their calculators. To accomplish this, we have developed a number of podcast tutorials that support the pedagogical objectives of LiaB. The podcasts tutorials are available for download by the students from a departmental website, which they can view on their iPods while they are running PSpice, MatLAB, or the software oscilloscope program on their personal computers in full-screen mode or place next to their breadboard as they construct and test their circuit designs. In addition, a format is available to run on the students’ computers using QuickTime.

## **Motivation**

One of the goals of the original LiaB project was to encourage women and under-represented minorities to study electrical and computer engineering through its use of hands-on experiments as early as the first course in the department. Another goal of the original project was to develop the experimental skills of all students in electrical and computer engineering that would help them understand and appreciate abstract concepts presented in introductory electrical engineering courses and that would also better prepare them for advanced undergraduate project work and for graduate research. As has been noted by our faculty and others<sup>3</sup>, the level of informal hands-on experience in the area of electrical engineering has decreased significantly as the high school hobbyist no longer engages in ham radio, builds electronic kits, or assembles his or her own computer. This unique concept has been tested for over five years and has met enthusiastic student and faculty response. However, during this extended implementation period, we have found that a majority of students in their sophomore year, even those who can analyze circuits proficiently via hand calculations and PSpice, are quite uncomfortable when faced with a bare breadboard, a set of components, a spool of wire, and a multimeter. They routinely seek assistance from the graduate teaching assistants (GTA) with even the simplest of tasks, demonstrating that the students have a significant lack of self-confidence in their ability to do experimental work.

In addition to this issue, the ECE sophomore-level students are not well prepared to use software programs, such as PSpice and MatLAB. Currently there is no formal instruction offered within the Virginia Tech ECE Department on either PSpice or MatLAB. Students are introduced to MatLAB during a freshman engineering course. However, roughly half of the department's sophomore student body enrolls in the LiaB course in their second semester sophomore year, with the result that there is a gap of a year between the initial instruction on MatLAB and the ECE course in which the students must write programs on their own. Instruction on PSpice is very limited, provided during optional help sessions given at the beginning of each semester; thus, the majority of student learning is done independently.

It has been demonstrated in other fields that multimedia tutorials are effective in resolving similar issues of self-confidence and guided independent learning.<sup>4</sup> Podcasts offer an ideal mode to distribute the audiovisual tutorials as they can be used to provide real-time support while the students use their personal computers to run PSpice, MatLAB, or the software oscilloscope program. Furthermore, the iPods are can be positioned next to the breadboard enabling the students to simultaneously view the podcast tutorials while they are engaged in circuit construction, test, and debug. The availability of tutorials online provides support around-the-clock.

## **Topics for Tutorials**

The initial objective is to identify the aspects of PSpice and MatLAB that will be used by students in the circuits and electronics courses, which are taken by the undergraduate electrical and computer engineering majors, as well as in the circuits and electronics service courses,

which are taken by students from chemical, civil and environmental, industrial systems, and mechanical engineering and materials science and engineering. Various means to collect information to identify the topics for the podcasts were pursued including conversations with the course instructors and graduate teaching assistants to determine what course materials had generated significant discussion in class and during office hours and input from the course supervisors. The initial topics selected after this process are a) opening a new project in PSpice and find common components including ground, b) sweeping the d.c. value of a current and voltage source, c) plotting a current versus voltage characteristic of a diode within PSpice, and d) changing a fuse on the digital multimeter, which is easily damaged when the students measure the current flowing through a circuit improperly.

## **Podcast Development**

The activities conducted to create the podcast tutorials and the identification of the software to create and modify the tutorials can be divided into procedure, photography, image editing, making the video, voice over, and website. Much of this work was performed using the facilities at the Innovation Space (formerly, the New Media Center), a resource within the University's Learning Technologies. Lastly, a website was developed to host the tutorials.

### ***Procedure***

Once the topic is selected, a document was created with the list of instructions to complete the task outlined by the topic. Next, a story board was created to insure that there were smooth transitions from one subtopic to another in the tutorial and that the materials were easy for the students to see, read, and hear. Images used to convey some of the instructions included real life photos and snap-shots of computer screens. The digitized images were then imported into Adobe Photoshop for editing. After modifications were made to the images, they were incorporated into the video file, where they were placed in order as determined from the layout on the story board. Transitions and visual effects were then added onto the video. Audio was added last using a voice over method to ensure the video and audio were in sync. The video was played multiple times with changes made to the overall product as it moved from a rough copy to the final version. The video files were named according to the topic covered in the podcast tutorial and .m4v and .mov versions of the files that can be viewed using an iPod and QuickTime, respectively, were then uploaded onto the video download of the tutorial website.

### ***Photography***

The tutorial on changing the fuse in the digital multimeter required photos of the digital multimeter in various stages of assembly to be taken so that the students could easily follow the instructions. We found that a single-lens reflex digital camera with a minimum resolution of 5 megapixels was needed as images taken using lower resolution imagers were either blurry or pixilated when view on a laptop display.

Lighting while photographing the hardware, particularly the breadboard, proved to be a difficult challenge due to the reflective surfaces in several areas of the breadboard, the level of detail, and the various heights of the components. It was found that the best image quality was obtained

using only room lighting without employing the camera flash when photographs were taken in a typical classroom environment (Figure 1). While there was some loss of detail, the image sharpness was significantly improved over that obtained when the camera flash was used.

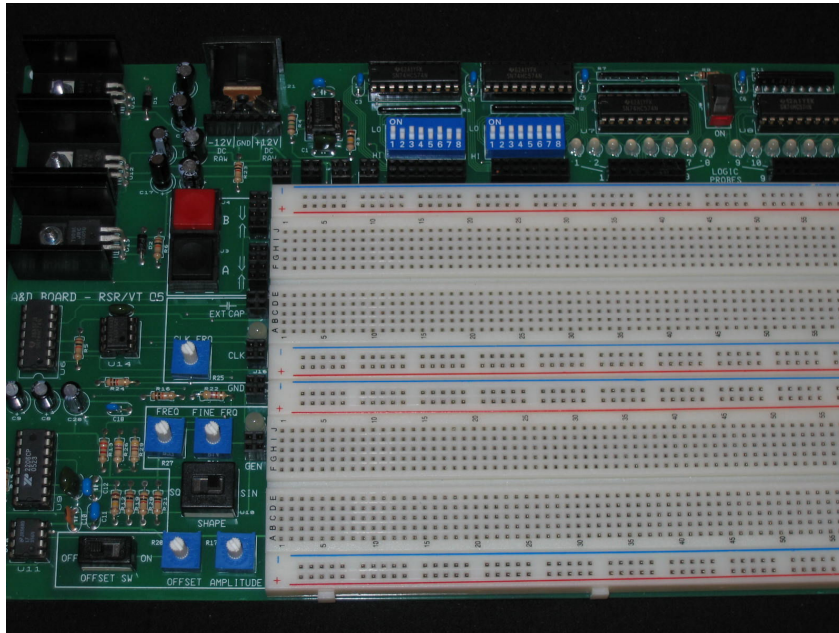


Fig. 1. Image of breadboard collected using diffused lighting without a camera flash

We found that we could increase the brightness and not lose the sharpness of the image when no flash was used by positioning the object on a white surface, as seen in Figure 2 below.



Fig. 2. Image of digital multimeter on a white surface taken using room lighting and without a camera flash.

### *Image Editing*

Images from photos and screenshots were edited in Adobe Photoshop. By simply adding arrows and a few words, the user was able to follow the tutorial much easier, as shown in Figure 3. This figure was designed to lead students through the required steps without removing the connection between the steps, providing a more visual means of learning.

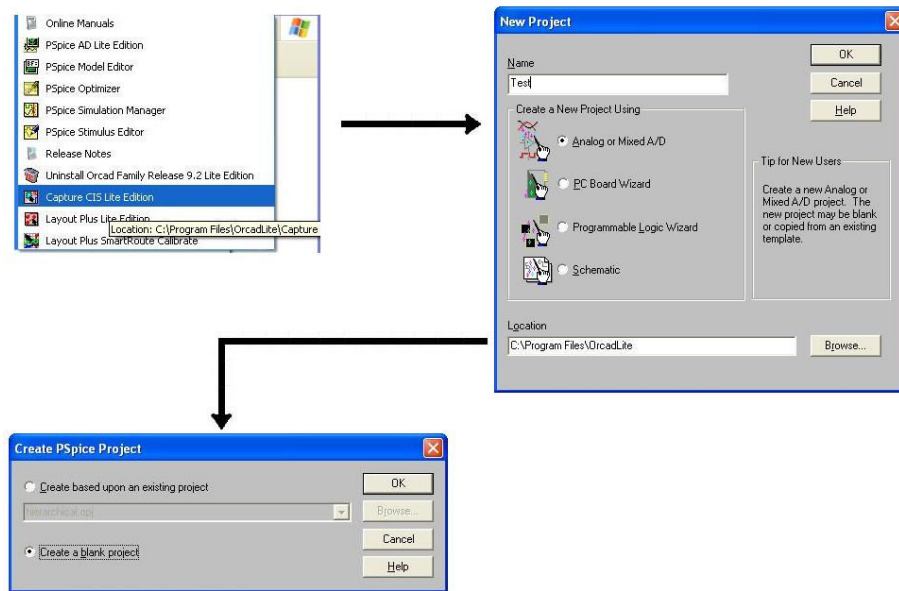


Fig. 3. Image that leads the students through the steps required to open a PSpice design project (ORCAD Capture version 9.1)

A useful tool that we used to collect still images for the tutorials was Snag-It (TechSmith). Rather than having to take a screenshot of the entire screen using the Print Screen function key on a personal computer, Snag-It allowed the user to redefine the screenshot to a specific area within the screen. For example, the image in Figure 4 is the whole screenshot, but the main focus is the message box that opened when selecting a part in PSpice. A second program such as Paint would then be used to crop the image so that the message box only remained. Using Snag-It, the screenshot was redefined to just the area containing the message box, as shown in Figure 5. We found that the use of this program greatly reduced the time and effort required to obtain the images needed for the PSpice and MatLAB tutorials. Overall, the image quality obtained was also higher as compared to that obtained after cropping an image collected using the Print Screen function key.

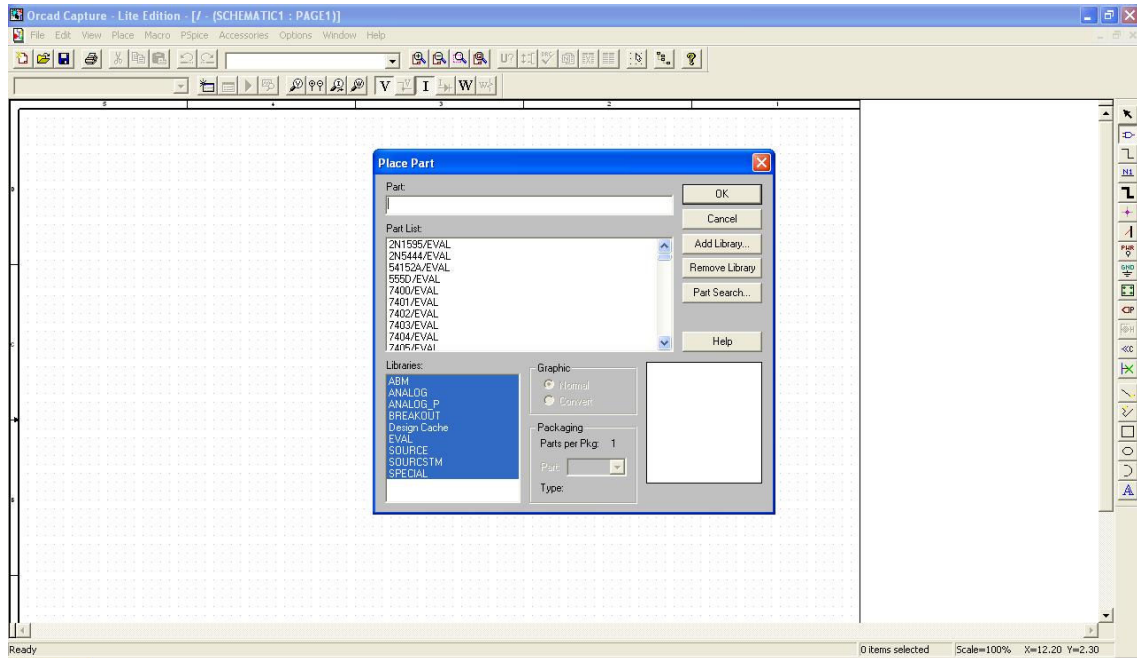


Fig. 4. Screenshot of the message box using the Print Screen key.

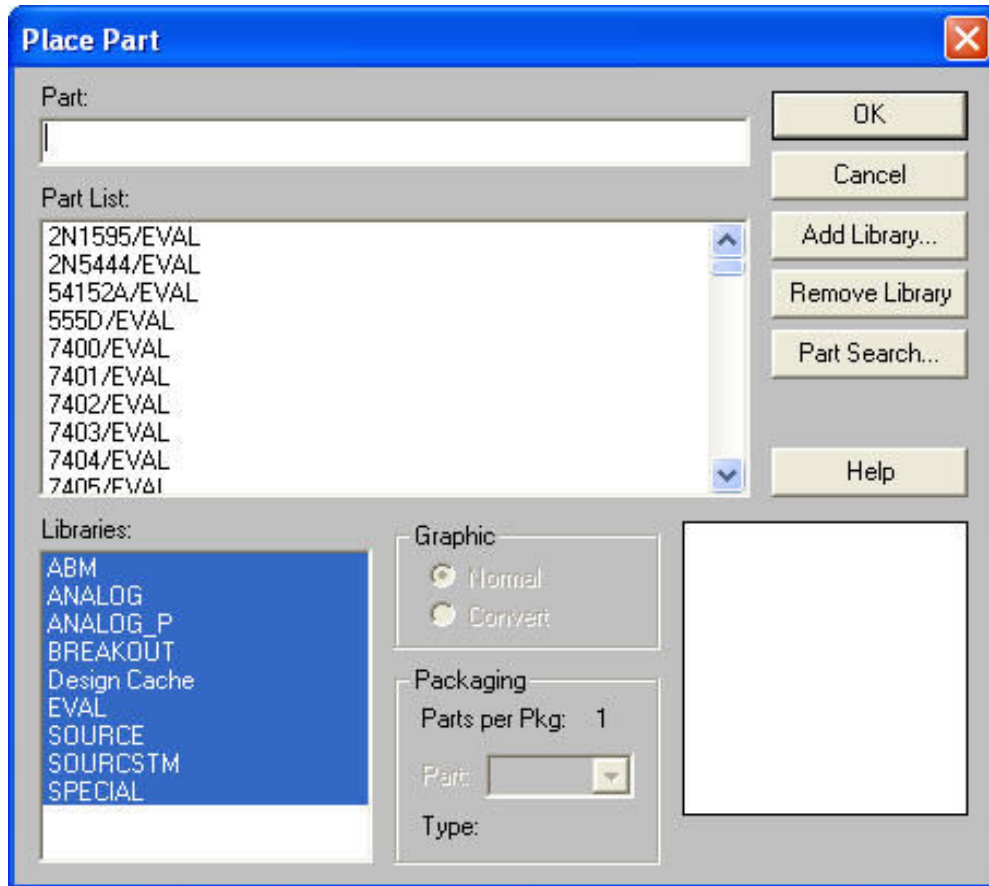


Fig. 5. Image of the message box in PSpice collected using Snag-It.

### ***Video Production***

The process used to make the video was fairly simple; the choice of software to use for the video was more difficult. The Innovation Space at Virginia Tech offered a Microsoft Windows-based program, Movie Maker, and a program, iMovie, which runs on a MAC PC. The layout of Movie Maker was simple and the program was reasonably user friendly. Images and sounds were imported into Movie Maker by clicking on the files and dragging them to the timeline. iMovie offered the same features as Movie Maker but had more options and a greater ease of use. For example, voice overs were much easier to produce. In addition, there were a greater variety of transitions and visual effects preloaded with the iMovie software than with Movie Maker. The deciding factor in our selection of iMovie was that the creation of the finished video can be exported directly as an .m4v, which is the file format for iPod videos.

### ***Voice Over and Audio***

One of the key features in iMovie was the availability to have voice over on the video feed. While the video was running, the user can add in speech in real time. If the voice over was not entirely correct, iMovie offered an audio editing program built into the software.

When recording the voice overs in iMovie, it was very important to be in a soundproof room and to have a good quality microphone to eliminate background noise. We included short pauses between the time in which the recording was started and the audio was started and between the time when the audio stopped and the recording has finished. Using this method, the audio clip was much easier to edit and also enabled us to eliminate unwanted noise that resulted from keyboard strokes.

### ***Website***

The website is the link between the tutorial and the students who want instructional support on PSpice, MatLAB, and the lab hardware. The website was created, <http://www.ece.vt.edu/tutorial>, with html, css, and java. There are five sections to the website; Home, PSpice, MatLAB, Hardware, and Contacts. Other than Home and Contacts, the other three contain links to the tutorials. In each of the three pages, students are able to either stream video or download the tutorial to a Window or Mac computer or to an iPod.

### **Conclusions**

The set of podcast tutorials, created to provide instructional support for two nontraditional laboratory courses on circuits and electronics, are available via the Virginia Tech ECE website. The initial podcast tutorials have been received very well by both the faculty and students in the department and will greatly help the new and incoming freshmen in the College of Engineering. An expansion of the topics covered with podcast tutorials is planned.

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