Multimedia Oscilloscope Training Program

John Bellando, Joseph H. Nevin
College of Engineering
University of Cincinnati

Abstract

Innovations in multimedia technology have expanded the realm of instruction from the static world of printed manuals to the dynamic world of computer-enhanced training. Utilizing graphics, animation, text, sound, and interaction techniques, developers are able to create tutorials, demonstrations and teaching aids, which are both visually pleasing and informative. Instrumentation manuals are particularly suited to multimedia development due to the level of interaction necessary for their operation, allowing users to interact with the tutorial as they would the real instrument. Because oscilloscopes—used for displaying and measuring waveforms--are widely used in many fields, the goal of this project is to provide a stimulating, interactive learning environment where users could simultaneously gain and review their knowledge of the functions of an oscilloscope. This paper discusses the motivation for as well as the implementation of an oscilloscope training and learning software package, written with Macromedia's Authorware and built around the HP 54600 series of digital storage oscilloscopes.

I. Introduction

In the information age where computers are common to home, work and school environments, a trend is beginning that shifts the focus of learning. In the past, learning was a two-dimensional process, involving text and pictures. With new multimedia and storage technology, many instructional lessons are being shifted to the three-dimensional realm of computer learning, utilizing not only text and graphics, but also video, audio, animation, and interactivity. Not only does this technology allow for an enhanced learning environment, but also extends educational opportunities to previously underserved populations. In fact, over the past several years, a magazine devoted to the discussion of enhancing the learning experience through multimedia and computer technology, *Syllabus Magazine*, has reached over 300,000 educators world-wide.

Already some major university programs, such as The Humanities Text Initiative at the University of Michigan and Project Bartleby at Columbia, have begun to create and disseminate online versions of many of the classics[1], allowing for a potentially wider reading audience. Barring copyright issues, the future could foresee the wide-spread use of online textbooks for college campus classes. On a grander scale, Iowa State has built a virtual reality CAVE-type facility, wherein architectural students can explore historical and contemporary buildings such as the Parthenon, Pantheon, and Notre Dame, thanks to the Historical Building Reconstruction project[2]. Even a local level of educating, many instructors are finding that whole concepts or single ideas can usually be understood better with the addition of images or animation. At the University of Cincinnati's College of Engineering we have had several instructors utilize the services of our Instructional Technology Center in creating animations and interactive programs

to illustrate concepts in heat transfer, fluid dynamics, mechanics, and vector analysis. At the University of Missouri-Rolla, students of Nuclear Engineering are able to access the Fundamentals of Nuclear Engineering Courseware, a set of multimedia modules which provide the students a concise, visual, and interactive environment in which to learn[3]. The realm of computer-aided learning is not limited to the education setting. Companies such as Apple Computers have begun to utilize multimedia training in their Apple University branch for the dissemination of managerial information[4]. As multimedia technology becomes even more wide-spread both on desktops and via the World Wide Web, the trends in transferring from two-dimensional learning to three-dimensional computer-aided learning will continue to rise.

In the College of Engineering at the University of Cincinnati, when sophomore electrical and computer engineering students are first shown the rudimentary operating principles of a modern digital oscilloscope, they often are overwhelmed by the plethora of controls and functions that are available. The richness of the functionality is offset by the time it takes to learn many of the operations that are possible on such an instrument. We proposed a solution to this challenge in the form of a multimedia training program to make it easier for a beginning student to learn the features of the oscilloscope. The program is designed to teach the student the use of an HP 54600 series digital storage oscilloscope. It was created with the idea that a graphical and interactive format was superior to the text-based approach that instruction manuals use. We describe in this paper the conceptual framework that was used to create the program and we show some of the major features using screen-shots.

II. Requirements and Conceptual Design

The concept behind the implementation of the oscilloscope training package was to present an application that would be visually pleasing, easily navigable, and richly informative. The software would need to be structured for students who had never used an oscilloscope as well as those who merely needed a refresher on particular functions. With few technological restrictions, the full range of multimedia components could be used in the implementation, including text, graphics, animation, video, and sound.

Before the actual implementation was started, several key factors were decided upon which would be necessary for a successful software application. The first requirement was that the oscilloscope be modeled accurately to provide a smooth transition from the software to the actual device. The graphics used for the oscilloscope had to be both accurate and proportional, allowing for the correct placement of knobs and buttons. In this way, students are assured of almost instant recognition of what was learned in the software when confronted with the physical device in the laboratory.

The second requirement was that the oscilloscope training program be easily navigable by new users. It is important that users have a clear and unambiguous idea of how to use the program, or the entire purpose is lost. To this end, it was decided that clear instructions would be presented at each new area showing the various navigation and interactive controls and their use. This would provide an illustrative example for new users and a reminder for those who have used the program already.

Reusability was the last requirement for the application. The goal was to have a learning program that would be used by those who had never operated an oscilloscope and those who needed to find out specific information. Care would need to be taken to present the information in such a way that new users could navigate through the entire application with ease on their first time and advanced users could instantly find the specific information they were looking for. Accomplishing this was the most important task, and features such as a glossary, bookmarks, a find feature, and menu navigation would be part of the solution.

III. Interface Design and Implementation

After finalization of the conceptual design and program requirements, appropriate software was chosen for the application. It was determined that Macromedia's Authorware Attain was the best choice for the actual program framework. The timeline-style authoring environment coupled with powerful Knowledge Object capabilities made Authorware the most attractive choice in terms of starting from scratch. In addition, Macromedia Fireworks provided an excellent graphics tool for developing the various graphics that were used in the software. Its expert use of layering and live effects would be of particular interest in editing graphics to suit particular needs of the application.

The various sections of the oscilloscope application are outlined in detail below, including screenshots that help to illustrate the graphical nature of the navigation in a particular section. Section A contains information about the general navigation framework and design. In Section B, the global menu window is discussed. The "How-To" section of the application is covered in Section C. In Section D below, the glossary is illustrated in graphical detail. The last section, Section E, covers the objectives list, the find and bookmark features, and the help section of the application.

A. General Navigation Framework

In order to facilitate the actual development of the oscilloscope package, an Authorware *Knowledge Object* was used for the framework of the application. Knowledge objects provide a means of rapid development by supplying a skeleton of an object then allowing the user to provide data for the feature placeholders. For instance, a Radio Button knowledge object holds the code for a basic radio button; a user is then able to supply the text associated with the button as well as a desired action when the button is selected. In this way, common objects may be developed faster and with less error than programming from scratch.

An *Application Knowledge Object* was used to provide the basic navigation framework for the oscilloscope application. Using this knowledge object allowed for the automatic setup of various options. First, the default screen size and program location were selected and used by the object. Also, the basic screen layout, positioning, and menu items were chosen based upon the needs of the user. In addition, the actual program sections and subsections were created and given titles. Finally, the objectives and glossary code was automatically generated based on simple text box entries. In this way, a functioning framework was generated, coded, and displayed with little programming effort, therefore allowing more time to be spent customizing the content of the application.

After the application was broken down into sections, the overall look and feel of the software was decided upon. Drawing from several sources and the default corporation theme, appropriate graphics were decided upon. A compromise was reached, providing for graphics that were both flashy enough to keep the attention of the user while being subtle enough that they did not overpower the content of the application. Coordination was the key in this process. To this end buttons, backgrounds, panels, and display boxes were drawn to provide an overall sense of unity of design. The program's outer interface would remain unchanged while the content at the center of attention would change based on the section being studied. Figure 1.1 shows the main training program interface as well as the graphic used for the oscilloscope throughout the application.

Navigation within the application is accomplished in two ways: a navigation panel with useful buttons and two sets of forward/back arrows. The navigation panel extends along the left hand side of the screen, and due to its coloration and distinct appearance, captures the users eye without overwhelming the information presented in the main area of the screen. The user is presented with a number of navigation buttons, each of which is labeled at the top of the screen as the mouse is moved over them. In this way, the user is able to choose the area of the program to explore. These areas are chosen for their global nature and do not necessarily reflect specific sections within the application. Each of these buttons will be explained in detail in the following sections.

The second group of navigation buttons—two sets of forward and back arrows—control which section of the program the user is viewing at the time. These buttons were graphically represented as double arrows to provide the visual understanding of a larger leap forward or backward within the framework. Beneath these was another pair of buttons, each represented by a single arrow, which would allow the user to move forward and backward between the subpages of a particular section. A small text area appears in the upper right hand side of the application that displays the user's current section and page within that section to better aid the user in keeping track of their current position within the application. Coupled with labels above the arrow buttons, the entire navigation process is presented succinctly and intuitively with appropriate graphics.

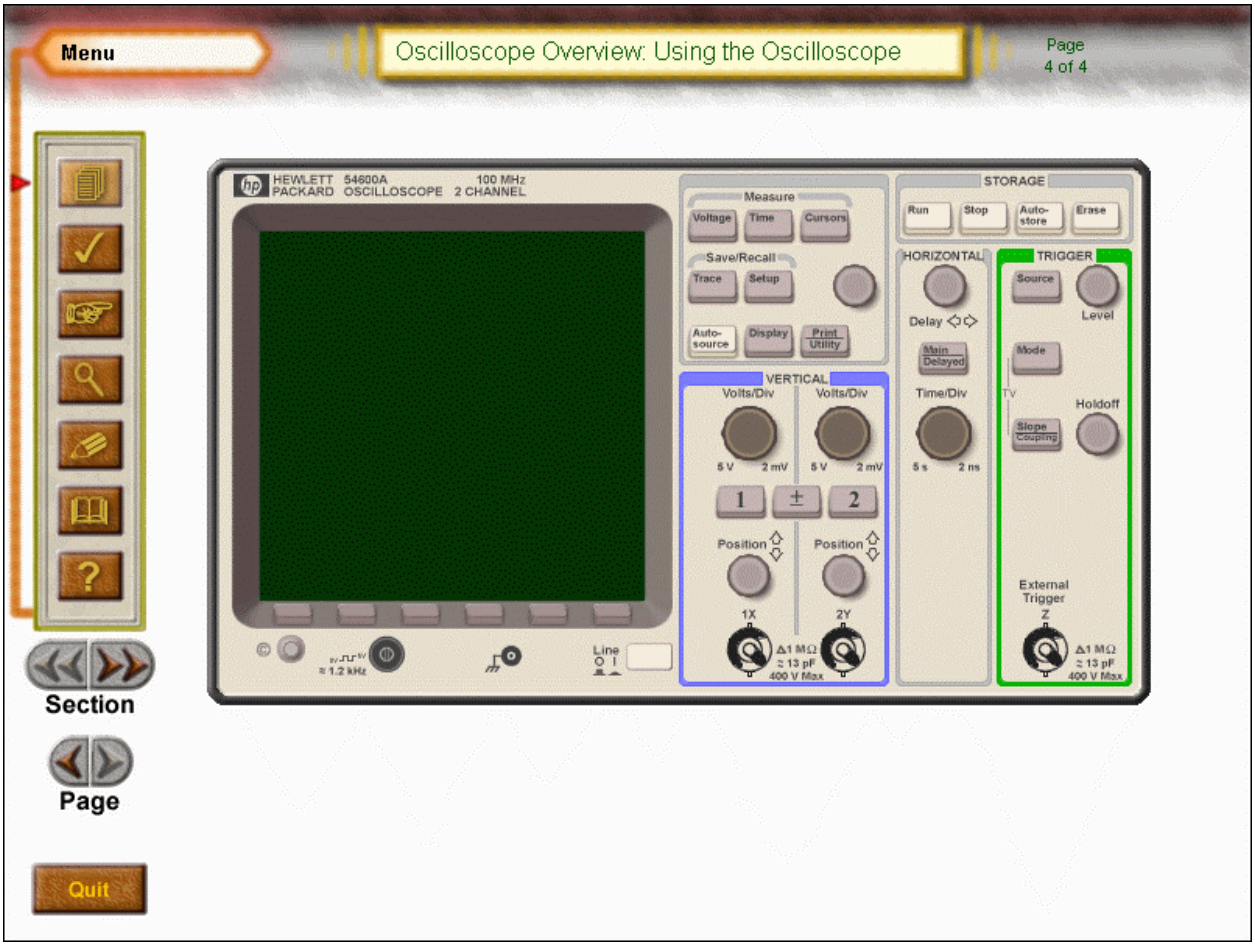

Figure 1.1 – The main navigation screen of the application, showing the oscilloscope graphic used for the entire program.

B. Global Menu Selection

One of the features created by the application knowledge object, is a collapsible navigation menu. The first button on the navigation panel brings up this screen, shown in Figure 1.2 below. By using this, the user is able to instantly go to almost any section and page within the application by the click of one button. This provides a quick and easy way for the advanced user to find exactly the information he needs and go to it instantly. In this way, support for those who have used an oscilloscope or who are familiar with the software is maintained, providing for a high amount of reusability for the package.

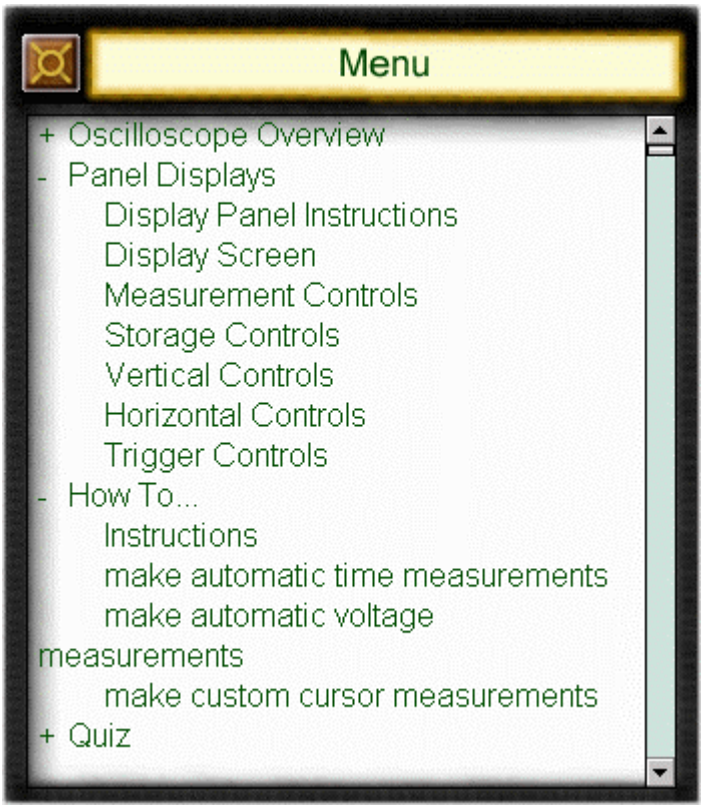

Figure 1.2 – The menu screen which allows users to navigate at the touch of a single button.

C. “How-To” Section

There will be times when a user is familiar with the use of an oscilloscope but simply needs a refresher on how to perform a certain task. There will be times also when a new user will wish to find out the best way to take a certain measurement, having only passing familiarity with the instrument in question. In both of these cases, the solution is to use the “How-to” section of the oscilloscope application. It is designed with the intention of providing an expedient way to find an answer to a particular problem or method of performing a particular function.

When the navigation “How-to” button is pressed, a screen is opened, providing a selection screen similar in format to the menu screen. This is done to provide consistency to the program, preventing the need to relearn how to use various sections. The “How-to” screen consists of the headings for the how-to sections, each of which is broken down into specific tasks within a given selection. For instance, there is a section on “How to take voltage measurements.” Within this section are tasks relating to taking peak-to-peak measurements, average measurements, and rms measurements. Utilizing the “How-to” menu screen, the user is able to instantly go to the exact help that they need.

Each of the “How-to” sections is set up the same way graphically. In addition to the global navigation arrows along the left hand side, a new set of subpage navigation controls is included within the how-to area itself. These buttons—one forward and one back—provide a way to

navigate within a particular how-to section, such as taking voltage measurements. Once the user is within the “How-to” section, using the global page navigation arrows in tandem with the subpage navigation arrows will allow quick access to all parts of the “How-to” Section.

The layout of the information in each “How-to” page is prepared to maximize the interaction between the user and the application. In addition to just providing a step-by-step set of instructions, the user is encouraged to follow these steps on the simulated control panels provided by the application. Buttons are represented as they would be on the actual oscilloscope, and the device navigation buttons are accurately represented graphically as well. By providing accurate visual feedback to the user as he navigates the “How-to” section, the program assures that this information will be easily recalled when working with the actual device in the laboratory.

D. Glossary Layout

It is important for any application which is to be used as a reference to have a glossary. This provides new users with a way to look up unfamiliar terms and experienced users to get quick help with a forgotten term. In this way, the application’s usefulness is expanded two-fold and it is reusable by a larger population. The oscilloscope learning application uses a neatly organized glossary—one that was automatically created by the application knowledge object but is easily expandable by the author of the program.

When the user chooses the glossary navigation button, a double-paned floating screen appears within the application as shown in Figure 1.3. The user is presented with an alphabetical choice along the top of this screen. Down the left hand pane of the screen appears all the terms that begin with the chosen letter of the alphabet. Each time a new letter is chosen, this list is refreshed with all the terms starting with the new letter. Clicking on a word in the left pane will bring up the definition in the right hand pane. If a graphic is associated with the term, then the graphic can also be included in this definition listing. This layout provides a rich interactive glossary which benefits both new and experienced users.

E. Objectives, Find, Bookmark and Help

Several of the panel navigation buttons provide instant information and help, instead of providing a means to navigate the application. These include the objectives, find, and help buttons. Each of these provides a useful function in the application, however, though each is fairly self-contained in a single listing.

The objectives button brings up an itemized list, similar in appearance to the menu screens of the other buttons. As authors of the application, there were several key points that we wanted the user to be aware as the application is used. These are included as objectives on this screen. The objectives are listed in order from the easiest and most basic to more complicated objectives that would take a little while to learn. In this way, the objectives list becomes a mental checklist that the user can use to gauge their progress, providing instant feedback on how much information they have covered.

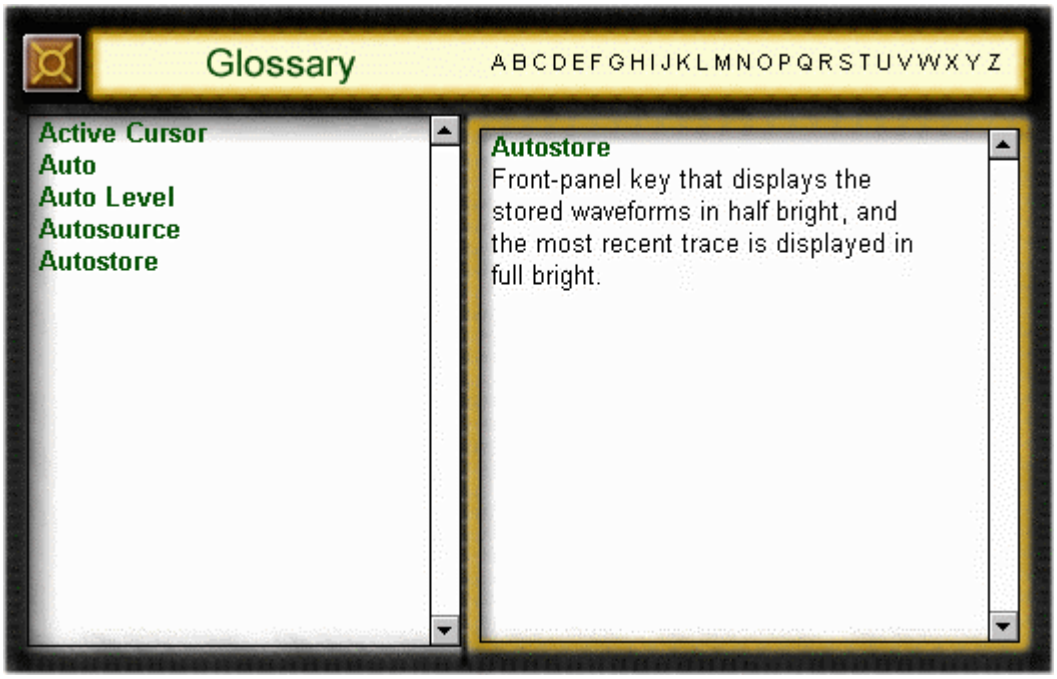

Figure 1.3 – Glossary screen that allows users to lookup information about a specific term related to the oscilloscope.

There are times when a user might be looking for any information about a given topic. The navigation menus might not provide the necessary breakdown for the user to be able to locate the topic quickly and easily. It is at this point that the 'find' feature of the application comes into play. The code for this is automatically generated and maintained by the application knowledge object and is not modified by the author. When the 'find' navigation button is pressed, a small window pops up with a text entry field and a text area field. The user types a word or phrase into the text entry field and clicks the 'find' button. Figure 1.4 shows the 'find' screen after a user has searched for a particular word. At this point, any page within the application containing the entered word or phrase appears in the text area box. The user then chooses which page to navigate to directly by clicking the title of that page in the text area. Using the find feature provides immediate access to any page within the application on the desired topic.

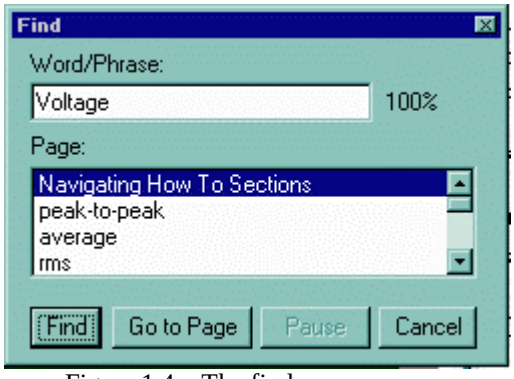

Figure 1.4 – The find screen showing the results of searching for the word 'Voltage' in the application.

An extension of the find feature is the bookmark feature. At any point within the application, the user is able to bookmark a specific page for later reference. This provides another one step navigation to a point of interest. In this case, the user has already determined that a specific page warrants another look or will be used for future reference. With a simple interface, the user is able to add or delete specific pages from the bookmarked list. In this way, the navigation controls may be brought more under user control, and provides for more customization of the interface for a specific need.

The final button on the navigation panel is the help button. While a detailed interactive help section is not part of the application yet, the screen that pops up when this button is pressed is still informative. The graphical layout is similar to all the other screen pop-ups, and provides a list of terms and definitions. These terms and definitions, however, are those used in the actual operation of the program. For instance, explanations for each of the navigation panel buttons are given with their name. Section and page numbers are clearly identified with a purpose, as are the navigation arrows beneath the panel. The help screen is easily expanded to include other help features that users might not understand. Providing a quick help screen such as this, allows users to both learn and refresh their knowledge of the application's features and purpose.

It is the navigation structure of the program that allows the user to move between the sections and pages easily. However, this structure is the framework around the actual information presented in the tutorial. The next section lists in detail the information that the tutorial contains as well as information that can and will be added as the application is expanded.

IV. Information Covered

The informative content of the oscilloscope program is presently contained in four major sections. These sections provide a broad spectrum of choices for the new and experienced user. While new sections may be added as needed, the current areas are sufficient to impart a wide array of knowledge to the user. Each section—*Oscilloscope Overview, Panel Displays, How To,* and the *Quiz*—will be covered separately in the subsections below. Much of the information covered in the program was influenced by the text manuals provided with the oscilloscopes by Hewlett-Packard[5,6] and enhanced for multimedia use.

A. Oscilloscope Overview

The Oscilloscope Overview section is the first section that the user is greeted with. It contains an instruction page as well as general information about the oscilloscope. Due to its nature, this section may be viewed only once, or it may be viewed each time that the program is utilized, as a reminder. There are four pages within this section which are described below.

At a Glance: This is a simple instructional page for the user. It shows the basic navigation of the program as well as a scrollable synopsis of the various navigation tools and sections. The layout of the instructions are similar to that of the other sections in order to maintain the sense of uniformity throughout the piece.

Proper Connections: The main intent of this page is to show the user the proper way to connect signals to the oscilloscope. On the page are three buttons and text to label each. The first button, when pressed, shows an animation of a BNC connector cable connecting to the Channel 1 input. The second button enables the animation showing the cable connecting to the Channel 2 input. The last button shows the animation of the cable connecting to the External Trigger. In this way, the user is shown graphically rather than textually the way to connect cables to the scope, providing a stronger visual reminder for the future.

Front Panel Displays: This section doubles as both an informational page and a link to pages within the *Panel Display* section. The user is presented with a front view of the oscilloscope. As the cursor is moved over the various front panel displays, they change color to indicate which is active. If the user clicks in one of these highlighted areas, he is taken to the appropriate page within the *Panel Display* section. In this way, the page is used as informative or navigational as the user deems necessary.

Using the Oscilloscope: Although unfinished, this page will serve as another information/navigation page similar to the Front Panel Display page. Each of the buttons on the graphically displayed oscilloscope is a functional navigation button. As the application is expanded, each of these buttons will allow the user to get help for a particular button at a glance instead of finding the appropriate panel display first. This will save time for more experienced users who need information on only one button's function.

B. Panel Displays

Half of the informative content of the program is contained within the *Panel Displays* section. Most users will spend more of their learning time in this section, getting multimedia aid on all of the front panel displays and their corresponding front panel keys. The layout for each of the pages within this section is the same and graphically similar to the other pages which present interactive information. The layout is illustrated in Figure 2.1. A subscreen is divided into three panes. The largest pane on the upper left contains a multimedia representation of the panel in question. It appears just as it would on the actual oscilloscope, with working panel key buttons. The panel keys correspond to various menus that appear at the bottom of the oscilloscope screen and are navigated by six soft keys. The bottom pane, which runs across the subscreen, contains a graphical representation of any soft key menu associated with a particular front panel key choice. Along the right hand side is the title of the current panel display as well as a functional description of the soft keys shown in the bottom pane. Navigation through the information is accomplished as a combination between the front panel keys on the panel display and the soft keys on the screen display. A list of the topics covered by the *Panel Displays* section, most containing several soft key menus, is below.

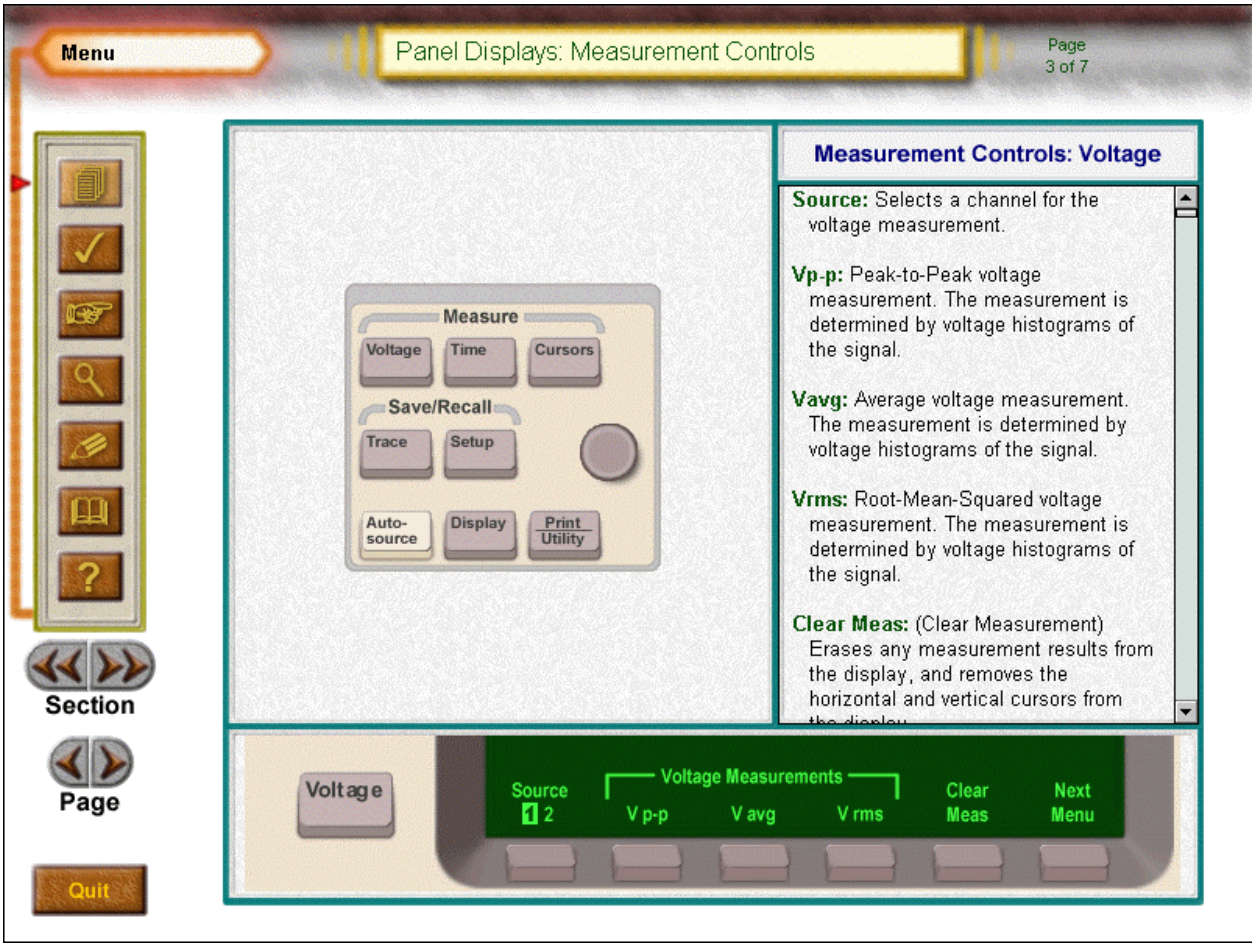

Figure 2.1 – The application window, showing the common layout for finding information about the oscilloscope display screens.

Measurement Panel – Voltage, Time, Cursors, Trace, Setup, Auto-source, Display, Print/Utility. Voltage, Time and Cursors contain instructions on taking these measurements with the oscilloscope. Trace and Setup give information about storing and recalling information on specific screen displays and oscilloscope setup. Auto-source provides a means to display a signal on the oscilloscope with the maximum readability. Display provides a menu for alternate display methods, and the Print/Utility key provides information on how to print out the screen contents.

Vertical Panel – Channel 1, Channel 2, Function. The Channel keys and the Function key, denoted by a ± (plus/minus sign) are used to setup measurement combinations between the two inputs, including fast Fourier transform information.

Horizontal Panel – Main/Delayed. The Main/Delayed key contains choices for how to display the signals on the oscilloscope screen.

Trigger Panel – Source, Mode, Source/Coupling. The keys in the Trigger panel all relate to changing information about how the signal is triggered for display, with respect to the trigger source, mode, and coupling choices

Storage Panel – Run, Stop, Auto-Store, Erase. These keys are used to change the oscilloscope from a run (display) more to a stop (frozen) mode. In addition, traces may be stores or erased with these keys as well.

C. How To Section

Another large source of the informative content of the program is embodied in the interactive *How To* section. Using this section, both new and experienced users are able to quickly and interactively find the specific help needed to perform various tasks relating to the oscilloscope. The subsections within the *How To* section are further divided into How To topics to aid in a more hierarchical structure. The How To section has a layout to maximize the information and interactivity similar to the rest of the application, as shown in Figure 2.2. The main subscreen is a three-paned window again. The right-hand pane is a scrollable set of instructions for performing the task in question. Along the bottom pane is the current soft key menu as it would appear at the bottom of the oscilloscope screen. The large upper left-hand pane contains a graphical representation of the oscilloscope display screen, upon which the results of the how-to instructions can be seen. In this way, the user is able to see what the results should look like for a general case. Providing an interactive multimedia learning experience in this way means that the user will readily remember the information.

The following subsections of How-To topics are covered in depth within the application. Following their descriptions is a list of topics that will be added as the application is expanded in the future.

Time Measurements – Frequency, Period, Duty Cycle, +Width,-Width, Rise Time, Fall Time, Delay, Phase. The How-To section covers every automatic time measurement that the oscilloscope is capable of performing. Some measurements (delay and phase) require that both channels have an input signal for the measurement to work.

Voltage Measurements – Peak-to-Peak, Average, RMS, Maximum, Minimum, Top, Base, Amplitude, Overshoot, Preshoot. Every available type of automatic voltage measurement has a corresponding how-to page associated with it. The purpose of each measurement is described in detail along with the instructions for performing the task.

Cursor Measurements – Time in degrees, Voltage in percent, Frequency in time, Frequency in degrees, Custom fall time, Custom rise time, Voltage in percent. The cursor measurements provide an alternate method of taking customary measurements in time and voltage. Time measurement results may be presented in seconds (sec) or degrees (°), whereas voltage measurements may be taken in volts (v) or percents (%). Each measurement produces the same result, but with a different label. Both are useful for certain tasks, the how-to pages provide detailed instruction for changing the measurement units. In addition, instructions are presented to for taking custom rise and fall time measurements where the cut off values are not at 10% and 90% of the signal amplitude (The default cut off points for most measurements of this nature).

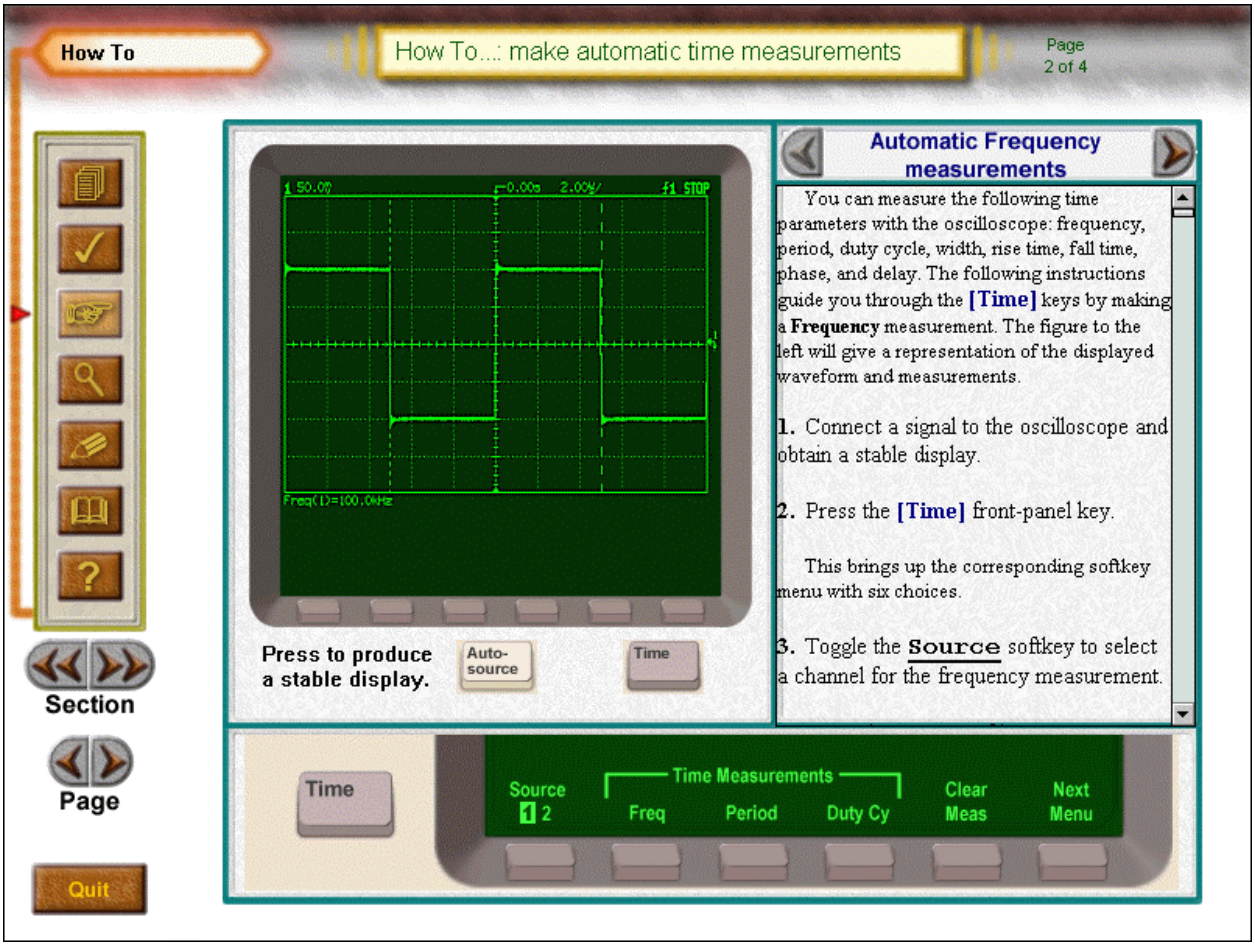

Figure 2.2 – The application window showing the layout for the How-To section of the program.

D. Quiz

The final section that is included with the application at this time, though not implemented yet, is a Quiz. This quiz was included to provide users with an opportunity to test the knowledge that they have learned in accordance with the objectives that were set out in the Objectives menu. In this way, the user is able to gauge his or her knowledge in a quantitative fashion. Macromedia Authorware provides an automatic test generation knowledge object that will be used when the Quiz is finally implemented in the near future.

V. Conclusion

While the multimedia oscilloscope training program is extensive and operational—providing users with a richly interactive environment to learn a complicated piece of engineering measurement equipment—work to improve upon it is certainly ongoing. The goals set forth in the application concept have been met with efficiency, utility, and creativity. A fully functional, easy to navigate learning program such as this will give students and other users an opportunity to go beyond the one-dimensional text manual and into the multi-dimensional realm of computer-aided learning. In order to quickly deal with any problems that might occur through

extensive use, students in the College of Engineering at the University of Cincinnati are already using the software. Changes to the program will be made over time, and these will cover necessary additions to the program (such as the Quiz section), as well as addressing issues via user feedback. In this way, we hope to keep the application informational, up-to-date, and user friendly. It is our hope that our application will change the method by which instructional learning is done at the College of Engineering, by providing inspiration and insight for others to follow.

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JOHN BELLANDO
John Bellando is currently a doctoral student at the University of Cincinnati. He received his B.S. and M.S. in Electrical Engineering from the University of Cincinnati. While conducting his research in the area of artificial neural networks, he has worked part-time as a web and multimedia developer for the College of Engineering at the University, providing support for faculty, staff, and students.

JOSEPH H. NEVIN
Joseph H. Nevin is a Professor of Electrical & Computer Engineering at the University of Cincinnati. He also serves currently as an Assistant Dean and is the director of the College of Engineering Instructional Technology Center. His teaching activities center around analog circuit design and he frequently teaches laboratory courses. His graduate level research is in the field of MEMS.