AC 2012-3434: E-CLOCK: A WIKI-BASED OUTREACH AND RECRUITMENT TOOL

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E-CLOCK: A WIKI-BASED OUTREACH AND RECRUITMENT TOOL

The Electronics Engineering Technology (EET) program has established outreach and recruiting as one of its highest priorities. In addressing this need, the EET program has developed a number of engineering kits that are both challenging and motivational for high school students to learn more about the areas of electronics and telecommunications. The newest of these kits is E-Clock, a small microcontroller-based development system that allows students to accomplish:

- Soldering of both through-hole and surface mount technology
- Use of a wiki-based development resource
- Units and measurement techniques for voltage and resistance
- Software development, programming and testing in the C high level language
- Design and development of expansion kits to add functionality and capability to the basic E-Clock

E-Clock consists of a printed circuit board and approximately 75 through hole and surface mount parts that the student must assemble and test. The price of the kit is low enough that the EET program, through support grants from a major electronics manufacturer, is capable of providing kits for a large number of students who are considering engineering as their choice for a college education. Capturing the attention of these students early and making sure they have a good understanding of the EET program curriculum is expected to increase the application and transfer of top-level students into the program. The E-Clock kit/projects are versatile enough to be used for recruiting/retention/teaching in a variety of different programs in engineering and engineering technology alike.

In addition to the initial building and programming of the basic E-Clock kit, the developers are hopeful that some of the high school students will contribute to the wiki by designing their own advanced kits and generating the new control software. Sharing their work with others via the wiki will allow the project to continue to expand. To support this, the developers plan to create a social communications link via Facebook to allow for increased information sharing and tracking of the high school students as they graduate and enter college.

Initial results will be reported in the paper/presentation based on kits that have been sent to female students who participated in the Krisys Robot Women Explore Engineering (WEE) Workshop hosted by the College of Engineering during the summer of 2011. In addition, the developers are working with a local high school, using E-Clock for both lower- and upper-division students to fully test and evaluate the E-Clock design and wiki-based support and development tools. This will also be presented.
E-CLOCK™: A WIKI-BASED OUTREACH AND RECRUITMENT TOOL

Introduction. The Electronics Engineering Technology (EET) program has established outreach and recruiting as one of its highest priorities. In addressing this need, the EET program has developed a number of engineering kits that are both challenging and motivational for high school students to learn more about the areas of electronics and telecommunications. The newest of these kits is E-Clock™, a small microcontroller-based development system that allows students to accomplish:

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E-Clock™ consists of a printed circuit board and approximately 75 through hole and surface mount parts that the student must assemble and test. The price of the kit is low enough that the EET program, through support grants from a major electronics manufacturer, is capable of providing kits for a large number of students who are considering engineering as their choice for a college education. Capturing the attention of these students early and making sure they have a good understanding of the EET program curriculum is expected to increase the application and transfer of highly qualified students into the program. The E-Clock™ kit/projects are versatile enough to be used for recruiting/retention/teaching in a variety of different programs in engineering and engineering technology alike.

In addition to the initial building and programming of the basic E-Clock™ kit, the developers are hopeful that some of the high school students will contribute to the wiki by designing their own advanced kits and generating the new control software. Sharing their work with others via the wiki will allow the project to continue to expand. To support this, the developers plan to create a social communications link via Facebook to allow for increased information sharing and tracking of the high school students as they graduate and enter college.

Motivation and Support. Enrollment in Electronics-based programs (electrical engineering, electronics engineering technology, etc.) and computer science / software based programs has been declining for a number of years across the US\(^1\). However, enrollments in programs like mechanical engineering have been increasing. One reason for this phenomenon is the opportunity young men and women have to experience mechanically oriented toys such as Legos and other construction kits. In addition to this repeated exposure starting at an early age, other factors such as many of the robot design contests that are held in primary and secondary education are focused on the building of a mechanical apparatus and far less on the electronic circuit design, fabrication and embedded control software development.
When the Electronics Engineering Technology program at Texas A&M University decided to respond to their decreasing enrollments through the development of an active outreach and recruitment initiative, one of the things they chose to do was to develop a new series of hardware/software kits for high school students. In so doing, the program believed that this would provide increased name recognition while providing STEM teachers other options for project-based learning in their classes. By placing more emphasis on the electronic hardware and software algorithm/program development in a structured (non-graphical) programming language, the EET program also hoped to provide rewarding learning experiences for the young men and women and have this influence their selection of majors when applying to the Look College of Engineering at Texas A&M.

This decreasing enrollment in electronics/computer science was also of concern with a major, Texas-based electronics manufacturer. One of the senior VPs within the analog product division saw this decline as an issue that needed to be addressed by his company. Based on a proposal submitted by EET, funding has been received to develop new educational project kits for high school students that will challenge their abilities and interests while providing them valuable skills in engineering prototype development and testing. Two such projects have been initiated and are currently being used in the outreach program of EET. One of these is Krisys; a small form factor autonomous robot that is used for on-campus summer workshops. The second is E-Clock™ shown in Figure 1 with the two students who designed and developed the project. E-Clock™ is a binary clock that is a low-cost embedded controller based development kit that allows students to understand and build a printed circuit board and then program the microcontroller using the C programming language to perform a number of sensor/actuator projects. The lower cost of the E-Clock™ kits together with the wiki-based educational materials makes it an excellent choice for high school STEM teachers to choose as a focus for a number of projects that can span multiple STEM disciplines. In addition, the E-Clock™ kit is something that will be a continual reminder to the students of the EET program and will hopefully encourage them to consider that program when applying to Dwight Look College of Engineering at Texas A&M University.

Two companies have now provided encouragement and financial support to underwrite both the Krisys and E-Clock™ projects. This paper will focus on the design and development of E-Clock™ and its current deployment and preliminary results. As the project moves forward, adding expansion kits to E-Clock™ is something the development team hopes will be forthcoming from the high school students. Sharing their successes on the E-Clock™ wiki will add another outreach and recruitment aspect.

**E-Clock™ Design.** As part of a summer research experience, the two EET undergraduate students shown in Figure 1 were charged with designing and developing a new outreach and recruiting tool for the EET program. The overall requirements for this new tool were:
• Low cost – so that kits could be given to high school students interested in enrolling in the Look College of Engineering at Texas A&M University,
• Focus on electronics and software design/development – the project should introduce or extend the current interest of the student in these areas,
• Memorable experience – the project must result in something that the high school student would see and use on a daily basis,
• Challenging and Educational – the project needed to be something that would motivate and challenge a student but also provide an opportunity to learn valuable engineering skills,
• Expandable – the project should provide the opportunity for the student to expand the capabilities and uses of the kit, and
• On-line support – all aspects of the project needed to be supportable using an on-line approach, preferably a wiki for the dissemination of teaching materials and as a resource to encourage collaboration and continued development.

Using the project requirements, the students looked at a number of possibilities, but quickly migrated to the concept of a clock. Because both students had recently completed their sophomore-level digital design course, they wanted to develop a binary clock with an alarm function that played the Aggie War Hymn. They believed that this project would be one that the high school student could build and use in and of itself, but also take advantage of its development board characteristics to support course projects or their own interest in embedded controllers, hardware design and software development.

With this as the basic concept for the microcontroller development board, the students developed their own set of performance specifications for the kit. Their selection of the microcontroller was made based on costs, software development environment support, and a number of input/output capabilities including digital I/O, analog to digital conversion, PWM waveform generation, USB port, and other pins that could be redefined as to function. It was also a desire of the design team to have a 16-bit internal architecture to support more robust expansion projects.

As depicted in Figure 2, E-Clock™ employs a digital readout for time which indicates the Hours, the Tens of Minutes, and the Minutes. Each of the three rings is used for one of these time elements. The outer ring, designated using Red LEDs, indicates the current hour. The middle ring, designated using Yellow LEDs indicates the Ten of Minutes, and the inner ring, designated using Green LEDs indicates the number of Minutes for the current time.

An example may be helpful in fully understanding how to tell time using the E-CLOCK™ digital time readout. If the current time was 9:58, the outer rings Red LED at the 9 position would be illuminated indicating the current hour is 9. The middle ring’s Yellow LED at the 5 position would be illuminated indicating that the Tens of Minutes is 5; and the

Figure 2. E-Clock™.
inner ring’s Green LED at the 8 position would be illuminated indicating that Minutes is 8. Thus reading the three rings would provide 9 Hours, 5 Tens of Minutes, and 8 Minutes which provides 9:58 as the current time.

**Hardware.** The design of E-Clock™ has undergone a number of iterations to provide the best performance and aesthetics for outreach and recruitment, along with expansion and teaching capabilities. In the design of the hardware system, the designers first considered the soldering capabilities of their primary audience – high school students. The board allows the teaching of both surface mount and through-hole soldering techniques and uses components that are sized for beginners. The two undergraduate students first did a functional block diagram design of E-Clock™. From this system definition, the student charged with the hardware portion of the project completed the schematic capture and board layout using EagleCad design tools.

**Schematics** – One of the major design considerations was the testing and expansion capabilities of the E-Clock™ project. E-Clock™’s primary purpose, of course, is to keep and display time through the use of LEDs. As shown in Figure 3, the LEDs were arranged in a row and column matrix so that only 15 digital signals (12 X and 3 Y) are needed to control the state (ON/OFF) of up to 36 different LEDs. To create the effect of up to three LEDs being on at the same time, the control software strobes the Y signals for a short period of time. Each light is turned on for a duty cycle (that can be varied) at a frequency of approximately 250 Hz. By varying the duty cycle of the Y signals, the intensity of the LEDs can also be varied.

![Figure 3. LED Matrix.](image)

As depicted in Figure 4, the E-Clock™ PCB also hosts circuitry for expansion and measuring. Digital and analog headers provide for system expansion. This allows a standard module to be set onto the board without the need of jumpers. This section of the board also features the signals needed for a USB module. The headers in this section are accompanied by regulated power at both 5 volts and 3.3 volts. Another portion of the circuitry, which supports future expansion and additions to the board, is the MOSFET transistor package. By including two MOSFET transistors on the E-Clock™ board, an ability to create PWM signals and control for devices such as motors and speakers is available and controllable via software. Use of the MOSFETs already includes the control of two small motors, and the small annunciator that plays
the Aggie War Hymn. By using a pair of headers connected to the MOSFET Drain pins, it is straightforward process to plug various electronic devices directly onto the E-Clock™.

Finally, E-Clock™ provides the capabilities to educate using various test points. The test points include a trim resistor and an LED. Students will be able to jumper between either the analog or digital pins directly to varying DC voltage. They also have the ability to jumper a PWM signal from the MOSFET to these points.

For its basic functions, E-Clock™ requires supporting circuitry. These electronics include an oscillator, the basic circuit for the PicKit programmer, and components for the regulation of power. The oscillator requires two 15pF capacitors. The circuit to support the programming headers is also simple, including only a resistor and capacitor.

The power management system shown in Figure 5 is slightly more complex due to its requirement to include multiple voltages for expansion purposes. That being stated, E-Clock™ provides two voltage regulators for 3.3 and 5 volts, respectively. This regulation is introduced after the supply voltage has been filtered through a capacitor and a protection diode. The diode allows for the addition of a battery. Even with a battery connected, this power will only be used if power from a wall wart drops below a certain value. This circuitry also allows the clock to continue operation during a power failure.
**Board Layout** – The final board layout and a fully populated E-Clock™ board are shown in Figure 6. E-Clock™ is a four-layer board with electronic components placed to support future expansion capabilities. E-Clock™’s board layout is unique due to its primary function of operating as an alarm clock. In order to prevent confusion, the clock face features the LEDs and silkscreen without any traces on the top layer. This requirement to hide traces was the major factor in selecting a four-layer design format. For the LED array to be properly arranged, multiple selection (X) and strobe (Y) signals are routed through the other layers of the clock face.

The Pic24F is a sixty-four pin device, offering a huge opportunity for expansion. To make use of each pin, there was a need to divide the pins into specific groups. By using multiple headers with uniformed spacing, the pins can also be used with standard modules. The MOSFETs, which are included in the E-Clock™’s expansion area, are located near the center of the board. This allows for multiple motors to be plugged in equidistant from both edges. This control capability has already been tested with a robotics platform. The test points are also located in the area designated for expansion, as they need to be isolated from the switch controls and expansion headers.

Control switches and LEDs that display the mode occupy the bottom left corner, so as to prevent confusion between the other LEDs on E-Clock™. Located on the opposite corner is the power management circuitry, which offers a locking power jack for wall sources. The isolation of power management on this side allows measurements and testing processes to be made more easily. In addition to power from a wall source, E-Clock™ also can be battery operated. The power pack that is included with E-Clock™ fastens to the backside of the board and becomes the stand for E-Clock™.
Bill of Materials – Another aspect which allows E-Clock™ to be a main promoter of the EET program is the cost of parts and board. The bill of material for E-Clock™, shown in Figure 7, indicates that it is a relatively inexpensive means to promote the educational program. When ordering in quantity, the electronic parts for each board can be purchased for approximately fourteen dollars. The board itself is priced around eleven dollars. At an overall cost of twenty five dollars per kit, the EET program can provide these to students interested in joining the program as a freshman at a later date. With the base kit price being below thirty dollars, the program can also consider sponsoring expansion kits such as motors, annunciators, or other modules to encourage high school students to use E-Clock™ as a hardware and software development platform as well as an interesting clock.

Table 1. Bill of Materials.

<table>
<thead>
<tr>
<th>Description</th>
<th>Partboard Reference</th>
<th>Quantity / Kit</th>
<th>Price Per Part</th>
<th>Distributor</th>
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<tbody>
<tr>
<td>6 mm Tactile Switch</td>
<td>HOURS,MINUTES,MODE</td>
<td>3</td>
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<td>Mouser</td>
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<td>MOSFET Power SO-8 SGL N-CH 2.5V</td>
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</tr>
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<td>$0.080</td>
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<tr>
<td>SMD 1/8watt 150 ohms</td>
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<tr>
<td>SMD 1/8watt 1 Mohms</td>
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<tr>
<td>Capacitor SMD/SMT 0.1uF</td>
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<td>$0.050</td>
<td>Mouser</td>
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<tr>
<td>Capacitor SMD/SMT 100 uf</td>
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<td>$0.590</td>
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<tr>
<td>Capacitor SMD/SMT 15pF</td>
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<td>$0.040</td>
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<tr>
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<td>$0.630</td>
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<tr>
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<td>$0.470</td>
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<tr>
<td>VREG 3.3V</td>
<td>VR1</td>
<td>1</td>
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<td>DC Power Connectors 2.0mm</td>
<td>S</td>
<td>1</td>
<td>$0.840</td>
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<td>Diode (Power Switching)</td>
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<td>Header 1x40</td>
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<td>12</td>
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<td>Battery Holder</td>
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<td>Wall-Watt</td>
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<td>$3.54</td>
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Software. To support software development on E-Clock™, a basic software framework with supplementary utilities was designed and created. This approach was taken in order to provide room for future expansion by outside developers. In addition, all the files have been documented so that new developers can get up-to-speed quickly.

The E-Clock™ software framework was designed using an event driven software base for implementing functionality for the E-Clock™. This design was chosen because it simplifies the process of developing code for the device, and allows developers to approach embedded software development in an object oriented manner. The design structure is versatile, allowing developers at all levels of expertise to create applications and incorporate additional functionality into E-Clock™ quickly. The E-Clock™ software framework empowers the developer to rapidly create E-Clock™ applications and have an enjoyable experience learning embedded software development.

Modular development – The E-Clock™ software framework was designed with expansion and young developers in mind. A modular approach was used when developing the code so that developers could begin adding additional functionality quickly without having to first acquire a complete understanding of the entire system. The modular approach also aids substantially when debugging code. Bugs are confined and so hours aren’t spent hunting through lines of code in order to fix problems. Another benefit that the modular design offers is the ease of expandability. The framework includes a wide variety of device drivers and utility functions that can be used to create different modes of operation as well as modules that can be used to interface with the microcontroller, all without having to modify the basic framework. This also allows for new modules to be easily shared and integrated amongst other developers that are using the E-Clock™ software framework. Advanced developers can still create new drivers and use any unused features and peripherals of the microcontroller without affecting the framework significantly.

Concurrent Modes of Operation – As delivered, the framework can accommodate 8 concurrent modes of operation. This is not a hard limit though. With a few modifications to the framework, the system is capable of supporting a larger number of modes. It is only limited by the processing power of the PIC microcontroller and the developer’s creativity in indicating which mode that E-Clock™ is in.

Events – To provide the illusion of mode concurrency, the E-Clock™ software framework utilizes polling via Events. These Events give developers a level of abstraction from the embedded subsystem, easing design, and offering them versatility in their software development. The Events are broken down into two main subgroups: everyEvents and whenEvents. everyEvents are time dependent, regularly occurring Events, whenEvents on the other hand are Events which occur irrespective of time, much like an interrupt. With the exception of whenSystemAlarmMatched, whenEvents affect only one mode. Also of note are the keystroke events, which affect only the currently active mode.

Interfacing with the hardware – The E-Clock™ software framework easily adapts to developers of all programming abilities, whether novice or expert. It does this by offering various levels of system control ranging from low-level drivers up to high-level control functions.
Low-level drivers
The framework has implemented many system drivers, allowing control of all aspects of the E-Clock™ hardware directly. These drivers provide fine control of the E-Clock™'s features and peripherals without having to do PIC-level code development. Drivers have been written for the display, the buttons, the expansion ports, the alarm outputs, and the internal timing devices.

Mid-level utility functions
Many mid-level utility functions have been provided in the framework to simplify some aspects of the E-Clock™ code development. These utility functions provide the power of the low-level drivers, but with the ease and usability of the high-level control functions. Many type-specific converters are included in addition to functions to execute simple date- and time-related arithmetic and normalization. Also included are getters, setters, and query functions for nearly all system parameters and peripherals.

High-level control functions
The high-level control functions combine drivers, utility functions, and other control functions, in order to get quick functionality from the system. These functions consolidate frequently used code snippets and other useful actions into a library of high-level E-Clock™ control functions. These include updating the display with various time and date related information and configuring various system properties.

User Library – The E-Clock™ User Library is a collection of high-level control functions geared to simplifying code development for beginning E-Clock™ developers. The library includes functions that update the display with various time- and date-related information and ones that allow configuring of various system properties. In addition to these, several fully functioning modes have been included so that developers will have a starting point and source of inspiration for future development.

Example Modes
To get beginning developers up and running quickly, several example modes have been included in the E-Clock™ User Library. These modes are basic applications that provide useful functionality to the device. Accompanying these modes are Wiki pages that document their usage and breakdown the process of software development using the respective mode as an example. In Clock Mode, E-Clock™ functions as a standard digital clock, showing the hours and minutes on the display as well as a flashing "second" indicator. In Date Mode, E-Clock™ functions as a digital calendar, showing the month and day on the display. Set Alarm Mode is used to configure the time that E-Clock™ will generate an alarm. When in Timer Mode, E-Clock™ functions as a countdown timer, and when in Stopwatch Mode, E-Clock™ functions as a basic stopwatch with half second resolution. Set Brightness Mode is used to configure the brightness of the LEDs on the E-Clock™ face.
**Date and Time Configuration**
Included in the library are functions that incrementally configure the system's date and time. These functions will typically be used in conjunction with keystrokes and other whenEvents. These functions also provide Date and Time rollover protection, guarding against invalid date and time values.

**Displaying Date and Time Information**
Several functions are included that update the display with various date and time information. Most are in the form updateDisplayWithSystemValueAndValue. These functions update the current mode's display register (containing information to display on the clock face) with the system's Value and Value. When used with everyEvents, these functions serve as useful display refreshers.

**Configuring Display Brightness**
Much like with Date and Time Configuration, functions have been included in the E-Clock™ User Library that configure the display brightness incrementally. These functions are also best used in conjunction with keystrokes and other whenEvents.

*Support for expansion* – Expanding the basic E-Clock™ kit is relatively simple. All unused pins have been mapped to pin headers just for this purpose. There are 23 expansion ports/pins, broken down as follows:
- 8 general purpose digital input/output (I/O) pins
- 4 analog input pins
- 6 remappable pins (can function as digital I/O, analog input, or be mapped to one of the internal peripherals)

These additional ports allow E-Clock™ to be interfaced with almost any expansion module, making the devices capabilities limitless. When used with a breadboard, E-Clock™ also functions as a handy digital control toolkit.

The software is just as easy to expand as the hardware. Care was taken to minimize the framework’s footprint on the microcontroller in order to maximize the developer’s freedom concerning the PIC’s peripherals. This gives the developer unhindered access to all aspects of the embedded device. Additional drivers can be written without conflicting with the basic framework and additional modules can seamlessly be integrated into the existing design.

In designing the framework, first time developers were kept in mind. Many of the C programming language constructs and device support files were encapsulated into beginner-friendly modules that will allow for E-Clock™ development with a minimal understanding of C. When used in conjunction with the E-Clock™ User Library, rapid development becomes possible. These quick results keep new developers interested instead of becoming discouraged due to early failures; however, these beginner modules do not hinder more experienced developers in any way.

**Deployment Strategy**. It is not difficult to develop kits that can be provided to high school students to use in their STEM activities, the real hurdle is how to deploy this technology and then support it in the field with a small group of college students that will be graduating on a regular
basis. The secret to this part of the process is to have solid hardware and software designs and then support these designs with good documentation and learning tools.

The EET program had tried to support their Krisys robot project using a series of web pages prior to the development of E-Clock\textsuperscript{TM}. This approach met with limited success for a number of reasons including the level of effort required to update and add web pages. To reduce this overhead, the EET program decided to employ a wiki environment for its E-Clock\textsuperscript{TM} project\textsuperscript{4}. The wiki pages have been created in parallel to the hardware/software design and implementation and, therefore, reflect the feedback that has been received from those high school students who have participated as beta testers for the 40+ E-Clock\textsuperscript{TM} kits that have been currently distributed.

Wiki-based instruction / feedback – While the hardware and software design of E-Clock\textsuperscript{TM} are critical to the overall success and functionality of the project, the deployment strategy that accompanies the platform is equally important. The industry is riddled with excellent products that have had limited success due to weak deployment strategies characterized by poor or outdated documentation, insufficient customer service, or inadequate support material. With E-Clock\textsuperscript{TM}, the goal was to develop an all-inclusive online wiki-based solution that provides both technical material and customer support. This implementation should be robust, scalable, user-friendly, and strive to remedy the weaknesses found in other product support packages mentioned above.

The cornerstone of the E-Clock\textsuperscript{TM} deployment strategy is the wiki-based website. Wikis, which gained popularity in early 2000, are websites that can be easily modified or edited through the use of a markup language or a rich-text editor. The most defining feature of Wikis is the fact that their content can be altered by their user base. The best example of this is Wikipedia, a free online encyclopedia that contains over 20 million articles created by its users. Wiki websites are ideal for sharing information and hosting support material due to their simple but straightforward layout, ease of access, host of features, and easily editable and updatable content.

The main way that the wiki-based approach solves problems like unreliable customer support and outdated documentation is through the integration of the user base, or customers, into the website. Users can add examples of their own projects or code, ask questions, or request updated documentation from the administrators. The fact that users can contribute to the content and the quality of the website creates an enjoyable and collaborative experience that stimulates the development and expands the scope of the project. Documents and information are also maintained and kept up to date on a much more regular basis than standard websites, since the user base is constantly using and modifying the online material. Furthermore, online content can be corrected, updated, and distributed in a much faster and cost-effective manner than its paper counterpart.

Upon navigation to the E-Clock\textsuperscript{TM} wiki homepage, the user is greeted with the Main Page of the website shown in Figure 7. The Main Page is used to give an overview of the website, and provide a framework for the website layout and the organization of the site’s content. The navigation pane on the left-hand side of the page provides links to pages that contain that primary content of the project, such as “Getting Started”, “Advanced Kits”, and “FAQ.” The
Main Page also gives the user access to their account, contact information, and a variety of other features. Furthermore, the simple and standard design of the wiki places the focal point of the website on the content and the layout of information.

Wiki sites are also based on the principle of access control – the user can only edit and modify those parts of the website to which they have been given authorization. Access control is critical to the integrity and security of the website since it prevents users from changing the layout of the website, deleting content, or adding false or incorrect information. For the E-Clock™ wiki, the administrators maintain root control over the website - only they can edit the layout, censor content, or maintain documents. Furthermore, only administrators can create and authorize user and guest accounts. On the middle level, testers and senior users can edit content and maintain some of the other features of the website. Regular users may only contribute to the parts of the website to which they have been given access. This system of access control helps create a secure website that still allows for the sharing and updating of project information.

The E-Clock™ wiki website was not the first wiki created and maintained within the EET program. Rather, it represented a refined effort of using an editable, online platform to share project information. The EET program has used wikis to support various classes, ranging from sophomore to senior-level. Wikis have also been used extensively to support summer outreach.
programs and various educational summits. The best example of this is the Krisys Summer Workshops that were offered over the summer of 2011. The Krisys Workshops were used for outreach and recruiting for various high school students. Students visit Texas A&M for a workweek. During that experience, they build their own robots, soldering a control board, constructing a platform, and programming the embedded microcontroller. The workshops are then concluded by a final competition, where all the participants race their robots and compete to earn the best time.

The Krisys Summer Workshops, although taught by students and supervised by professors, were completely supported through a wiki. The wiki for the workshops contained all the hardware and software documentation, platform manuals, source code, and files and utilities that were needed to successfully build and race a robot. Furthermore, each team of students was given their own wiki page that they could edit and build to describe their team and their robot. While the teams could edit and maintain their own page, they could not edit the other teams’ pages or any other part of the wiki.

The Krisys Summer Workshops Wiki proved to be an excellent resource for hosting and sharing information, offering project guidance, and showcasing the robots that were designed by the student teams. Furthermore, the wiki served as a scalable and cost-effective alternative to published or handwritten material, allowing the documentation, source code, and reference material to be easily maintained and circulated. The success of the wiki was one of the main reasons that it was chosen to be the primary support resource for the E-Clock™ project. Since the E-Clock™ will be distributed nationwide, the wiki creates an environment where ideas, information, and updates can be shared between different users without the need for physical interaction, all the while developing and extending the capabilities and functionality of the E-Clock™ project.

**Krisys Summer Workshops** – During our Krisys Summer workshops, a number of students asked about purchasing a Krisys robot kit so that they could continue their interests in electronic fabrication and testing as well as algorithm design and software development. Although this would have real benefit in continuing the outreach activity, providing Krisys robot kits in this manner is cost prohibitive for the EET program. This is one of the reasons the E-Clock™ kit was developed by EET undergraduate students. Based on their high level of interest and commitment to participate, seven high school students were then selected to assist in the beta testing of the E-Clock™ kit. These students, although part of the same workshop, were not from the same high schools nor did they have any previous association. This gave the development team the opportunity to evaluate the E-Clock™ wiki as both a source of information and as a vehicle for asynchronous help and assistance.

**STEM High School Teacher Outreach** – A small number of E-Clock™ kits have been provided to high school STEM teachers for use in their courses. The feedback that has been received thus far is that doing surface mount technology soldering is far more difficult and demanding than what is required for through-hole soldering. This deployment has allowed the EET program to better inform new STEM teachers on what they will need to provide in terms of fabrication and testing resources. The deployment has also demonstrated difficulties in accessing (content blocking) wiki video information from some high school computers over the internet. Based on
the pilot project that involved five high school students, the EET program is currently delivering another ten units to a STEM teacher to use in two of his technology courses. This group of ten students will be the final beta testers before beginning its first major deployment.

*Early Results* – E-Clock™ is just starting to be moved into the high school STEM environment. The first major evaluation of the success E-Clock™ will have as a recruiting and outreach tool will be from the interaction and feedback that comes from the ten kits being provided to a STEM teacher for his advanced computer classes. Having the opportunity to support the twenty students in these classes through the wiki-based knowledgebase should provide additional quantitative and qualitative assessment. These data will be added to the report and presented at the conference.

**Future Activities.** Based on early successes, the EET program is pleased with the ability to leverage E-Clock™ as a recruiting and outreach project capable of meeting our goals. The major areas for future work include full deployment of E-Clock™, adding to the basic kit with expansion kits, and continuing to improve the project and associated documentation. The goal will be to identify at least ten different STEM high school teachers who will participate in the E-Clock™ initiative by integrating the kit into their course each year. The development team wishes to identify five of these teachers during the Spring 2012 semester and begin interactions with the remaining five or more teachers during the Summer/Fall semesters. A STEM Teacher Summit will be held at Texas A&M University in late January. The summit includes approximately 100 high school Science, Technology, Engineering and Math teachers who attend the summit. Offering of a three-hour workshop will allow the team to meet and interact with over 100 STEM teachers across the state. This opportunity should provide the desired interest and participation.

In addition to developing relationships with high school STEM teachers, the team also plans to incorporate opportunities for other undergraduate students to become involved in the E-Clock™ activities. Having other students building/using E-Clock™ as a development platform will provide a new resource to create expansions modules/kits for our outreach and recruiting activities. The more interesting things that can be done using E-Clock™, the more name recognition and interaction the team should be able to generate. Motivations for the undergraduate students could be a cash award for the best expansion kit, etc.

**Conclusions and Recommendations.** As with many engineering/technology programs across the nation, decreasing enrollment is a major concern. More than ever, innovative outreach and recruiting is necessary to garner the interest of the young men and women graduating from high school and choosing a university and academic program. These student need to seriously consider engineering as they begin the pursuit of their post-secondary education. Unfortunately, there is not enough fun and exciting projects available to the high school STEM teacher that really demonstrate the cool things engineers do in the areas of electronics, telecommunications, embedded software development, and testing. We need to work towards correcting this problem. E-Clock™ with its wiki-based development and support knowledgebase is one of the steps that the EET program at Texas A&M is taking.
References


Biographies

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