**TekBots: Enabling Electrical Engineering Education with Application during a Four Year Program**

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**Introduction**

The TekBot™ Platform for Learning™ (PFL) is a tool designed to take traditional laboratory experiences and improve their effectiveness and complexity. A Platform for Learning is any object, software, or concept that is used to unify a curriculum. In an entrepreneurial program it might be a business plan; in electrical engineering, a robot; and in computer science a computer program. The key features of any of these platforms need to be: personal ownership, curriculum continuity, context, active learning, and fun. A student needs to feel ownership of the platform, and through the platform, an ownership of what they have learned. The platform should also fit with what a student is learning when they are learning it and should connect knowledge across different courses to show the ‘hidden’ connections between topic areas. A platform that students can interact with and that is enjoyable to interact with adds many dimensions to the platform[3].

Traditional ‘one off labs’ give and application for student to explore the lecture material but often fall short in showing how the connections in the material between different courses. This missing systems perspective creates engineering without a grasp of project engineering as a whole. Such an engineer may try to persistently use a single previously learned approach to a problem when a different approach may yield a better result. To best support the TekBots curriculum, better trained teaching assistants are needed. These training paradigms are as important as the materials used and in many cases are more important.

**Educational Hardware Design**

To approach the concept of application in electrical engineering courses, there needs to be consideration given to effectiveness, ease of use, and flexibility. These three traits shape educational hardware design. Materials used in courses need to support the material being taught in lecture. If the application does not support the lecture material, it will be ineffective and often actually only reduce student understanding as the student struggles to see understand the relationship. When teaching new material, students’ needs to be able to focus on the information being learned, thus educational hardware needs to be ‘easy to use.’ This does not mean that the materials need to be easy, only that the most difficult elements should be related to what is being taught. For hardware to be able to fully utilized, it must also be flexible. Well taught material will often cause a student to want to explore new and additional knowledge. If the lab materials allow for students to experiment beyond the basic requirements, they build a strong knowledge base and improve their understanding.

The TekBots platform uses a combination of in-house designed hardware and software focused on these three attributes of educational hardware. For example the TekBots motor controller board could be replaced by a single integrated chip solution. Instead the board given to students involves a discrete component implementation of the circuit. This gives opportunities for the associated course (in analog circuits) to probe and explore the circuit.
Effective Instructional Techniques

The TekBot Platform for Learning helps instructors use the following four strategies: active learning, technology enhancement, just-in-time learning, and curriculum integration. Active learning gives students an opportunity to practice minimizing digital logic using Karnaugh Maps in ECE 271. This helps reinforce the material used to program the digital logic board on the TekBot in ECE 272 [Figure 2]. Technology enhancement allows for students to practice with new technologies. The TekBot in Figure 3 is controlled with Bluetooth through a laptop, and the TekBot in Figure 4 is connected to another Wunderboard using a Zigbee controller. Just-in-time learning adds relevancy to the material being discussed in lecture, because students will be using it that week in lab. Lastly the TekBot allows for concepts to implicitly bridge multiple courses, without alienating transfer students that didn’t take the prior courses. Figures 1-4 show the multiple technologies that can be used to control a TekBot, giving student’s experiences about the inherent abilities and limitations.

With the development of excellent materials there is also the need for development of exceptional teaching staff. The TekBots program encourages the ‘near peer’ mentoring approach hiring and training undergraduate students to act as teaching assistants. This method produces teaching assistants who have a vested interest in student performance. The selected teaching assistants called ‘peer mentors’ develop strong leadership skills and technical excellence. They create a group of ‘ideal’ role models for incoming students to attempt to model.

Conclusion

The combination of educational hardware and educational techniques can improve student enthusiasm and performance. This partnership of hardware and personnel has been developed over the past decade, and there are many lessons that have been learned during this time that help guide current and future goals for the program.

References

Fig. 1. The TekBot starts as an Analog bumping robot.

Fig. 2. A digital logic board is added to the TekBot, enabling it to be controlled by infrared, TV Remote.

Fig. 3. A Bluetooth module enables this TekBot to be

Fig. 4. This TekBot is controlled by two linked Wunderboards