Appendix
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Using the Book in the Classroom

One of the authors of the book, Steve Decker, teaches at Oregon Episcopal School in Portland, Oregon. He incorporated the material in this book into his Electronics course before it went to press. The following is an account of his classroom experience. He is happy to collaborate with anyone using this book. You may contact him at sdecker@vernier.com.

INTRODUCTION

In late 2009, I taught LabVIEW programming using *Hands-On Introduction to LabVIEW with Vernier* " to a group of 15 seniors and one junior at the Oregon Episcopal School, in Oregon. OES is a private Episcopal school, with both day students from the local community and boarding students from other countries and other parts of the US. I used the Vernier SensorDAQ.

LabVIEW was taught as part of a semester-long Electronics course that is a senior elective, so to some degree the students are self-selected based on interest in science and engineering. The students worked in teams of two on the LabVIEW exercises. The course is lab and project centered and starts with basic conceptual circuit concepts and moves through detailed AC circuit analysis. A centerpiece of the course is a semester-long independent design project, assigned in early September and completed by the end of the semester, that absorbs about 25% of instructional and homework time. The scope of the independent-design project and its implementation techniques are left to the students. For many of the students' projects, LabVIEW and the SensorDAQ could be used to advantage.

TIMING

The LabVIEW unit was placed immediately after an extensive series of conceptual circuits labs, just after the midpoint of the semester, and as the students were moving from system level to detailed design on their independent projects. A copy of this book was distributed to each student, and a heavy emphasis was placed on reading the appropriate chapters before the class session. The unit was set up to take four 50-minute periods to accomplish all eight exercises, and two periods for the project. Groups that were moving faster than the average were encouraged to pursue as many extensions as possible. Classes were organized with 10 minutes of initial lecture about tips and techniques, followed by hands-on work with the exercises, sensors, and SensorDAQ. Students were allowed access to the lab after school to complete work not finished in that day's session. The sessions were divided up as follows:

Session	Allotted Time for Activities	Activity
1	50 minutes	Exercises 1, 2, and 3
2	50 minutes	Exercises 4 and 5
3	50 minutes	Exercises 6 and 7
4	50 minutes	Exercise 8
5	50 minutes	Project day 1
6	60 minutes	Project day 2

The session with Exercises 6 and 7 had a bit too little time, while the one with Exercise 8 was too generous, which surprised me. The high-performance teams completed all exercises in the allotted time. The average team required about an extra hour outside of class, and the slowest team required about two hours outside of class, due in part to some struggles with English. The design challenge project was put at the end of the course. The students were given one 50-minute period and one 60-minute period to complete their chosen design challenge. The 60 minute period included a brief presentation/demo by each team. I added a third design challenge[1] choice that I judged to be intermediate in difficulty between the two in the text—the design of a musical instrument. Again, some teams elected to put in time outside of class, largely because they got absorbed in the project.

EVALUATION OF THE STUDENTS' WORK

The completed exercises and the design challenge were e-mailed to me for evaluation. They were judged on the basis of functionality, appearance, and quality of comments included in the code. My comments were inserted directly into the LabVIEW virtual instrument (VI) and mailed back to the students. The teams were required to make a brief presentation of their design challenge results to the class at the end of the second work period.

Two minor difficulties arose in this process. In Exercise 7, the students need to be reminded to mail in the subVI as well as the VI. In Exercise 8, the DAQ Assistant Express VI did not run on my computer because my SensorDAQ had a device number that was different than the student's[2]. It was easier to evaluate this exercise by looking over the students' shoulders.

DISCUSSION

During both the exercises and the design challenge, the students' engagement level was high, even in the face of some frustration for those who had no programming experience. (Only three of the students had had any programming experience prior to the course. Some teams have been learning microprocessor (Basic) programming on their own as part of their design project.)

The following information came from written anonymous evaluations by students at the end of the unit:

Most students reported a good correlation between the circuit and communications concepts in the earlier weeks of the class and the information flow concepts in LabVIEW.

Some students thought the information would help their independent design project, depending on its nature. I think more students would have benefitted in this area if the unit had been earlier in the semester, before their system level designs were complete.

In terms of timing, most students found the pace a little fast, both on the exercises and on the design challenges. In general, they felt that one more period on the exercises and one more on the design challenges would have been beneficial. The pacing is a tradeoff between keeping the fast groups engaged, and allowing enough to time to let the slower groups have enough success to motivate themselves. If the students could get a version of the software on their personal computers, then some of the material could be pushed into homework time without requiring the students to use out of class time at school on the school computers.

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[1] An outline of this project to create a musical instrument is included on the CD.
[2] An explanation of the device number issue can be found in *Appendix F*.

In the design challenge project, to induce students to challenge themselves, I offered an extra-credit incentive of 30% if they worked on the most difficult challenge (the cell phone DTMF decoder). I offered a variable incentive (up to 30%) for the musical instrument, depending on how far the student took the idea beyond the basic audio instrument of the first challenge. One group went as far as to build external circuitry to make an electric piano. This aspect of the unit needs a bit of tuning; I think the incentive was a bit too high.

Overall, over half the class liked the material in this unit. With one exception, the remainder of the class was neutral towards it. I will definitely include this material again in this course next year, with a few adjustments.