Should we eliminate hands-on laboratories in undergraduate curricula?

Editorial for Sound & Vibration by Raj Singh

"We should eliminate undergraduate labs since they are redundant and resource-intensive. Computational codes, such as CFD (computational fluid dynamics) and finite element analysis (FEA) could be easily employed instead. Videos on youtube may suffice to illustrate difficult subjects or concepts. This would be embraced by students (easy scheduling, no boring labs, early graduation, more time available for thinking) and faculty (lower teaching loads, less grading, more in-depth theoretical courses)."

I share the provocative thought to encourage S&V readers to reflect on their pedagogical approaches, in the digital age, and how we can together best meet the needs of noise and vibration control community.

While there are many different types of lab experiments and measurement goals, instructional experiments tend to fit the following:

(i) Reinforcement of theory or principles covered in lectures;
(ii) learn how do the sensors, signal conditioners and data acquisition systems function;
(iii) explore physical phenomena;
(iv) conduct statistical error analysis;
(v) learn best practices in report writing or safety.

One, these simple experiments are designed to enhance learning objectives, but they may be too rigid and may not allow sufficient freedom to explore alternate settings (e.g. change in the boundary conditions say from the safety standpoint). Two, students often perform pedagogical experiment in groups (with minimal discussion) and often, students are reduced to bystanders. Three, students have historically viewed measurement type labs with prejudice (and less pride) and there is plenty of anecdotal evidence as horrors from the labs get revisited during alumni reunions. Millennials seem to have taken this prejudice to a new level. For instance, they view analog instruments and old fashioned but essential equipment (and the associated report writing) with disdain and in general do not like the slow pace of a 2 to 4 hour lab. Typical comments range from "boring", "tedious" to simply a "waste of time". Ill-prepared or ill-informed teaching assistants add little value, only ensuring that the experiment is completed in the allotted time and focus on knob-turning or button-pushing.

Four, students get repulsed by the idea of a hard-copy lab manual that has to be read ahead of time and then followed. They like to now see instructions via a video.

Five, experimental validation of the material covered in the lectures does not enthuse students. In fact, a well-designed experiment (with minimum deviation from theory) becomes counter-productive as students do not find any excitement. Lengthy report writing and error analysis type of exercises engender dissatisfaction among students and bad evaluations for the teacher and the course. Finally, a student told me that he does not need to know any of experimental issues in industry as he can always access a resource or outsource the work (technicians, suppliers, outside testing companies or even overseas)!

In contrast, many students love simulation and CAE type labs, exercises or demonstrations. Often commercial, large scale codes are used in several courses via homework, course projects or capstone courses. Students are only exposed to pre-processors or canned analysis routines and asked to treat this as a 'black-box' or 'gray-box'. Though they may not understand the underlying theory, assumptions or approximations, computational methods, they tend to believe the colorful results instantaneously. On a positive note, one could easily change material properties, boundary conditions, initial conditions and forcing functions, and compare the results. I suspect that now they want apps for simulations, instead of running these codes on the antiquated workstation or PC.

Interestingly, undergraduates perk up when they are required to perform experiments as part of research work or a capstone project (in a small group setting). This tells us that canned experiments in required or technical electives are dismally viewed no matter how exciting the concept may be.

Are student's attitudes approach to lab work likely to change? Probably not. We must learn to be creative and mix measurements with modeling work. It is easy for an emeritus professor like me to say this, but, as a concerned citizen of the engineering community, we need to have more (not zero) hands-on experience. After all, much of the work in industry relies on operating system and lab tests though attempts are being made to employ digital models or virtual reality simulation to reduce (but not eliminate) prototyping and actual testing.

There are no easy solutions and I welcome your views.

Send your comments to the author at singh.3@osu.edu.