EDITORIAL

How Should We Educate Undergraduates in Sound and Vibration?

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I often receive regular inquiries from industrial organizations to hire undergraduate students with expertise in the topics covered by *Sound & Vibration* magazine. Also, a few professional conferences have requested undergraduate participation in their student paper or poster competitions.

Invariably I tell them that the "supply" of such undergraduates is very limited. Typical dialog between industry representatives and me (and probably other professors at schools with expertise in sound and vibration) goes along the lines of the following:

Company: *We would like to hire three undergraduates from your lab.*

Faculty: What background do you want these students to have in noise and vibration control?

Company: *A lot!*

Faculty: We do not have such students; one student may qualify but he wants to go to the graduate school and learn more.

Company: *Why? He can work for us and then learn what he needs to do via short courses or on-line tutorials.*

Faculty: Feel free to discuss this directly with him.

I will attempt to address the underlying issues presented here and suggest ways to rectify the situation.

First, let me address the curriculum considerations for most accredited undergraduate engineering programs such as in mechanical engineering (www/abet.org, which is the Accreditation Board for Engineering Technology). Total credit hours (say around 120 semester credits) are usually selected to suit the competing needs to actually complete the degree in four calendar years. (But a large majority of students still do not, thereby making some parents unhappy.) And a suitable coverage of subjects (related to basic education in humanities, physics, chemistry, mathematics, engineering principles, computational and experimental methods, engineering design and the like) must be covered.

Many schools are even dropping laboratories from their curriculum and some have trimmed the list of technical elective courses to make room for newer subjects (perhaps driven by research needs) hands-on design, building and testing courses, business-oriented courses, etc. While very desirable, many times these courses do not include the elements of S&V discipline. For instance, many undergraduate programs do not even cover eigenvalue problems for a multi-degree-of-freedom vibrating system as part of their required courses. Therefore, many graduates do not understand computational or experimental modal analysis that is commonly employed in industry.

Second, consider a recent study, *Technology for a Quieter America*,[1] carried out by the National Academy of Engineering. Since the author was involved in writing the major elements of "Education" (Chapter 9) in this report, the following conclusion was reached on p. 125:

> *Because the demand for noise control engineers is much greater than the supply of formally trained engineers, distance education and continuing education play a large role in developing practitioners in the field. The strongest offerings play a valuable role and should be encouraged to continue. However, many offerings compromise quality for expediency or marketability.*

As a solution to this problem, one key recommendation was made on p. 129:

> *Recommendation 9-1: Academic institutions should offer an undergraduate course in noise control engineering, broaden the scope of the engineering curriculum, and increase the pool of engineering graduates who are equipped to design for low-noise emissions. The course could be offered as an elective in a bachelor's degree program or as part of a minor (acoustics or interdisciplinary studies).*

Third, let us pose this question: "Are *S&V* topics of vital importance to industry?" The readers of *S&V* would obviously agree, but how about the engineering profession as a whole?[2] To answer this, we would need to understand the engineering skill sets that are often acquired by an undergraduate student while studying a sound and vibration subject. These include exposure to single- and multi-degree-of-freedom vibration models, eigenvalue problems, transfer functions and forced harmonic responses, wave equation and elementary plane wave or spherical radiation solutions, measurement devices and dB scales, noise and vibration control principles (isolation, damping, absorption, resonators, etc.), basic signal processing tools (including FFT methods) and the like. These constitute life-long skills and they can be applied to many engineering problems.[1,2]

Fourth, how do we find room in the undergraduate curriculum for the all these topics? One way would be to integrate them into required courses, such as dynamic systems, control and measurements, thermodynamics, fluid mechanics, mechanical design and mechanics of solids via interesting case studies, computational exercises, course projects and laboratory experiments. This would allow a wider coverage (though at a relatively lower level) than a dedicated technical elective (which might be attended by fewer students). Interested students can supplement their knowledge by pursuing independent research or enroll in graduate courses.

Let me cite a few successful examples of our efforts at Ohio State. Through a well-defined honors program, we can offer a challenging research topic in vibration and acoustics (or any other subject) to highly motivated undergraduates; there are several enticements for students (such as research scholarships and "graduation with distinction" honor in their diplomas) to pursue these.

Another is the development of a new capstone design course where we have attempted to tackle noise and vibration problems via focus on simulation (CAE) methods. This effort has been funded by General Motors Foundation in 2013-2014 to develop innovative pedagogical methods while creating a culture of simulation. A team of 18 students (under the supervision of two research scientists, aided by two industrial mentors) analyzed brake system modes and steering wheel dynamics from squeal noise and vibration shake, respectively.

Finally, we are also developing a senior-level capstone laboratory course as part of the new B.S. degree curriculum where we synthesize the concepts of energy and mechanical systems via hands-on engineering experiments and problem-solving skills while using modern digital data acquisition and engineering analysis methods. We will discuss this more in detail in future issues of *S&V*.

I appeal to our colleagues in industry, business, and government . . . Please show an interest in undergraduate education and share your resources with local institutions in enriching the learning environment. Otherwise, there may not be any supply of well-educated students in the subjects covered by *Sound & Vibration.*

References

1. *Technology for a Quieter America*, National Academy of Engineering, National Academies Press, http://www.nap.edu, ISBN 978-0-309-15633-2 (pdf) 1, Washington, D.C., 2010.
2. *The Engineer of 2020: Visions of Engineering in the New Century*, National Academy of Engineering). National Academies Press, Washington, D.C., 2004.

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The author has retired from The Ohio State University (with 35 years as an educator) but plans to stay active in the profession we love and cherish. I plan to offer advice via S&V and encourage younger colleagues to start thinking about refined ways to educate and motivate students. I can be reached at: singh.3@osu.edu.