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Capturing the Big Picture: The 2015 Capstone Design Survey

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Although capstone design courses are common across engineering programs, they vary substantially in implementation. In an effort to capture current practices, the first nationwide survey of capstone courses was conducted in 1994. [1] This was followed in 2005 by another nationwide survey [2] to update the data and also to capture trends over time. The 2015 capstone design survey marked the official continuation of the decennial data collection effort with questions on many pedagogical and logistical aspects of capstone design. Some highlights of the data are presented below, providing a big picture context to complement the case-study examples throughout this magazine.

Respondents

A total of 522 respondents, representing 464 distinct departments at 256 institutions, participated in the 2015 survey, all but two of whom had a capstone design course. Of the survey respondents, 14 were from Agricultural and/or Biological Engineering programs; this represents one-third of U.S. institutions with ABET-accredited programs in Agricultural and/or Biological Engineering. An additional 12 respondents noted that they involve Agricultural and/or Biological engineering students in their (multidisciplinary) capstone design courses.

Course Info

Capstone design courses can be structured multiple ways, but the most common approach has been and continues to be to run the design project(s) and class in parallel. The duration of capstone design courses is increasing; more than half of the 2015 survey respondents noted having a 2-semester capstone course, some had even longer durations.

Pedagogy and Evaluation

Capstone courses typically cover a wide range of topics, often geared toward professional preparation. The top five topics selected by respondents to the 2015 survey were written communication, planning/scheduling, oral communication, concept generation/selection, and team building/teamwork. Responses in 1994 and 2005 were similar, also with an emphasis on professional topics. A common debate in capstone design circles is about "product vs. process" – in other words, is the outcome more important than the approach used to achieve it. Data from the 2015 survey form a roughly normal distribution along the product-process spectrum, with the peak located between "balanced" and "slight emphasis on process". Regarding evaluation of student performance, capstone instructors themselves provide the most input, followed by project coaches, industry liaisons, other students, and other faculty. Final reports, presentation, and product have the largest role in evaluation, but process and design reviews are also important.

Faculty and Students

Capstone faculty commonly have previous industrial experience involving engineering design; more than half of the 2015 respondents indicated 6 or more years working in industry, and many respondents had worked for 25 or more years. Capstone design itself is considered as normal teaching activity for tenure and promotion by nearly all respondents to the 2015 survey, but typically very few faculty members (1-2

for more than half of the respondents) receive teaching credit for their involvement in capstone; less than 10% of respondents provide capstone-related teaching credit to all of their departmental faculty. Moreover, student numbers in capstone design (like engineering enrollments in general) have increased from 2005 to 2015; the average capstone enrollment in 2015 was 51, with some respondents noting upwards of 200 students per capstone course cycle.

Projects and Teams

Capstone design projects are sourced from many places, most commonly industry, followed by faculty research. The prevalence of entrepreneurial and service learning projects has increased since 2005 as well. In keeping with rising enrollments, the number of projects per course cycle has increased in the past 10 years; 25% of respondents in 2015 had more than 15 projects concurrently. Team sizes of 3-5 students remain most common.

Expenses and Funding

Typical expenses in capstone courses include project supplies, hardware, and software, among others. While the range of expenses varies significantly by institution, discipline, and especially project, most capstone courses have relatively low breakeven costs. Of the 325 respondents in 2015 who provided breakeven cost data, 300 were under $5000, 200 were under $1000, and 50 had no costs at all. The institution and external sponsors are the primary source for project funding; students are less likely to fund capstone than they were in 1994 or 2005.

Sponsors

Sponsor funding spans as broad a range as project expenses, but 75% of programs who responded in 2015 receive less than $5000 per project from sponsors, and 50% receive less than $2000 per project, typically in the form of gifts, grants, or reimbursement for expenses. Ownership of intellectual property from capstone projects has increased over the past 20 years; external sponsors remain the most likely owner, but ownership is often divided. The majority of sponsors are still located within 20 miles of the institution, but there has been an increase in international sponsorship since 2005.

These 2015 capstone design survey data were highlighted in the keynote presentation at the 2016 Capstone Design Conference. Slides from that presentation in addition to various papers from the 2015 and other capstone design surveys are available at the Capstone Design Hub (www.cdhub2.org) and the Capstone Design Conference website (www.capstoneconf.org). Readers are encouraged to see how their capstone design programs compare with others around the country. The results of these surveys are an important step in understanding, assessing, and ultimately improving engineering capstone design education.

Stay tuned for the next decennial survey in 2025 – the tradition continues!

References:

1. Todd, R. et al. "A Survey of Capstone Engineering Courses in North America," *Journal of Engineering Education*, Vol 84, Issue 2, April 1995, pp. 165-174.
2. Howe, S. "Where Are We Now? Statistics on Capstone Design Courses Nationwide," *Advances in Engineering Education*, Vol 2, Issue 1, Spring 2010.