2015 Capstone Design Survey – Initial Results

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The goal of the decennial capstone design survey initiative is to capture data from capstone design courses every ten years to identify current practices and changes over time. In keeping with its predecessor surveys, the 2015 capstone design survey included questions on capstone course information, pedagogy, evaluation, faculty, students, projects and teams, expenses and funding, and sponsors. This short paper presents some of the highlights of the 2015 quantitative data from 523 respondents at 256 institutions, documenting the variety of implementation strategies for capstone design programs nationwide.

Keywords: capstone design courses, capstone projects, capstone pedagogy, decennial survey

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Introduction

Capstone design courses provide a culminating design experience for engineering students, usually during their final year. Although these 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 marks the official continuation of the decennial data collection effort. The 2015 survey included most of the questions from 1994 and 2005 plus a number of new multiple choice and open-ended questions. The results of these surveys are an important step in understanding, assessing, and ultimately improving engineering capstone design education.

Survey Methods and Respondent Profile

The 2015 survey was formatted with eleven sections with a combination of multiple choice, fill in the blank, and open response questions related to capstone course logistics, pedagogy, finances, and external relations, among others. The collection of questions was informed heavily by the previous nationwide surveys, as well as other studies of capstone design courses and discussions at the biannual capstone design conferences.

The survey was implemented using SurveyMonkey and sent via email to the department chairs of all ABET-accredited engineering and engineering technology programs, the ASEE DEED (Design in Engineering Education Division) monthly newsletter, and the Capstone Design Community mailing list. Recipients were asked to take the survey themselves if they were in charge of capstone design or to forward it to their capstone design colleagues. The survey was officially open during the month of February 2015 and responses were accepted through mid-March. A total of 523 respondents, representing 464 distinct departments at 256 institutions, participated in the survey. All but two of the 523 respondents had a capstone design course.

Results and Discussion

The 2015 survey responses covered the following general topics: course information, pedagogy, evaluation, faculty, students, projects and teams, expenses and funding, sponsors, respondent personal experience, and open-ended responses. The sections below present highlights of the quantitative data. The number of respondents are provided for each question since not all respondents answered every question.

Course Information

Figure 1 shows the duration of the capstone course. The semester format is the most common: of 499 respondents, 55% have a two-semester capstone sequence and 31% have a one-semester sequence.

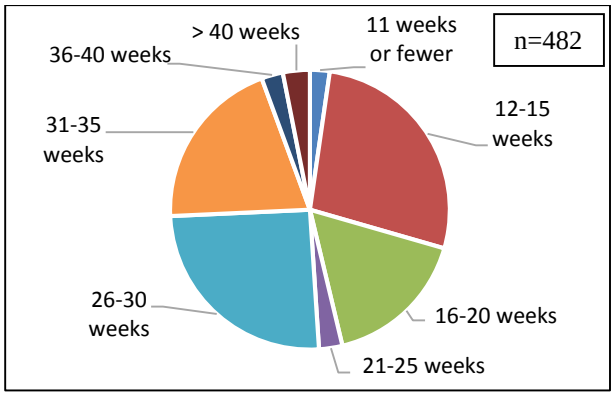

Figure 1 – Duration of Capstone Course

Capstone design spans the engineering disciplines, as shown in Figure 2, and many involve more than one (the 506 respondents noted 1061 departments).

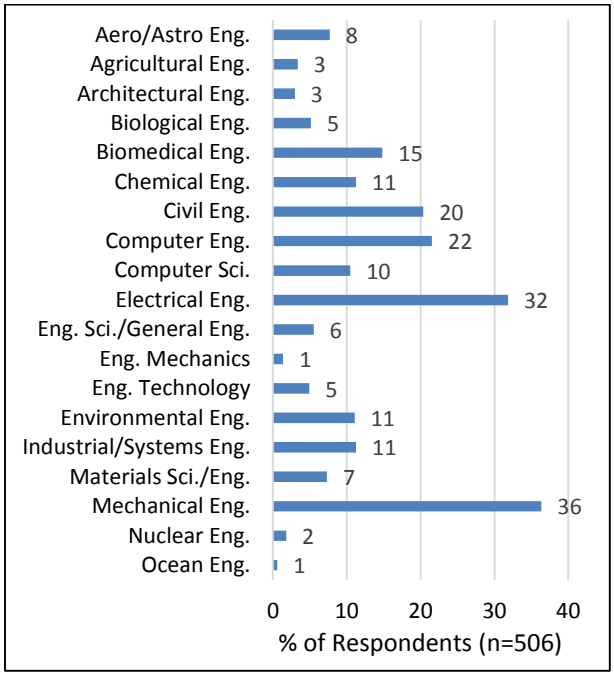

Figure 2 – Departments in Capstone Design

Pedagogy and Evaluation

Capstone design courses cover many topics, as shown in Table 1, in lecture (L), in an individual assignment (IA), or as part of the team project (TP).

Table 1 – Topics Covered in Capstone Design

		% of Respondents			
Category	n	L	IA	TP	NC
Analysis tools	450	45	25	83	9
CAD design/layout	440	23	18	67	28
Concept generation	453	62	23	80	7
Concept selection	451	61	24	81	7
Creativity/prob. solving	462	53	24	80	6
Decision making	458	58	19	80	7
Functional Specs	455	56	24	77	12
Engineering ethics	455	69	30	45	12
Intellectual property	440	51	12	33	37
Leadership	443	47	14	64	19
Optimization	430	36	12	57	32
Oral communication	469	57	29	89	1
Project management	468	67	26	89	2
Prototyping, testing	445	41	16	71	22
Sketching	422	18	14	46	44
Standards/regulations	448	59	17	70	10
Sustainability	434	44	13	53	27
Teamwork	463	57	21	81	5
Written communication	472	56	42	91	1

n = number of respondents; NC = Not Covered

Beyond the list provided, 184 respondents provided an additional 433 topics. Most common were engineering economics/financial analysis, design for X, professional preparation and licensure, and safety/liability.

As shown in Figures 3 and 4, evaluation of student performance is informed by many people and based on many different types of work.

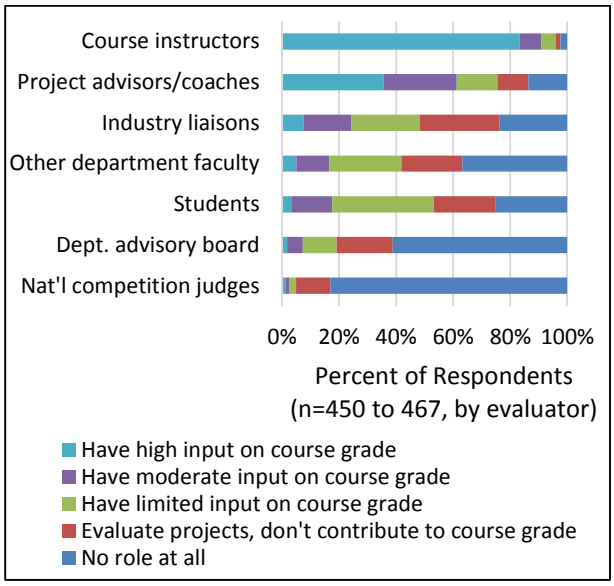

Figure 3 – Evaluators of Student Work

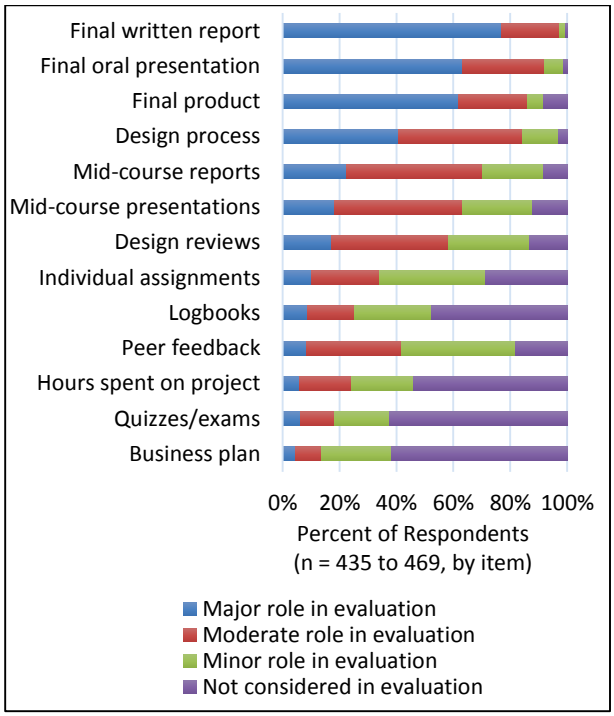

Figure 4 – Items that Contribute to Evaluation of Student Performance

When asked how grades were assigned in capstone design, 90% of respondents (n=469) chose "Individually assigned based on both individual and team performance."

Faculty

As shown in Figure 5, programs vary substantially in what percent of faculty in the department receive teaching credit for their involvement in capstone design.

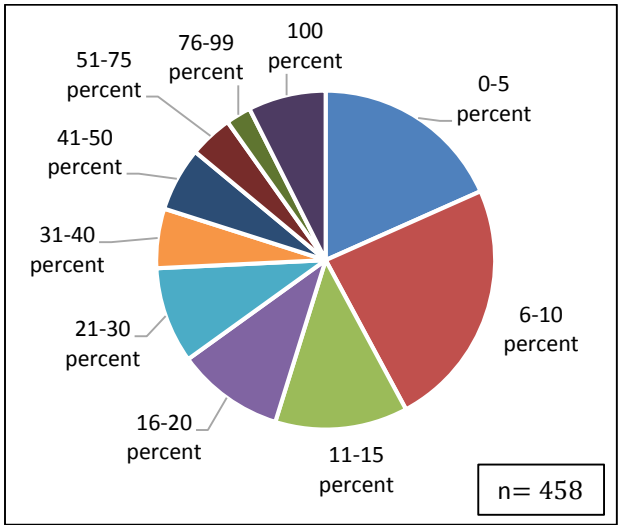

Figure 5 - Percent of Faculty in Department Getting Teaching Credit for Capstone Design

Students

Student numbers in capstone design also vary by program and institution, as shown in Figure 6. For most programs (88% of n=463), the students are undergraduate seniors, and do not include juniors or graduate students.

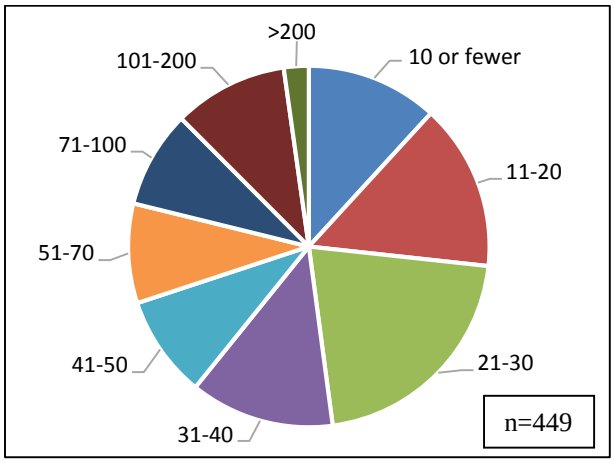

Figure 6 – Average Number of Students per Capstone Design Course Sequence

Projects and Teams

Figure 7 shows the range of sources of capstone design projects, and Figures 8 and 9 depict the number of distinct projects capstone programs in a given cycle and average team size. The most common ways to assign students to teams are student choice (72%, n=458), instructor choice (48%), and student skills (44%).

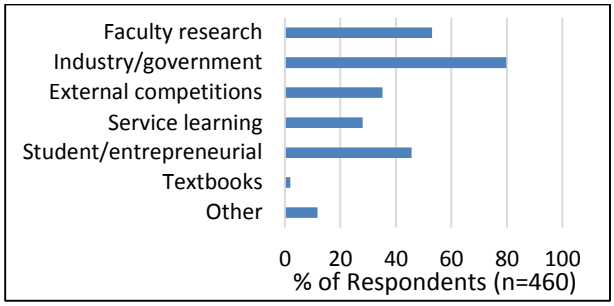

Figure 7 – Sources of Capstone Design Projects

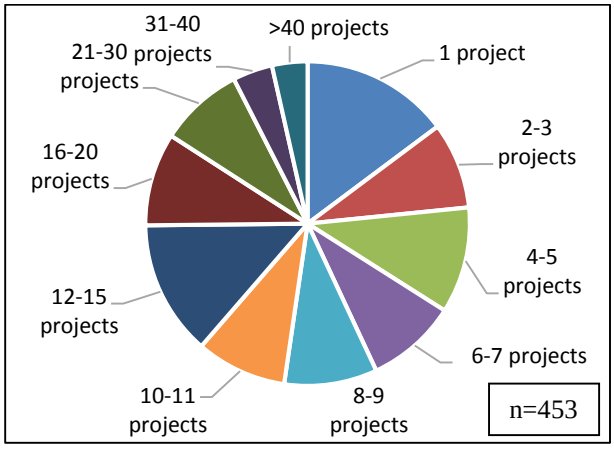

Figure 8 – Number of Distinct Projects in Capstone Design Course Cycle

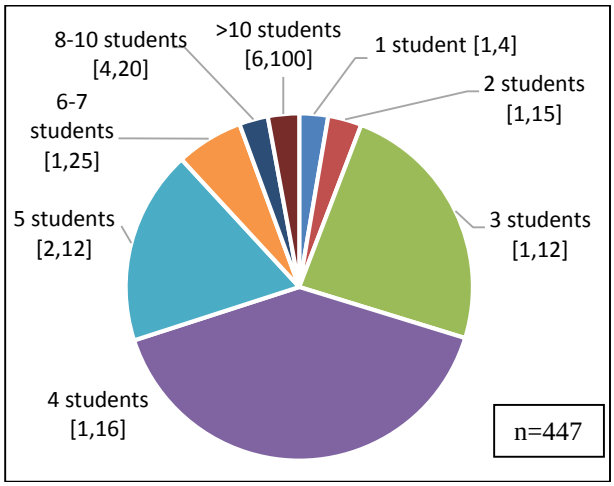

Figure 9 – Average Number of Students per Capstone Design Team (with [min, max] for respondents with that average team size)

Expenses and Funding

Capstone design courses have a number of different associated expenses, as shown in Figure 10. Respondents noted the minimum, average, and maximum break-even cost per project; Figure 11 shows the averages. Sources of funding for these expenses include the department (73%, n=451), industry (57%), the institution (35%), students themselves (26%), government/foundations (22%), alumni and other individuals (19%), and reimbursement for expenses (14%).

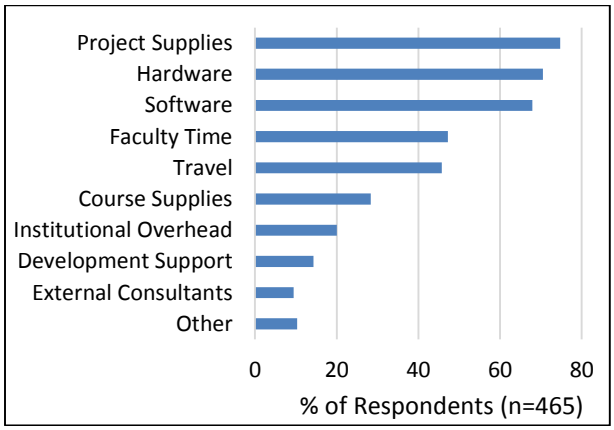

Figure 10 – Types of Expenses Associated with Capstone Design Projects and Course

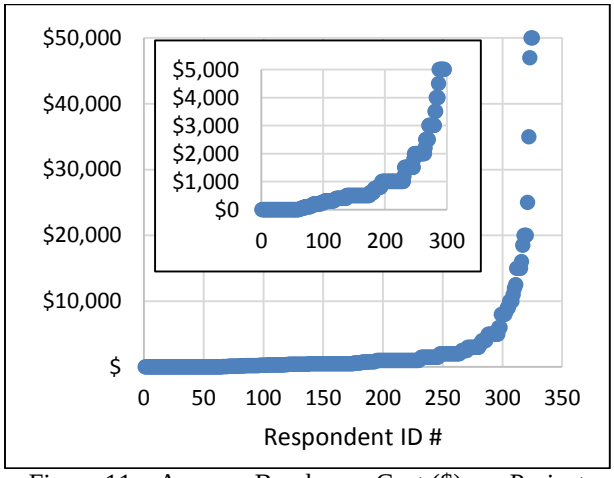

Figure 11 – Average Breakeven Cost ($) per Project (Inset graph shows lowest 300 responses of n=325)

Sponsors

Seventy percent (n=461) of respondents have external sponsors for their capstone design projects. Many of those respondents offered data about the average level of financial support from sponsors, as shown in Figure 12. This funding can come in the form of grants (38%, n=274), gifts (56%), reimbursement for expenses (50%), or some other format such as contracts or in-kind contributions.

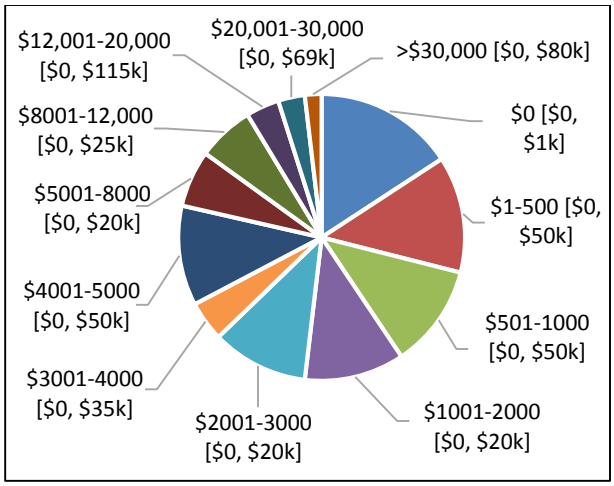

Figure 12 – Average Financial Support Provided by External Sponsors, n=266 (with [min, max] for respondents with that average financial support)

Related and Future Work

This paper presents highlights from the quantitative responses to the 2015 capstone design survey. The qualitative responses are discussed in an ASEE 2016 paper. A longer paper including these quantitative and qualitative results, plus longitudinal and disciplinary comparisons is in process for IJEE. In addition, the 2015 survey has already been distributed to capstone programs in Australia and New Zealand; plans are underway to collect data from other countries as well.

Summary

The 2015 capstone design survey collected information about capstone programs nationally, including course logistics, pedagogy, evaluation, faculty, students, projects and teams, expenses and funding, and sponsors. Capstone programs share a common core, but vary tremendously in their implementation. By capturing current practices every ten years, the capstone design community can better understand and share strategies for effective capstone design education.

Acknowledgements

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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.