AC 2007-92: DESIGN PANEL: A TOOL FOR ASSESSMENT IN DESIGN COURSES

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Design Panel: A Tool for Assessment in Design Courses

Abstract - In this paper, we first present the fundamental framework of our ABET assessment plan for our program and explain how an assessment tool called Design Panel fits. The Design Panel tool is used to assess courses with substantial project components. Then, we explain the details of organizing and managing such a panel assessment. Next, the Design Panel assessment results and their relations with other ABET assessment data are discussed. Finally, we provide lessons learned and feedback from the Panel members to improve the "Design Panel" as an assessment tool.

1. Introduction

Capstone design courses with substantial student projects are usually one or two semesters long. Assessment in such courses for the purpose of continuous program improvement and ABET accreditation is a challenge. At the School of Engineering and Computer Science, we have a mechanical engineering program with a manufacturing option. For the past two years, our program has been preparing for its first ABET accreditation visit. As part of this effort, we established a "Design Panel" to evaluate student design projects. The panel consists of faculty, industry representatives, alumni and graduate students.

The mechanical system design stem of our curriculum contains 6 required courses starting with a small-scale project in the freshmen-level "Introduction to Mechanical Engineering" course, continuing through the junior year with two courses and terminating with three senior-level courses. Two of the senior-level courses constitute the capstone sequence. The thermal stem of the curriculum contains one design course.

ABET criterion 3.c. requires demonstration of "an ability to design a system, component or process to meet desired needs within realistic constraints …" Furthermore, the mechanical engineering program criterion requires demonstration of "… the ability to work professionally in both thermal and mechanical systems areas including design and realization of such systems." These criteria are met collectively by the activities in the seven design courses of our curriculum mentioned above. The literature suggests that each criteria should be assessed using at least three tools (triangulation). Furthermore, the assessment should be done using a combination of direct and indirect tools. In each course, faculty members assess student achievement of these criteria using direct measurements. Course surveys are administered as indirect measures. We developed the Design Panel as another indirect assessment tool. The Design Panel is a group of people gathered to assess design related courses. A group of people consists of local industry

leaders, faculty, and graduate students. There are number of examples on using panels as assessment tools for programs, curricula, and projects [1-3].

The Design Panel is used to assess Mech 314 "Design Process", Mech 402 "Thermal System Design" and the second course of the capstone sequence Mech 417 "Mechanical Systems Design II" courses. These are the courses where substantial activity and materials are available to demonstrate the achievement of primarily the above ABET criteria.

2. Program Outcomes Assessment Process

We adopted the ABET-EAC "a" through "k" outcomes as our program outcomes. We collect data annually using various tools to assess each of the 11 program outcomes. Figure 1 shows the top-level of the loop.

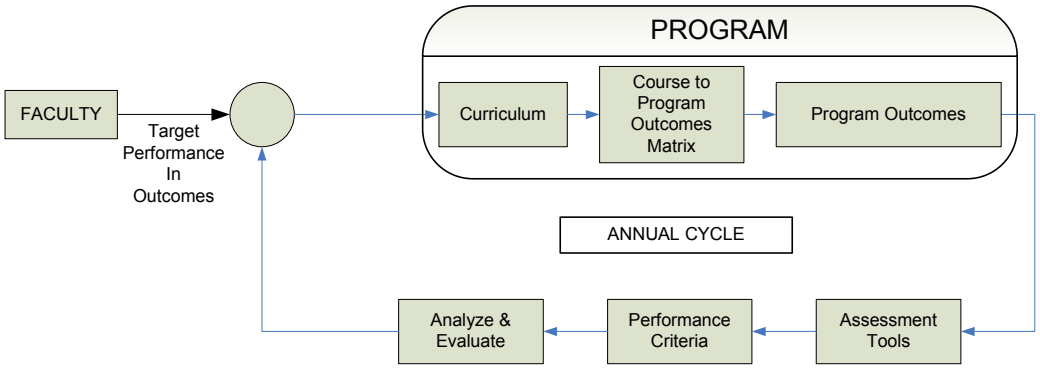

Figure 1. Top-level of the short-term loop for program assessment (only one of the 11 parallel loops are shown).

To assess each outcome, we use performance criteria for that outcome. The performance criteria (PC) are measurable attributes describing the performance required to meet an outcome as a program. For example, for program outcome "C" we developed the following four performance criteria:

C. Ability to design and realize thermal and mechanical components, systems, or processes to meet desired needs and realistic constraints.

C-1. Analyzes needs to produce problem definition for thermal or mechanical systems.

C-2. Carries out design process (such as concept generation, modeling, evaluation, iteration) to satisfy project requirements for thermal or mechanical systems.

C-3. Can work within realistic constraints, (such as economical, environmental, social, political, manufacturability, health and safety, ethical, and sustainability) in realizing systems.

C-4. Can build prototypes that meet design specifications.

Each PC appears in various courses. For example, the faculty identified that the performance criterion "C-1" would be achieved if the corresponding activities in Mech 314, Mech 414 and Mech 417 are successful. We have a total of 38 such PCs for the 11 program outcomes. We developed a mapping of the PCs to the courses.

For example, C-1 is interpreted in the context of Mech 314, Mech 414 and Mech 417 courses. These interpretations are used to generate a course outcome in each course that is related to the C-1 at the program level. In each course, we assess the course outcomes using direct and indirect assessment tools. The data coming from each course for each PC, such as the C-1, are then combined to analyze and evaluate level achievement of each *program* outcome. If any program outcomes are not met at the targeted level, then actions are taken to improve the program.

The Design Panel is used as one of the assessment tools in Mech 314, Mech 402 and Mech 417 to assess the following program outcomes:

C. Ability to design and realize thermal and mechanical components, systems, or processes to meet desired needs and realistic constraints.

D. Ability to function on multidisciplinary teams.

F. Understanding of professional and ethical responsibility.

G. Ability to communicate effectively.

3. The Design Panel

The Curriculum Assessment Committee (CAC) took a major role in planning, organizing, and managing the Design Panel assessment. The concept of the Design Panel was introduced during the Program's Industry Advisory Board (IAB) meeting to get support from the IAB members. Approximately one month prior to the design panel event, the CAC invited several panel candidates whose specialty areas were quite varied. The design panelists' backgrounds were diverse so that they could cover various sub-disciplines of mechanical engineering. In addition to the selected IAB members, two alumni, one graduate student, and one faculty member were on the Panel.

The primary charge to the Design Panel was the assessment of the students' design and realization ability, teamwork, professional and ethical responsibility and communication skills. Therefore, we prepared design project final reports, streaming video files of the students' final presentations and the digital pictures of the design project prototypes were prepared for the Panel to examine. The CAC met with the instructors for the design courses to have all necessary materials for the meeting on time. The Program staff assisted in creating assessment bubble sheets, complete video streaming files and in setting up the Panel meeting room layout. Figure 2 shows the room layout and the actual Panel meeting.

Figure 2. Design Panel room layout and a photo taken during the meeting.

The Design Panel meeting was two hours. Two IAB members, two alumni, one graduate student, and one faculty member joined this event. Each panelist picked three or more projects which they preferred to assess. During the assessment, most time was spent reading the final reports. They also used laptop computers to watch the students' presentation videos and looked at the pictures of the project prototypes. After reviewing all materials, the panelists filled out the assessment bubble sheets with scores in the range of 1 to 5 (highest). These sheets contained the Performance Criteria (explained in Section II.) they were assessing. Furthermore, they had a section to provide written comments. The total assessment time was approximately 1-1/2 hours. The last half hour was spent on group discussion.

4. Results

The Design Panel assessed four projects in Mech314, eight projects in Mech417, and seven projects in Mech402. Figure 3 presents each program outcome's % distribution from the Design Panel.

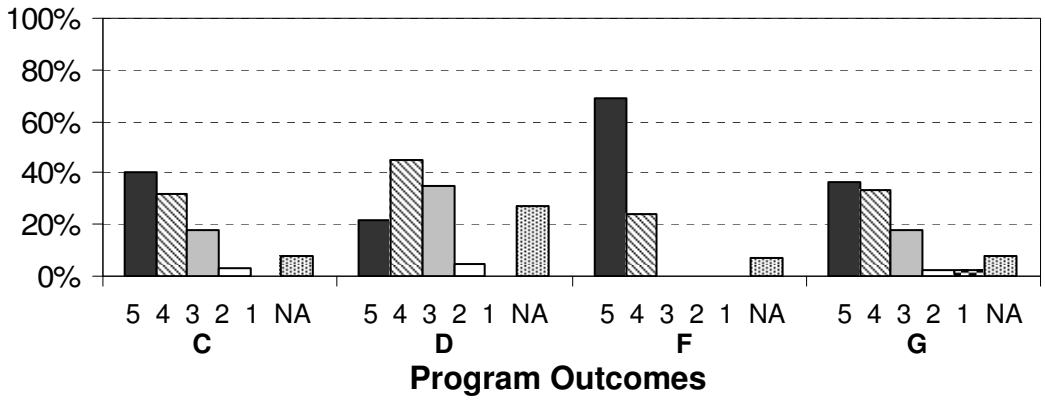

Figure 3. % distribution of each program outcome.

Table 1. Average of % distribution of each performance criterion

Outcome	Average	Distribution (%)					
	(Ave.)	5	4	3	2	1	N/A
C-1	4.08	39%	29%	32%	0%	0%	0%
C-2	4.31	44%	40%	6%	6%	0%	5%
C-3	4.26	50%	32%	13%	6%	0%	0%
C-4	3.86	27%	26%	20%	0%	0%	27%
D-1	3.70	27%	141%	74%	14%	0%	43%
D-2	4.18	34%	33%	19%	0%	0%	14%
D-3	3.89	5%	60%	11%	0%	0%	24%
F-1	4.67	67%	33%	0%	0%	0%	0%
F-2	4.83	71%	14%	0%	0%	0%	14%
G-1	3.96	33%	35%	28%	5%	0%	0%
G-2	4.29	39%	32%	8%	0%	4%	16%

Table 1 shows average points and distributions for each performance criterion. The Program Outcome D (Ability to function on multidisciplinary teams) received the lowest score (3.79/5.00) while the Program Outcome F (Understanding of professional and ethical responsibility) has the highest score (4.74/5.00). In particular, the student performance criteria D-1 (Shares responsibilities and information on schedule with others on the team) got the lowest score (3.70/5.00) out of all the criteria. The panelists expressed that it was quite challenging to evaluate teamwork by just reading the final reports. The low score on this item was partially attributed to this reason.

The Design Panel also provided some comments for design projects including:

- Showed a logical thought process. They took time to truly understand the user's abilities and limits. Very good conceptual design process! Effective use of design for Quality Concepts.
- Needs improvement of conceptual designs. Simple CAD drawings would help. All the details about the ethics they took in the background are not critical to the project. Be brief and don't need to share thoughts or feelings.
- Hard to follow the relationships between conceptual designs and the morphological matrix. It is important in the design details to explain why the criteria should be met, such as, "accommodate at least 2 children at an appropriate physical height." Why?
- The project was written up very poorly. Lacks basic skills of grammar, spelling, and proofreading.
- The Project Statement and Definition is unclear from the report. Were they supposed to recommend a rack type? What was the purpose for all the analysis?
- Good project report! Adequately described process and experience. Report Budget vs. Actual Expense. (It's not a budget when its spent) Planned vs. Actual should be on some chart. Nice touch on the O&M Manual!

The panelists' comments were ranged from design issues to writing skill issues. These comments were given to the design course instructors.

After the meeting, the panelists made the following suggestions for the next year's Design Panel meeting:

- Scheduling, timing, and set-up of the meeting were fine.
- Background information of the design courses must be provided before the meeting, so the panelists can have better ideas of what they would evaluate during the meeting.
- The panelists had a hard time evaluating students' oral presentation skills through the computerized video systems provided. Panelists suggested each project should have its own video file on the computer, so they can easily pick up what they want to watch.
- Overall, 'Program Outcome D' was quite challenging to measure with the reports.
- Not many design project reports had nice descriptions about the information of customers' needs.
- The panelists found lack of standards in students' project report writing style. Some reports looked like essays or journals.
- More panelists must be invited.
- All panelists were interested in joining next year's Design Panel.

In order to assess the Program Outcomes C, D, F, and G, other ABET assessment tools were also used. Table 2 shows the average scores of student performance criterion using various assessment tools. When compared these data with other sets of data such as course instructor score, student course survey, focus group, and exit survey, the Design Panel data shows a good agreement except Program Outcome D: team work. In Program Outcome C, overall average is 4.28/5 while the Design Panel score was 4.07. As mentioned above, team work was not appropriate to be assessed by the panelists.

Table 2. Average scores of student performance criterion using various assessment tools.

Assessment Tools	Program Outcome C				Program Outcome D		
	1	2	3	4	1	2	3
Design panel	**4.07**	**4.33**	**4.26**	**4.03**	**3.72**	**4.21**	**3.99**
Course instructor score	4.46	4.46	4.38	4.32	4.44	4.61	4.49
Student course survey	4.06	4.35	4.18	4.31	4.50	4.59	4.51
Exit survey	4.20	4.43	4.30	4.19	4.64	4.64	4.64

Assessment Tools	Program Outcome F		Program Outcome G	
	1	2	1	2
Design panel	**4.67**	**4.86**	**3.94**	**4.32**
Course instructor score	3.99	4.53	4.32	4.42
Student course survey	3.98	4.50	4.40	4.39
Focus Group	5.00	4.00		
Exit Survey			4.36	4.36

5. Conclusions

Assessment in design courses with substantial student projects for the purpose of continuous program improvement and ABET accreditation is a challenge. In this paper, we presented the fundamental framework of our program outcomes assessment system and explained details of the Design Panel assessment tool we developed.

The Panel evaluated student design projects from three different design courses, including the capstone design course. The Design Panel provided scores for targeted program outcomes which agreed well with those from other assessment tools we used. The panelists suggested that it would be improper to assess the students' team work with only reading the project final reports. The Design Panel is found to be a useful assessment tool in the ABET accreditation process.

6. References

[1] Reese, Susan, "Elements of an Effective Mentoring Program," Connecting Education and Careers, v81, n6, p20-21, Sep 2006.
[2] Snyder, Ilana ; Jones, Anne ; Lo Bianco, Joseph; *Using Information and Communication Technologies in Adult Literacy Education: New Practices, New Challenges. An Adult Literacy National Project Report*, National Centre for Vocational Education Research Ltd. P.O. Box 8288, Stational Arcade, Adelaide, SA 5000, Australia.
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