Panel 4B: Demystifying ABET's Capstone Expectations

Facilitator: John Estell (ONU)

Panelists: Nathan Kathir (GMU), Greg Watkins (CSU Chico), Darin George (Trinity)

Description: Capstone courses can be used to satisfy ABET student outcomes. This panel has ABET experts who can answer your questions on how to make sure your course meets your department's needs.

Potential Questions

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Notes:

Panelists:

Darin George — Trinity University
Darin George works with Trinity University's senior design program and ABET assessment process. Trinity has a multidisciplinary engineering science degree, and he helps coordinate assessment and accreditation activities. Before joining Trinity, he had more than 20 years of research experience in nonprofit research institutions and DOE sites. He noted that this background helps him understand standards, constraints, and the design process students are expected to learn in capstone.

Greg Watkins — California State University, Chico
Greg Watkins has 18 years of capstone experience and has coordinated a large senior design program. At Chico, the program runs both fall–spring and spring–fall project sequences, with about 20 to 25 projects per year. He also served as department chair for five years and was chair during the department's last ABET visit. In that role, he wrote self-studies for mechanical engineering and electronic engineering and gained experience with how capstone connects to ABET assessment.

Nathan Kathir — George Mason University
Nathan Kathir is in the Department of Mechanical Engineering at George Mason University. He has more than 33 years of experience in industry and government as a working engineer and came to Mason to direct the capstone program in mechanical engineering. He has also volunteered with ABET for about 27 years, including roles as an EAC program evaluator, commissioner, executive committee member, and incoming ETAC commissioner. He has led self-study workshops, PEV training, readiness reviews, consulting work, and departmental assessment coordination.

John Estell — Ohio Northern University; Host
John Estell began as a department chair in 2001 and served in that role for nine years. During that time, he worked on five self-studies and two accreditation visits, including the first accreditation of a computer science program. He has participated in the ABET Symposium since 2003 and has conducted research on streamlining outcome assessment processes. He became an ABET program evaluator in 2010 and a commissioner in 2013, serving with both the Computing Accreditation Commission and Engineering Accreditation Commission.

1. Engineering Standards

Question: What shortcomings have you experienced in dealing with appropriate engineering standards?

Nathan Kathir:
The biggest issue is documentation. Students may use standards, but if they do not write them in the report, ABET cannot see the evidence. Even if no standard applies, students should state that and explain why. Standards should be introduced early and included in reports throughout the year.
Greg Watkins:
Our issue was also documentation. We discussed standards with students, but it was not visible enough in the self-study. In response, I added a first-semester lecture on engineering standards, including examples such as Tesla's charging-port standard. We also require a standards section in the design report and include a standards checkbox in the grading rubric.
Darin George:
The first challenge is access. Trinity worked with the library so students, staff, and faculty could access ASTM standards. Other standards, such as IEEE or ASME, may need to be purchased. The second challenge is getting students to take standards seriously. We require standards in the project charter, discuss them in class, and ask students later how they applied them.
John Estell:
Standards exist in almost every field. IEEE has standards for many electrical and computer engineering topics, and ASTM F963, the toy safety standard, is a useful teaching example. Standards help students understand that engineering design protects the public and requires serious documentation.

Question: How can standards be incorporated naturally throughout the design process?

Darin George:
Start with a project charter that identifies the problem, design requirements, standards, and constraints. During the design-build-test cycle, each test should evaluate the design against a requirement or standard.
Greg Watkins:
For company-sponsored projects, ask the sponsor what internal, company, or national standards they use. This usually helps students identify relevant standards.
Nathan Kathir:
Students should already encounter standards in earlier design courses, such as machine design, thermal design, structural design, or materials. Capstone should be the place where they apply those standards to a real project.

Question: What happens if students do not include standards?

Nathan Kathir:
The goal is not to fail students, but to make them understand that engineers design for safety and the public. Standards should be required from the beginning of the course, not added at the last minute.

Greg Watkins:
We do not use standards as a punishment. If teams do not address standards clearly, we use that as evidence for improving the program through the continuous improvement process.
Audience comment:
One program gives students an incomplete if they do not include standards and codes at all, so they must revise before graduating.
Nathan Kathir:
That can work, but students should know this expectation from the first day of the first semester.

2. Constraints, Requirements, and Standards

Question: What shortcomings have you experienced with multiple constraints?

Darin George:
Sometimes students realize midway through the project that they cannot meet all constraints. They should go back to the sponsor and discuss whether requirements or constraints need to be revised. Another common issue is that students focus only on the constraints they know they can meet and ignore harder ones.
Greg Watkins:
We use a structured process to turn customer requirements into verifiable engineering specifications. The first presentation in the first semester focuses on customer requirements, so students begin working with sponsors and advisors early.
Nathan Kathir:
Two constraints are always present: budget and schedule. Other constraints come from the project and sponsor. Students often use constraints without realizing it, so they need to document them clearly in reports and presentations.
Darin George:
It helps to ask sponsors which requirements are essential and which are optional. We classify them as essential objectives and optional goals. Students should meet all essential requirements before focusing on optional goals.
John Estell:
ABET gives examples of constraints but does not provide one fixed definition. One useful rule is that if a number can be negotiated, it may be a requirement or preference rather than a hard constraint. For example, a $3,000 budget may be flexible if the best solution costs $3,100 and the client agrees.

Question: How should we distinguish standards, requirements, and constraints?

John Estell:
If a standard applies, mention and cite it somewhere. It is not enough to say the design is safe; students should connect the safety decision to the specific standard and testing method.
Nathan Kathir:
Requirements usually come from the sponsor and drive the design. Standards guide how to do good design and meet safety expectations.
Darin George:
Standards are best practices agreed on by experts. Requirements are specific to the project. Using words such as “shall,” “should,” and “may” can help distinguish required items from preferred items.
Greg Watkins:
We use simple categories: must do, should do, and would be nice. If a concept does not meet the “must do” requirements, it is eliminated.

3. Documentation and Evidence for ABET

Question: What is the best practice for documenting the final project?

Nathan Kathir:
ABET is looking for evidence of compliance with the criteria. Evidence can include reports, videos, posters, and presentations, but the final report is usually important because evaluators often request project reports before the visit.
Darin George:
Final reports and presentations should show how the prototype was tested and whether the design met requirements, constraints, and standards. Each test should connect back to a requirement or standard.
Nathan Kathir:
Programs should also review the Accreditation Policy and Procedure Manual, the self-study template, and the relevant commission materials.
John Estell:
The **PEV workbook** is publicly available and useful. It includes forms and checklists that show what evaluators look for. Make sure to download the workbook for the correct ABET commission.

Question: Is there a library of excellent ABET examples?

Nathan Kathir:
At the **ABET Symposium**, there is usually a room or showcase with examples of good self-studies and reports. These examples can help programs see what strong evidence looks like.

4. Changing Capstone While Staying ABET-Compliant

Question: ABET is sometimes used as a reason not to change capstone. How can programs make larger changes?

John Estell:
ABET should not be used as an excuse to avoid change. If the program still meets the criteria, changes such as redesigning lectures, using AI, or creating multidisciplinary projects are allowed. Evaluators will not be confused by a thoughtful change.
Nathan Kathir:
ABET gives programs flexibility. The criteria provide guardrails, but programs can choose how to meet them. People sometimes blame ABET because they are resistant to change.
Darin George:
Programs can make changes while still meeting ABET guidelines.

Question: How can we convince the administration that changes before a visit are safe?

Nathan Kathir:
The dean can talk with the ABET team chair if there are concerns. ABET encourages continuous improvement, so change is not automatically a problem. However, some departments may choose to delay major changes until after a visit to avoid disrupting the process.
John Estell:
Continuous improvement is central to ABET. If a program has a good reason to change and still follows the criteria, it should push back against the idea that ABET prevents change.

5. Multidisciplinary Projects and Earlier Coursework

Question: Can aerospace students work on mechanical engineering projects or multidisciplinary projects?

Nathan Kathir:
In the real world, engineers work across disciplines. ABET does not say the capstone project must be only aerospace, mechanical, or another single discipline. The key is that students use knowledge and skills from earlier coursework. For multidisciplinary projects, assessment data may need to be separated by program for continuous improvement.
John Estell:
A reflective essay could help document how each student used major-specific courses or knowledge in the design project. This gives evaluators clear evidence that students applied earlier coursework.
Nathan Kathir:
Course evaluations can also ask students which earlier courses helped most or least with capstone. That feedback can support program improvement.

6. Student Outcomes, Rubrics, and Assessment

Question: How should ABET outcomes, such as communication or ethics, be incorporated into the final report?

Greg Watkins:
Not everything has to be in the final report. Communication can be assessed through oral presentations. Ethics can be assessed through a separate assignment related to the capstone project. Different outcomes can be documented in different ways.
Darin George:
We use a chart that maps student outcomes and performance indicators to courses. In senior design, many outcomes are addressed through lectures, rubrics, advisor assessment, and external judges.
Nathan Kathir:
It is better to assess each student outcome in two or three courses, not only in capstone. If assessment waits until the final report, there may not be enough time to improve the program for current students.
Question: Which criteria or outcomes are most difficult?
Nathan Kathir:
The most common issues are Criterion 4, continuous improvement, and Criterion 5, especially capstone documentation. Programs may fail to assess all outcomes, process the data, or use the results for future improvement. For multidisciplinary programs, data should be disaggregated by program when needed.

7. Closing Takeaways

Darin George:
Take continuous improvement seriously. Use feedback from students and faculty to improve capstone, especially requirements, standards, and documentation. Senior design should be a learning experience, not just something students pass through.
Greg Watkins:
Keep attending the capstone conference. Many improvements in my capstone course came from ideas shared at this conference.
Nathan Kathir:

ABET is not the enemy; it is meant to help improve engineering education. Many problems come from lack of understanding rather than ABET itself. If there are questions, ask for help instead of treating ABET as a barrier.