



Panel 3D: Student Voices

Facilitator: Susannah Howe (Smith)

Panelists: Grace Newman (UCI), Deangelo Maestas (NMSU), Crystal Goecke (NCSU), Luc Boswell (NCSU), Pepito Thelly (TAMU)

Description: We work hard to develop capstone courses but how do the students experience our efforts? This panel of students will give you their ideas on how to improve Capstone design.

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- What's one takeaway from capstone that you know you're going to carry with you after graduation?
 - Teamwork is everything. Relationships with peers, advisor, sponsor can make or break a project. Quality of work is better when the team works together better.
 - As project lead, sometimes you have to make sacrifices. (example) No one likes doing documentation, so I did it. Success is shared by the team, failure belongs to you.
 - Project was difficult to define. I learned how to organize that and present it to different audiences (e.g., team meeting vs mgmt vs shareholders). Also, relationships, similar to what was said previously. My teammates became my friends.
 - The project is structured like a tower, and as early as you can, make the foundation as solid as you can. E.g., 3d modeling to help you firm up the plan.
 - Multidisciplinary of everything - we were 6 MEs and our project had a strong electrical aspect. I'm continuing as an ME, but I now recognize that MEs have to code, solder, etc.
 - What was something that, as a student, you found effective in how your capstone was set up/run/organized?
 - Focus was put on working with our sponsor as directly as possible, and keeping in contact. If communication starts to dwindle it can completely fall away.
 - When the instructor said early on that we wouldn't be graded on whether the project worked, but on the process/learning. That eased fear of failure going into capstone. Also, before the semester began, we filled out a spreadsheet with name, skills, contact info, and were encouraged to network and form teams early.
 - We all went into a room and bid on projects. We started with role designations before looking at the actual design project - great foundation for moving the team forward. E.g., one student with a strong test background, one with a strong CAD background, one with EE background. Didn't stop people from getting input from one another, but having those roles gave everyone purpose, motivation, and ownership.



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- Project planning. First semester, we did a terrible job. Would start working on Gantt chart assignment at 11:30pm for 11:59pm deadline. Second semester, we were behind and had to go back and do it all again, and realized that if we had done it right the first time around it would've gone more smoothly, but we learned from it.
- Students need structure. Different philosophies mean some departments have very loose capstones with a lot of creative freedom but mine was very strict. Structure represents what exists in industry, and helps prevent scope creep. Some of us come into capstone with very grandiose ideas, very excited, but structure helps keep expectations reasonable
- What is a challenge you experienced in capstone that negatively impacted your experience, that you'd like us NOT to have happen.
 - Purchasing: we filled out a google form with our BOM. After that, good luck. We didn't know what came in, no tracking numbers, never got notified when it came in, stuff got delivered to other teams. It was infuriating, and delayed the team.
 - Follow-up Q: How did you work through that? A: I was a pest. Told instructor that if we're going to be successful, we need to know what's going on with hardware delivery. (Note: doesn't seem pesty - seems realistic!)
 - Struggled with asking for help. It's hard to gauge how much time something is going to take when you're learning something new. Instructors said you can come talk to us and ask for help, but that isn't quite enough. Needs to be facilitated, or need to have some direct conversations with students.
 - Follow-up Q: What would have worked? A: Some professors have required office hours. Or some students are grade-driven, so if you require it or put a grade on it, we'll do it. Turning point was when we had program reviews w/ 5 teams and the instructor in the room - that changed things for me.
 - Guilt. Every student is going to have a bad week or some bad time when work slows down. It's very disheartening to show up to a meeting with little to no progress and feel guilty by your professor or sponsor. It slowed progress more than it would've if you had had the bad week and moved on. Just have a little bit of empathy with your students, encourage and welcome honesty. Everybody has bad weeks. As long as it's not a pattern and is just an outside circumstance influencing, just let it be and move on.
 - Our capstone was pretty well organized with all projects running on the same timeline. But for us, our sponsors were a nonprofit, so our timeline was a little different and didn't fit with our structured timeline. We had to spend more time on brainstorming and were late to build a black box model. A little more flexibility to accommodate project scope would be appreciated.
 - My successes were shared with others, but my failures were my own - I get in my own way. That said, our introduction to capstone was rushed. We moved into designing before defining the problem, then looked back at the early assignments and realized we were ignorant and can see how far we've come now. Projects were defined in a waterfall format, but our project was novel technology and fit better with an agile product development style. It worked out, but there was a bit of a learning curve. It's difficult to teach project management to people who have never done it.



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- Follow-up Q: Is there anything you or your instructor could've done to get you over the initial hurdle of rushing the process? A: We should've spoken up and asked questions sooner.

- Have you seen reviews where teams are reluctant to speak truthfully or accurately and avoid being seen as unprepared?
 - "Yes, I do that". It happens with high achieving students who are used to doing well with little effort and it's hard coming into capstone and realizing that you're going to have to work hard to get anywhere.
 - Explicitly tell students that it's OK to say "I don't know".
 - Yes, the grade system: college feels very grade-driven, and grades don't always reflect learning in the same way. 3+ years of school in one model are then turned around in capstone.
 - Capstone is supposed to reflect the workplace. There, you either do the job, or you're fired. In school, there's a spectrum of success 70-100, and it leads to this mindset.
 - Students need to see the benefits of being honest and the dangers of not being honest. In order to seem prepared or knowledgeable, they'll fake it.

- What skills or courses would've prepared you better for capstone?
 - Need to promote on campus organizations. First internship is the hardest, and the rest fall into place. Internships and involvement with things like design competition teams prepare you for capstone. School gives you a rough background for what you need to know. But get freshmen to go out and get involved to develop other skills (besides the ones you want to learn - learn the un-fun stuff, too). We need to learn problem solving.
 - Follow-up Qs: Can a 1st year participate in a capstone team? And what other courses would you put before capstone? A: Our school had no mechanism to get course credit for something like Baja or FSAE, and it's hard to find the time to do those. But maybe a preliminary course where you learn the design process and participate in something like Baja. Getting credit for this experience would help too.
 - Working together as a team. Specifically, the act of taking one problem and solving it together. In other classes you do that individually - e.g. a one-time small assignment that could be solved alone.
 - My courses did a good job preparing us for the technical aspect. Not the planning aspect, but that comes with experience. Also, when you take courses like Statics as a sophomore, you don't yet appreciate how important it is for something like doing FEA 2 years later. Have the seniors circle back to the sophomores to show them how this content comes back to you as a senior. These shouldn't be treated as small things just because they're underclass courses.
 - We weren't pressed into going into the machine shop early enough to understand what's feasible and what isn't. Talk with machinists early.



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- Regarding project management: we create a collection of “wish I knew project management” type comments and share them. Students still make that mistakes. Is there some other way to convey this peer lesson learned information?
 - Fail early. It's a safe environment because it's academic. Get those failures out of the way so you can learn. We were cocky and didn't listen, but had a turning point when one of our mentors just got really blunt (won't quote it here 😊). You're engineers. If you wanted, you could just build this in a week, but you're learning the process: justification, verification, component selection - this is important. Then it finally stuck and we turned it around.
 - Let us screw up. This is the safest time for us to figure stuff out.
 - Same. We had a lot of early lectures on project management, but I still don't think I would've learned it without just doing it.
 - For mechanical projects, encourage students to get to the machine shop early - they need to know what the timeline hurdles may be.
- Do you think learning from failing is why you're here as a select group of students. or do you think this sentiment was universal among your peers?
 - We were highly motivated by our project and that drove us to recover from failure. The project had a lot of meaning for us.
 - Depends on the structure of your capstone and your instructor's response to failure. It's so easy to get frustrated when it feels like your team isn't motivated and misses deadlines, etc. Keep expectations high and stakes low. That'll separate out highly motivated students from the rest.
 - Instructors can lean into their belief in their students' abilities.
- Lots of books have been written about failure. Fail fast. fail often. Is the grading system in your course working counter to that?
 - Our professor told us not to look at grades until the very end of the course, and his grading would be based on industry standards. We'd see lots of C's and D's throughout the project, but our final grade was curved from that. Every assignment got feedback and grades to match, representative of what a supervisor might say - reinforces that you can't BS your way through a report because your boss will call you on it.
 - I never worried about grades, but we had a good team. But it doesn't make sense to me why the instructor gives grades and doesn't ask your client. There should be a part of the grade that's based on customer satisfaction. I don't think our instructor knew our client's name. Our project was a competition - I want to win the competition not get a grade.
 - Reward students for taking initiative to improve - that might help to reduce the fear of failure. Can I recoup some lost points by iterating. In our class, the instructor said that your grade wasn't determined by whether your project was successful. I rarely looked at my grades because I felt good about the work that we were putting out.
 - Instructor said there are two types of failure: one is failing by accident and the other type is failing intentionally in order to learn. We were penalized for the first, not the second.



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- Do you feel like it would be beneficial to shift the grading from the instructor to the sponsor?
 - Sponsor feedback is crucial to the process. Having sponsors directly grade students might be a hard sell to the sponsors, and it might not be in their expertise to grade students, but their input is important.
 - I think it would be chaotic - many, many different people individually grading. Instructors probably have the best sense of the actual learning that's going on.
 - Note from audience: FERPA prevents us from having sponsors actually grade students.
- Are hands-on courses like machine shop required in your curriculum?
 - At our school, we do have experimental methods classes, but no machine shop. That's in engineering technology, and isn't required for engineering students. Asking students to take one ET course would help to bridge that.
- One of the problems I've seen in capstone teams is interpersonal problems, but I don't often find out about that until late in the project. What suggestions do you have to uncover this sooner?
 - Regular peer review. What percentage do we think each team member - including myself - contributed to the project. Instilled a sense of accountability. We used google forms.
 - When you have 6 people trying to pull a project in 6 different directions, it's a problem. We broke our project into sub-teams with one lead and one support
 - I recommend having clearly defined roles and responsibilities. There can be some role shift, especially since you don't know at the beginning what you will be doing throughout the year. You can also branch into project-specific roles later (emergent approach)
 - Suggested tool: [Daily Smirk](#) (used at UC Irvine) - teams use it 2x/week, rating teammates on a 1-5 scale (1=red emoji, 5=green emoji). If you rate someone below or above neutral, you have the opportunity to explain why. If you rate someone a 1, then you must explain why.
- What do you think about hacking-type projects vs more rigid system engineering projects?
 - All respondents felt that there is a place for both and gave good reasons/examples
 - Think about hacking for future proofing, but also identify the rigidity
 - Rigidity vs hacking is a bit like waterfall vs agile
 - for agile to be successful, all team members need to be competent and motivated
 - structure is useful for students
- How did internships inform/transfer to your capstone experience? What similarities/differences? [Note: all 5 panelists had previous internship experience]
 - Internship in health & info technology in an HIV/AIDS clinic in a community near my college. No structure there, I was the only IT person in the building. Felt more like a temp than an intern. I did every step of the design process alone. Vague requests, few guidelines and check-ins. Capstone was much more structured in comparison.
 - I held five different internships. In the first week of one, my team of five was reduced to two, and I had to pick up the slack on those projects. Had to just go run with it. Another one with Lockheed



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- Martin was much more rigidly structured. Structured engineering work with Johns Hopkins. I think the internships were invaluable in helping understand the importance of project management.
- 2 internships with Duke Energy. Very different from capstone learning. I was exposed to the real world, but also got a foot into the door at a company, which helped with job prospects - I signed my contract in October of senior year. Info that I needed was clearly defined, and there was always someone in the office who had what I needed. Capstone was much more vague and I had to look for things on my own.
 - Also worked at Duke Energy - 2 rotations and worked part-time there in between co-ops. There was structure to the job, but my assignments were more free flowing. I had free rein to play in the sandbox, which gave me a great feel for what it's like to be on a project. Pretty much all independent. I learned how to see coworkers as just other people, in contrast to instructors who were sort of separate.
 - Had a variety of experiences to explore options. Interviewing with a large multinational company for an engineering role, and they asked me about my capstone experience. When interviewer heard I had experience with FMEA and probed that, I was surprised that this was actually a thing that someone would ask about, and now I think that's why I got that job offer.
- Wrap up Q: What's one piece of advice for our audience as they prepare for their next cycle of capstone design?
 - Be a bit more flexible
 - Establish early on that capstone isn't like other courses. Avoid lecturing.
 - Highlight the importance of communication. Every solution to our problems started with communication. A lot of problems can be avoided with early communication.
 - Promote on-campus organizations and internships with your students to build experience. Tell students to talk with machinists early.
 - Be clear with expectations for students. Let the expectations motivate students. Never shame students for lack of progress or results.

Nice job, student panelists!