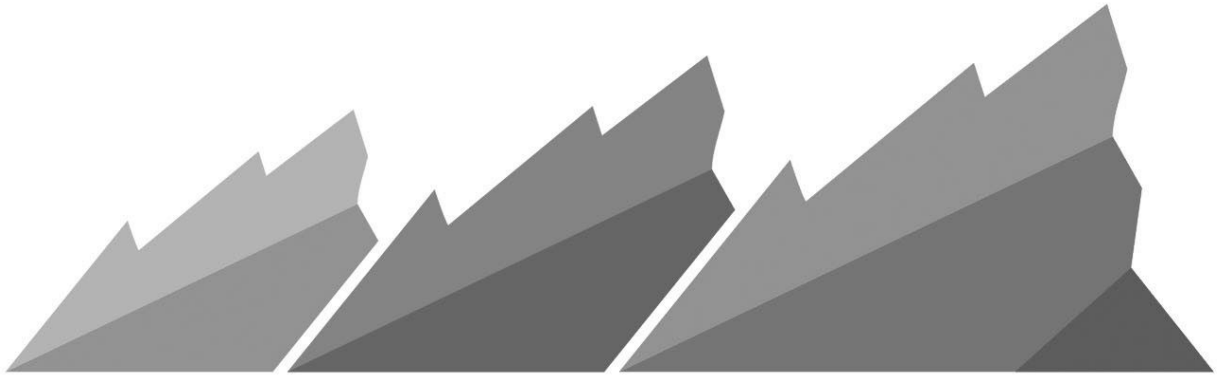**Virtual Capstone Design Conference 2020**
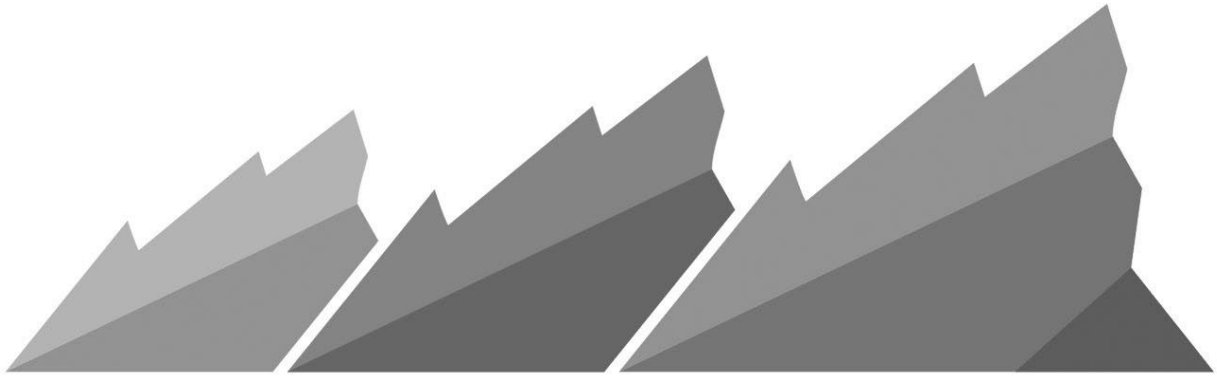
Questions

- **How do you grade projects to encourage teamwork and continuous progress, without penalizing early failure?**
  - Renee: We have extensive documentation requirements (with weekly milestones) where there are "individual" and "team" contributions - this helps us manage the teamwork and continuous progress fairly well. The projects are often just too big for a team to "cover" for a student, so we have an opportunity to work with students who are struggling early in the process. The only "failure" that we penalize is the failure to make progress and the weekly milestones are effective at monitoring that.
  - Susannah: My class has a spirit of continuous improvement throughout. I expect teams to submit weekly progress reports and meet with me weekly, so I have a sense of the team's progress and individual team members' contributions. I require teams to complete a written report and presentation in October about 6 weeks into the class. These are the very first draft of their final project report and presentation. I provide feedback on them as if they were graded, but the score isn't part of their final grade - so teams have a chance to see how they are doing but not have it count. I let students resubmit individual assignments multiple times if they choose and I average the grades. My two-semester class is set up (through the Registrar's office) that the spring grade replaces the fall grade, so in essence the fall grade is just temporary.
- Does anyone have plans for how to deal with a **full year being taught online** due to Covid?
  - Renee: Not yet! Brainstorming ideas so far: The "build" and "iterate" is the challenge, of course. Could the students develop "manufacturing plans" that are implemented by our departmental technician or even another student on the team, assuming they can be on campus? (Seems like a lot to ask of a technician! But could also lead to some great "teachable moments" regarding budgeting for technician/machinist time?) Maybe we could ask industry sponsors

to allow (i.e. pay) for outsourcing any machining or prototyping that we can't do due to campus restrictions? (**Please** share your ideas - we are all eager for possible solutions, recognizing that one size won't fit all!)
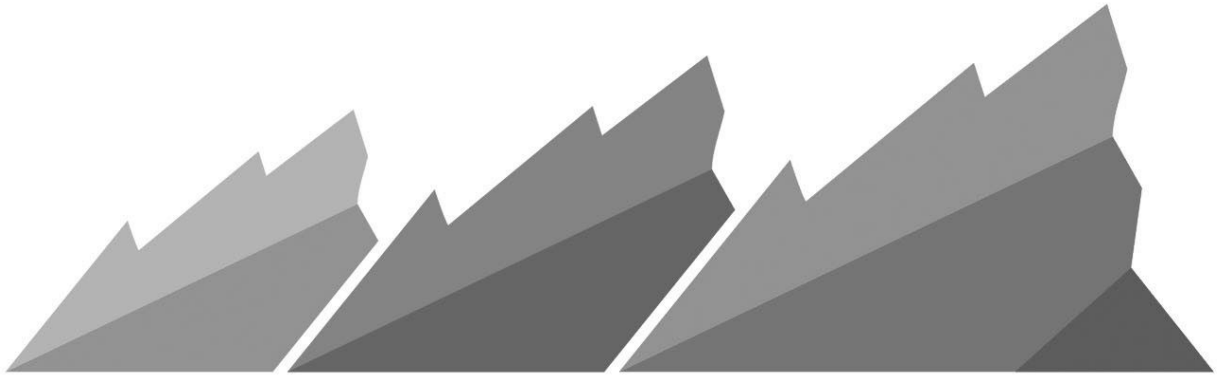
- *How can you design your curriculum to help students/professors be more prepared for capstone projects?*
  - We're working on expanding the use of design in non-Capstone courses to better and more broadly introduce them to the engineering design process - Mark Anderson @ RPI
  - Terminology can be "sprinkled" into earlier classes if other faculty are on-board or aware of the need for more scaffolding. Calling faculty in for a "consult" can reinforce good practice - not a semester (or quarter) commitment, just another set of eyes on the problem formulation or solution? (this can really open the lines of communication between students and faculty they may be nervous about reaching out to for help) - Renee
- How many hours per semester do you lecture? Is it evenly spaced, or front loaded?
  - I have tried both models of front loading all lectures and teaching just-in-time. Either way works if you are mindful that teams are going to be progressing at different pace. If you front load all your lectures - be prepared to nudge them to look over the notes as needed - *Shraddha Sangelkar*
  - @ RPI the course meets twice a week, 2 hours each. There are no "lectures".
  - We do some just-in-time lectures as appropriate through the quarter, but most of the "lecture/lab" time is for group work and checking in with teams. - Renee
- How do you grade projects? Especially when you are so close to all of the projects. It can be hard to have a different perspective for grading.
  - We make them present to external evaluators at least 2-3 times (it could be as low as 10% of their grade). But they take it seriously and it gives you additional perspective on you grading scale - *Shraddha Sangelkar*
  - In the first term (the "planning" phase), we have rubrics for each of the documents that the teams are creating and that helps with consistency between projects - the teams know we will be evaluating the quality of the work on those milestone documents. Including external reviewers is also very helpful for improving the quality of the work done by the students but it can be difficult for
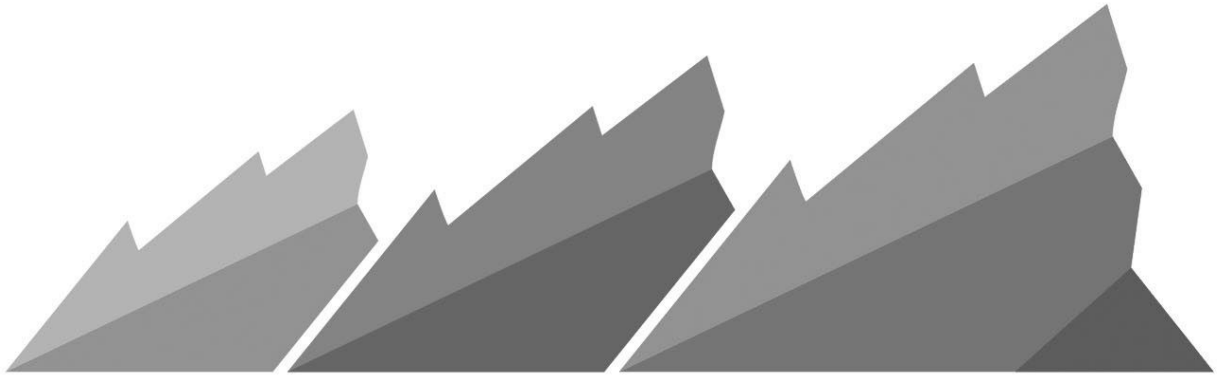
external reviewers to "grade fairly" unless they are trained on the rubrics/expectations. For the second term (the "building" phase), there is a portion of the grade that is focused on the safety and efficacy of the final product, but testing and reporting accurate results (even if the product doesn't "work") is emphasized so that projects that don't "work" (i.e. meet all the product specifications) aren't penalized if the team has been diligent in their documentation and thorough reporting of their process and test results. We have found that this keeps teams working on more challenging projects as opposed to picking a less challenging one that they think they could "do well on".

- Do you take project ideas from non engineers? if so, are engineering faculty assigned to those projects.
    - - Jenn Carlson here from Univ of Michigan. We have had projects with non engineer sponsors. We make sure to match strong engineering faculty to those projects.
    - Mark Anderson @ RPI - yes, we do. Creates a different experience for the students wince our team must provide the engineering support
    - Absolutely! Some of our best project ideas come from non-engineers and we find it a great experience for the students to learn how to describe their project progress in "non technical" terms. (We also provide engineering backup since we know the client may not have the expertise.)
- Most of the discussion so far seems to be related to industry design projects (possibly mechanical) but **are there examples from the panel /options for industry projects for more Civil Engineering capstone projects**?
    - Mark Anderson@RPI - I understand from a colleague
    - that our CIV/ENV dept engage with municipalities for projects
    - Agreed, we regularly do projects with the local Department of Public Works and we've also worked with various state and federal agencies such as the Department of Environmental Protection, the US Fish and Wildlife Service, and the Natural Resources Conservation Service. --Susannah
- What if I cannot find a new project? The company has completed the project, **can I just revise and use the finished project**?
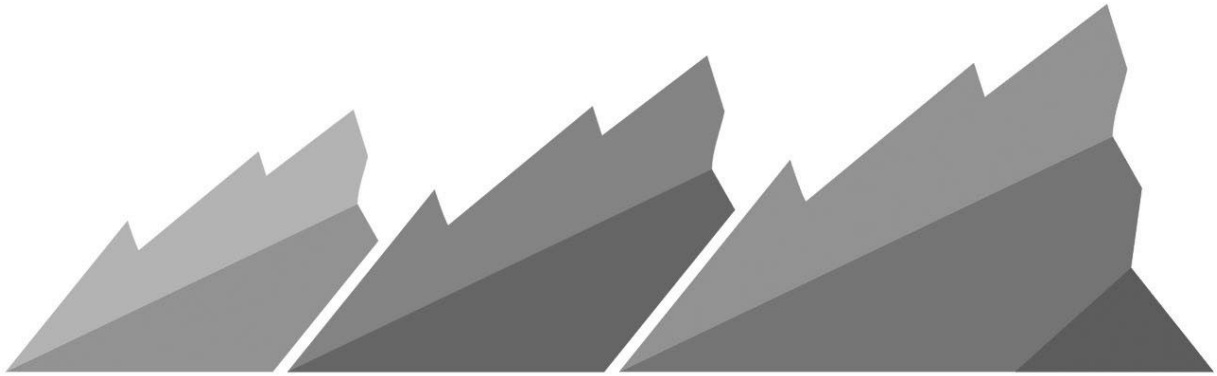
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- ○ Mark @ RPI - probably depends on the IP agreement. Assuming no IP conflict, you can always recycle past projects, not giving students access to the previous work to ensure a fresh perspective. OR give them access for a continued one!
- ○ Also - changing the "constraints" on a previous project (i.e. different user population, sizing, environment, etc.) can often result in a very different solution
- How do you address Diversity and Inclusion in your team choice?
  - ○ **Diversity of GPA w/in a team**?
  - ○ We form teams based on student preferences for the project or a particular team of students. I try not to have a lone female on the team but sometimes it is not possible to avoid especially if the female student wants to be part of a particular team.
  - ○ I do not consider GPA as a criteria for diversity - there are some "C" students who are excellent team leaders and some "A" students who are not good at leading teams or able to let others do their share of work.
- How do you handle IP? Who owns the intellectual property coming out of the student projects (if there is any)?
  - ○ Your university probably has policy that defines this. Our school (RIT) says that a student in an undergraduate class owns their own IP, so we have to ask their permission ahead of time if the sponsor is asking for an IP assignment. It's not usually an issue, just requires additional communication.
    - ■ Same at Michigan. Students hold the IP from class work. They largely sign IP assignments to the sponsors in my class.
  - ○ There's a collection of sample project agreements on CDHub that cover both IP and other typical "project charter" information (scope, preliminary requirements, etc.). http://cdhub2.org/ or http://capstonedesigncommunity.org/
  - ○ Some states mandate that companies cannot own the IP created by student teams (I think NC is like this); in these cases, the university can provide exclusive licenses. The sample agreements on cdhub2, show ways that students assign their IP to either the university or to the sponsor.
  - ○ Do you typically enable industry partners to own the IP, or the students?
    - ■ Confidentiality Agreement Primer for students (Keith Stanfill from UT): https://design.utk.edu/students/resources/nda/

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- **@Susannah**: 4-5 page project description, **what are the "prompts" you give the sponsors, what exact info are you looking for**?
  - The project summary form asks for project scope/discussion of design components, discipline(s) involved, background/motivation, expected deliverables, and implementation plans. There's also space at the beginning for contact information for all liaisons from the sponsor (and any other relevant project contacts) and space at the end for any additional information not already captured. --Susannah
- **How much time and effort burden do you put on the company mentor, if you even require a company mentor?**
  - In the Multidisciplinary Design Program at Univ. of Michigan, we have year long projects and we require 1 hour a week from the company mentor. It is a key part of the learning outcomes.
  - I tell liaisons the expectation is ~1 hour/week, but to know that can vary with some weeks (such as during a site visit) being more and some being less. I like to have students be in weekly contact with their liaisons even if it just a quick check-in. --Susannah
- How do you balance design process vs design project?—to students it may seem like there are 2 projects—one for the client and one for the class.
  - Ideally the process should be taught in a separate course before the capstone. The capstone is supposed to be a synthesis of prior learning (according to ABET). Most schools do not teach process as a separate course. Oregon State Univ has during the Jr. year since 1985 - David Ullman
  - Ashley from the Project Management Institute: We get lots of requests to give "bite-size" project management tools/templates/etc for the process - either as a separate course, or at the start of a semester-long project. Are faculty utilizing outside resources, relying on their own instruction, etc? Disclaimer: Our curriculum resources are free; but we would like to bundle something in a way that would be meaningful for this group.
  - Ashley: We use some LinkedIn Learning resources that I believe were developed by PMI folks.

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- How do you differentiate between the prototype and the design specification? The quality of the prototype may be limited based on manufacturing / fabrication experience or may not exist because of COVID.
    - The project team can submit manufacturing documentation (drawings, etc.) and work instructions that describe a more detailed manufacturing process than what will be used for the prototype.
- What documentation do you collect for projects?
    - Project Definition, Customer Needs/Target Product Specifications document, Formal Proposal, Peer Reviews, Project Schedule and Risk Assessment, Experimental Verification Document, Final Report, Prototype
    - All of the above, plus I also have capstone teams submit weekly project reports, and I have individuals submit selected logbook entries at least once per semester. --Susannah
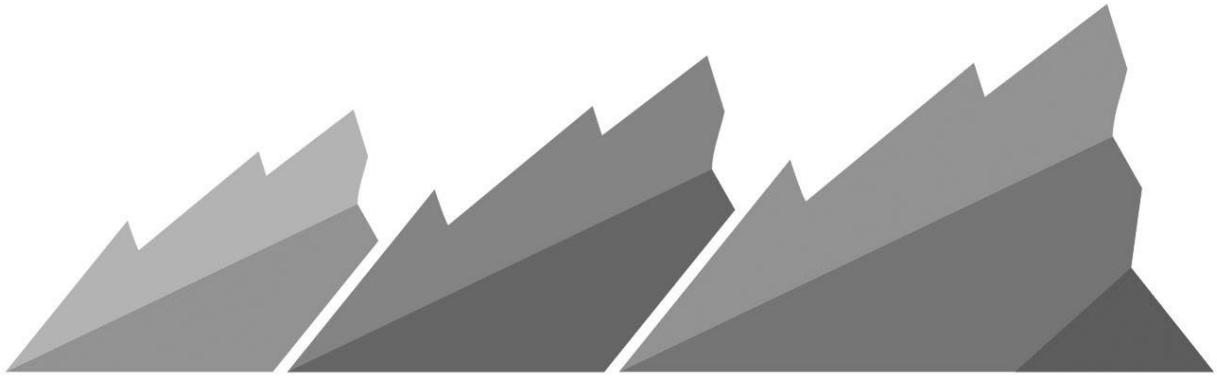
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● How do you assess or "teach" ethics for ABET assessment purposes?

Although ethics is included in capstone design, we "assess" it in a different course. Here is a reference that might help you develop some ideas! - Renee https://www.nap.edu/catalog/21889/infusing-ethics-into-the-development-of-engineers-exemplary-education-activities (Each of these case studies has an assessment component. You can download the ebook free!)

Answered

Panelists Questions

● **What you wish you knew when you started teaching Capstone?**
  ○ Susannah: Capstone is very different compared to other classes and less structured. Projects are different and things change. It is much more manageable if you let go and roll with it.
  ○ Renee: capstone is more like a product development where the product is the "student" and not what they make.
  ○ Amy: get the client on the same page. That helps for the project.

● **How to solicit the projects? Where, who and what type of projects?**
  ○ Susannah: Alums are a great resource. It is not always possible for new programs but you can build overtime. Either the alums themselves or their managers. Look at local industries and organizations around you. Board of trustees also have connections.
  ○ Renee: Career services want to support you . Local connections are always helpful.
  ○ Amy: Students work at internships in summer or co-ops. Tap into their connections or network.
  ○ Jay: Advisory board members are helpful.
  ○ Attendee: You can also work with your Dean, as deans cultivate relationships that can be tapped into

● **When you ask or provide for project descriptions are they specific or vague?**
  ○ Amy: As specific as possible. It is better to have more information in your back pocket as an instructor and maybe provide it to students as needed.

- ○ Renee: Avoid locking in too much which can take away from students freedom to design. It should not be a research project but a design project. If the students struggle to define what is needed it doesn't hurt (i.e. it can be a good experience for them to identify user needs).
- ○ Susannah: Use stretch goals like the onion. The core is what you need to make sure to get done and then do more of needed. Figure out the absolute baseline. Set milestones along the way, some check-in points to help toe students feel accomplished. I provide a 4-5 page write up. In the beginning with lesser description they students spent entire fall to just figure out what the project was about.
- ○ Attendee: There is a balance of too broad or too confined (does not allow for creativity)

- ● Are all your projects sponsored?(How much does each project cost?)
  - ○ Susannah: Papers discussing survey results of typical practices are [here](#).
  - ○ Renee: Average project tends to be less than $1000. We ask industry clients to pay for supplies; assistive technology projects are funded through other ways (we have found external sponsors to fund them and even some industry clients will fund a project to help a member of the community)
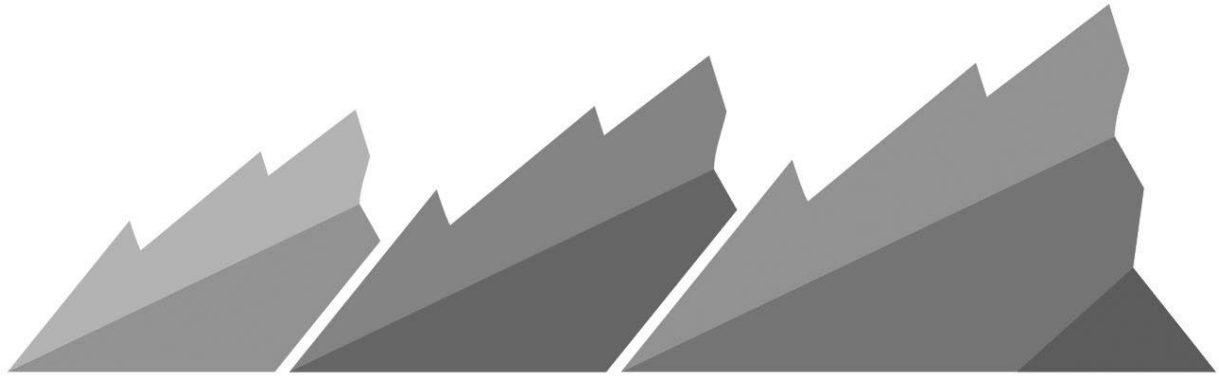
Team-Related Questions to Panelist

- ● **How do you form teams?**
  - ○ Renee: We allow students to put preference on the projects or teams. If they insist on the team then they all have to prioritize the projects as a team on their preferences. This works since our students know each other from other classes. We do lectures on working with people they already know.
  - ○ Amy: Our students get a choice in mechanical but in interdisciplinary teams select projects. There is a survey at the before forming teams.

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- ○ Susannah: students get 20 points to assign in favour of projects, in favour of other students and not in favor other students. (→ more discussion in other sections of this documents)
- ○ Addition from attendees:
  - ■ You can choose to ask students whether they want work with teams of their own choosing or on a specific project (and grouped on interest)
  - ■ Students can bid points for specific projects and people to work with. This strategy allows the instructor to form teams that incorporate both interests.
- **How do you define success in teams?**
  - ○ Susannah: it is the best when I am not needed anymore. As soon as the instructor is not needed for coaching and guidance → indicator of success.
  - ○ Renee: The growth of the team: independence and the confidence to set them free in the world. It is more like observation and you get a feel for it. Sometimes growth and learning happens but their product is not the best. There are resources to assess this.
  - ○ Amy: When communication is clear throughout the team, to the sponsor and to the instructor. We see that in the reflection when they learn to work as a team and communicate with each other.
  - ○ Jay: students should not be penalized if the product did not work in the end. success is not the end product; what they learned about design and how to create value for a customer is more important and this can be demonstrated with a discussion of why their design did not work as planned and what they would do to make it work properly given more time.
- And how does it compare to the way your students may define success?
  - ○ Students are more focused on the final product of the capstone course

- How do you ensure there is inclusion within teams?
  - ○ Amy: Peer evaluation, Example: CATME. Speakers brought in the address difference topics around diversity and inclusion.
  - ○ Renee: Maybe should not start in a Capstone program, but should be something throughout the entire engineering program
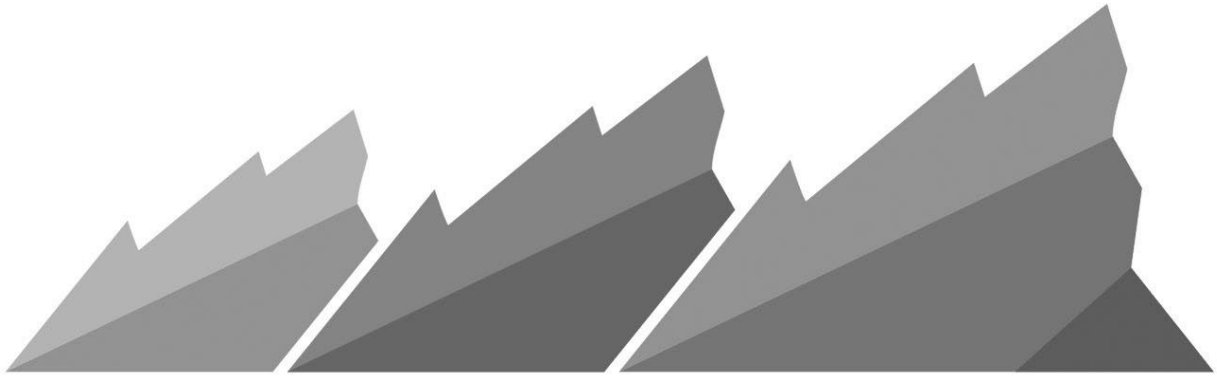
- ■ Either way, Capstone is about professional growth and diversity and inclusion is a big part of that
    - ○ Renee: anonymous reports of who has been an awesome team member and who has caused difficulties
- Diversity: should women be clumped onto teams or spread evenly? x2
    - ○ Same Q for student of color or other minority groups
    - ○ Singling them out may not be the best. At least pair them if possible. (Shraddha)
    - ○ I will talk to the student who will be "single" on the team and discuss my concerns with them. (I start by citing the literature and sharing some of my personal observations from previous experiences.) They usually really appreciate the concern and we have a good conversation about their views and thoughts and strategies for "handling" the situation. It also opens the door for future conversations and need to talk through any challenges they face. - Renee

Faculty & Instructor Involvement

- **How involved should instructors be? (balance between handholding v/s sending them adrift)**
    - ○ Susannah: depends on the length of capstone. For a 2 semester project, it is possible to allow the students to try things on their own and letting them flail a bit. Eventually, there is a shift and students overtake the project's responsibility. Being in the background to provide support is important.
    - ○ Renee: Definitely intervene if there is a serious problem with out of bound students (i.e. a student not showing up or behaving problematically). Otherwise let them go and check in regularly.
    - ○ Amy: We have a single semester, there is more hand holding in the beginning and then letting them go. We have certain things in our mind but sometimes they just blow us away.
    - ○ Jay: Faculty should not be making an inventive contribution. Let the students be creative and find their own solutions. If patents are being filed with faculty named as an inventor, it indicates that the faculty member helped design the solution. This is about student design, not student/faculty design. See websites for the Ohio State University and Texas A&M for how they discourage faculty invention in capstone design projects. I would prefer to see a less than optimum design
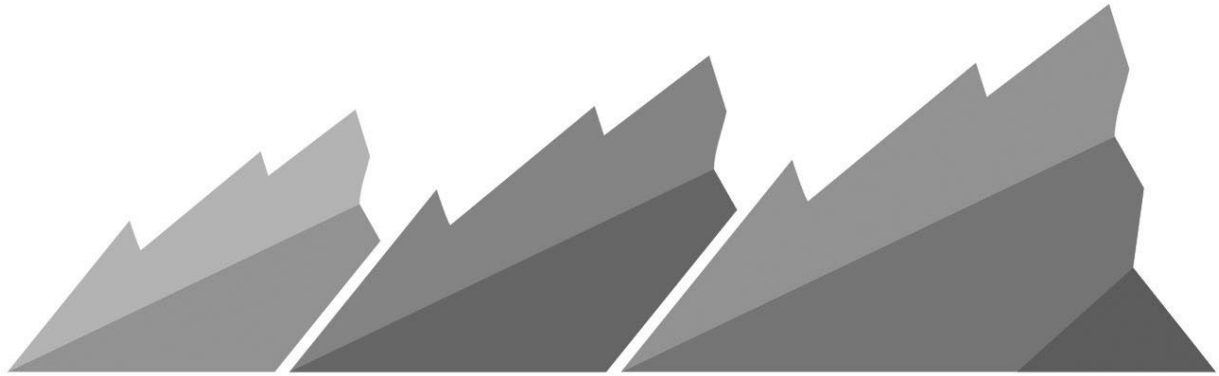
that was 100% from student work than a patentable design in which the faculty member was a co-inventor.
- ○ Attendee: Allow students to try and fail; be there as a support system, but do not hold their hands

- ● Comments from Veterans
  - ○ You are not responsible for their success or failure
  - ○ It is important for the student teams to meet with their clients or advisor often (at least every other week).
  - ○ New instructors
    - ■ read some relevant literature
    - ■ Attend professional society meetings
    - ■ Get involved in such meetings
  - ○ Team size (3-5)
    - ■ Less than 2 is trouble
    - ■ More than 5 becomes hard to keep track of couch potatoes, slackers, hitch-hikers
- ● **Pick one piece of advice you would like to give the new capstone instructors**
  - ○ Susannah: try not the single out a person on a team - pairing them is better. Do not be afraid to set a high bar. Scaffold it since capstone is a difficult class. They will be able to deliver excellent products.
  - ○ Renee: Ask for help, there are so many resources out there. You can make drastic improvements by listening to what people have tried before and making changes to suit your needs. It is not going to be perfect, so every year I add something new or change something. Don't start with a blank page.
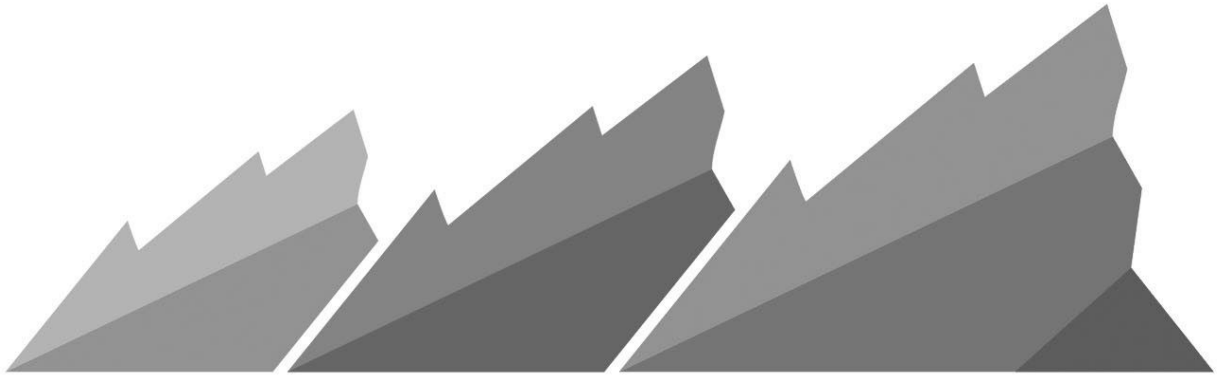 - ○ Amy: Importance of networking! Talk to lots of people; on campus, off campus, subject experts.

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Comments

Type your comments about presentation content here

- From Cassie Bowman (concerning where/how to find projects): We have projects open to universities nationwide: psyche.asu.edu/capstone-projects. NASA Psyche Mission
- Re: scoping projects - Always nice to include stretch goals in the project descriptions - Keith Stanfill
- Are the panelists willing to address side questions outside this panel? I am very interested in Susannah's 20-point team selection thing, though that's a level of detail beyond this session- Kimberly Demoret kdemoret@fit.edu I am too: Cassie Bowman c.bowman@asu.edu
  - More detail on 20 point system would be helpful.
- Regarding diverse and inclusive teams, we have a free online course developed by the Psyche mission: The Inclusive Mindset: Tools for Building Positive Team Culture: https://courses.cpe.asu.edu/browse/sese/courses/cpe-psyche-102
- Susannah's survey data (one of several papers): https://peer.asee.org/the-2015-capstone-design-survey-observations-from-the-front-lines
- Jennifer Turns: If anyone is curious, this past spring I created an affinity map of papers from the 2016 and 2018 conference… The map is in Lucidchart and includes the titles and abstracts. If you zoom out to 25% you can see the whole, but it needs to be around 75% in order to see the words … https://app.lucidchart.com/invitations/accept/e7048108-54db-4c5e-b04f-ebe3a92872f6

- Multidisciplinary projects sometimes need larger teams; 7 is my max, but I have had 8… finding team meeting times is really hard if there are more than one discipline involved
  - If you can break it into subsystems and define interfaces well, you can almost treat larger teams as separate subteams. Also good for students to learn!
- David Ullman: Ideally the process should be taught in a separate course before the capstone. The capstone is supposed to be a synthesis of prior learning (according to ABET). Most schools do not teach process as a separate course. Oregon State Univ has during the Jr. year since 1985.

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