Virtual 2021 CDC Workshop - June 21, 2021 - 1-2:30 ET (10-11:30 PT/AZ)

Baby Steps or Giant Leaps: Models and Means for Promoting
Interdisciplinary and Inter-University Opportunities in Your Capstone

Facilitators/Proposers:
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Psyche Interns (ASU): Ishna Barwey, Tyler Burnside, Ninad Kulkarni, Kax Nessi, Amber Simon

Agenda:

10:00-10:05 PT/ 1:00-1:05 ET	5 min	Announcements from Todd Polk (UT-Dallas)
10:05-10:15 PT/ 1:05-1:15 ET	10 min	Interactive Introduction: Logistics, intros, Google Doc, breakout rooms, etc.
10:15-10:25 PT/ 1:15-1:25 ET	10 min	Interdisciplinary Capstone - Obstacles and Opportunities
10:25-10:30 PT/ 1:25-1:30 ET	5 min	Q&A - Head to Breakout Rooms
10:30-10:55 PT/ 1:30-1:55 ET	25 min	Breakout Rooms (select your own): 1. Curricular Approaches 2. Grassroots Approaches
10:55-11:05 PT/ 1:55-2:05 ET	10 min	Report-out/Q&A: Curricular
11:05-11:15 PT/ 2:05-2:15 ET	10 min	Report-out/Q&A: Grassroots
11:15-11:30 PT/ 2:15-2:30 ET	15 min	Wrap-up: Document take-aways, discuss next steps, Slack channel in CDC workspace; exchange contact information, sign-up for group listserv (CAP-ALL@asu.edu)
Optional (post-workshop): Talk w/ Steve Trimble (ASU) about new ME Capstone handbook		

Attendees:
(Please self-introduce; consider "renaming" yourself for this Zoom under "participants" in order to indicate your institution/role). In the last column, please indicate if you'd like to be added to a shared listserv about this topic.

Name	Institution	Discipline	Email	Role	Listserv
Cassie Bowman	ASU	Education	c.bowman@asu.edu	Capstone sponsor/mentor	X
Steven Trimble	ASU	Engineering	steven.trimble@asu.edu	Capstone instructor/mentor	
Sarah Oman	OSU	Engineering	soman.osu@gmail.com (temporary)	Capstone Coordinator	X
Susannah Howe	Smith	Engineering	showe@smith.edu	Capstone Director/Instructor	X
Bob Rhoads	Ohio State	Engineering Education	rhoads.2@osu.edu	Multidisciplinary Capstone Director	X
Beth DeBartolo	RIT	Engineering	eademe@rit.edu	Multidisciplinary Capstone Director	X
Courtney Pfluger	Northeastern University	Chemical Engineering	c.pfluger@northeastern.edu	Associate Teaching Professor/ Capstone Director	X
Dean Nieusma	CO School of Mines	Engineering	nieusma@mines.edu	Dept Head (interim acting Capstone Director--multidisc)	X
Robin Queen	VT	Biomedical Engineering and Mechanics	rmqueen@vt.edu	Professor (developer for COE Interdisciplinary senior design)	
Eli Patten	Univ. of Washington	Mech Engr	epatten@uw.edu	Asst. Teaching Prof. / Capstone lead	X
Stevan Hunter	ASU, BYU-Idaho	EE, CSEE	stevan.hunter@asu.edu	Faculty Asso	x
Anthony	ASU	Engineering	anthony.kuhn@asu.ed	Engr.	

Kuhn			u	Representative for multidisc. capstone	
Gary Lichtenstein	ASU	Engineering	gary.lichtenstein@asu.edu	Infusing entrepreneur mindset into all capstones	
Dean Knudson	NDSU	Computer Science	dean.knudson@ndsu.edu	International Capstone Project Exchange coordinator	X
Laura Southard	Oklahoma State	Engineering	laura.southard@okstate.edu	Interdisciplinary Capstone Coordinator	x
Junichi Kanai	RPI	Engineering	kanaij@rpiedu	Prof. of Practice	x
Mike Mancini	VCU	Engineering	mmancini@vcu.edu	Director of Capstone	x
Kathryn Dannemann	RPI	Engineering	dannek2@rpi.edu	Director, Multidisciplinary Design Lab & Prof. of Practice-MSE	
Jill Kaatz	U of WA	Engineering	jmd4@uw.edu	Director, Industry Capstone Program	X
Todd Polk	UT-Dallas	Biomedical Engineering	todd.polk@utdallas.edu	Capstone Director	X
Robin Ott	VT	Mechanical Engineering	rso@vt.edu	Capstone Instructor	X
Sid Deliwala	UPenn	Electrical and Systems Eng	deliwala@seas.upenn.edu	Capstone instructor	yes
Joe Juarez	ASU	IE/EM	joseph.juarez@asu.edu	IE/EM Capstone Lead & Lecturer	
Abdel Shuaib	ASU	Mechanical Engineering	Abdelrahman.Shuaib@asu.edu	Capstone instructor/mentor	X

Notes:
- Capstone organizing committee: capstonedesigncommunity.org (email: capstoneconf@gmail.com); slack channel name: Capstone Design Conference
- Above connection is also available at:

- Finding ways to create/coordinate multi university capstones
- Capstone/senior design is often considered a gateway to professional practice, regardless of discipline
    - Work with capstones including engineering, communications, art & design. Importance of interdisciplinary teamwork, importance in workplace growth.
- Attempt to overlap subjects can be difficult due to communication; chance for practice through capstone before entering into the workplace.
    - The potential for misunderstanding increases
    - Importance of demonstrating that all roles in a team are critical.
- AI is transforming the job market, a more valuable skill to teach interdisciplinary teamwork and problem-solving. Demonstration that the workplace is already asking for this and other soft skills.
    - Self-directed learning & teamwork/communication demonstrated as key takeaways from involvement in capstone.
- Common obstacles to interdisciplinary capstones documented in the research literature:
    - Accreditation requirements
    - Logistics
    - Bureaucratic roadblocks (prerequisites, departmental approval)
    - Shared physical space (after hours classroom/lab access)
    - Limited faculty time/incentive
    - Conflicting student schedules/demands; major requirements/ standards
    - Conflicting student perceptions of the value of other disciplines and roles
- Interdisciplinary capstones persist through at least two common means:
    - Grassroots efforts
    - Curricular (re)design

Q&A and Breakout Room Prompts

What strategies have worked?

What strategies haven't worked?

What are the (your) persistent challenges?

What are the possible solutions?

What other lessons learned are important to share or document?

What advice would you give someone who was trying to do this on their own?

Is what you are doing sustainable (if you left, would it continue?)

- Curricular Approaches Report Out:
  - What does curricular mean? Different meanings in different places.
    - Two examples of capstones that were organized through the programming efforts of the college to foster interdisciplinary capstone.
    - Both cases had programs designed to break down barriers & faculty assistance. Students are assessed like in a common curriculum.
    - Focus on professional skills. Students should pick up technical skills & learn those they do not have.
  - Lifelong learning is important to demonstrate in a group. Set up expectations at the beginning. Chances are that engineers assigned to projects will have to learn more outside their specialty.
    - How can we do more to prepare students for that?
      - Need to utilize strong research skills.
      - [Eli P, Univ WA]: we've had it where we dedicate one class to having someone from the engineering library come and demonstrate how to find journal articles and other resources, how to evaluate a source's trustworthiness, researching patents, etc.
  - Making interdisciplinary experiences possible - challenging, need windows of time to be able to build those interdisciplinary opportunities.
  - ABET - underplayed card to your advantage.
    - Curricular driven
    - 6 years to document work, then afterwards go to department, serves as a leverage point & play to advantage.
    - Junior level course created to develop soft skills in students & utilize ABET.
- Grassroots Approaches Report Out:
  - Importance in having appropriate communication for ALL involved (faculty, students, etc.).
  - Sustainability is key. If we remove current players in the team that are making this happen at the grassroots level, how will the program continue?

- - - Huge problem that hasn't been solved.
    - Make students feel a part of it & like adults in the real world. Create a professional culture within the program.
    - Make the program highlight-able by your department/university. Let students showcase their work & demonstrate how great their projects are.
  - Multi-country capstones: Talk to other colleagues in your school that may work with other universities & the study abroad office to aid in creating connections & developing an understanding of what would be required for formation & running a program of this kind.
    - Online teams - online courses with students from 4-5 countries. International teams perform well & have shown success with international teams. *Require **structure**, well-defined outcomes, adjustments for time differences.
      - Structure needs to be based on skills of your groups & outcomes.
- Three synthesized takeaways from the breakout groups (Gary L, ASU):
  - 1: Interdisciplinary capstones begin with inter- and/or intra-departmental communication between faculty. Those desiring to promote interdisciplinary capstones need to reach out.
  - 2: ABET criteria are not as much an obstacle to creating interdisciplinary capstones as are the structures and procedures for documenting ABET.
    - ABET is not supposed to lead us, we are supposed to lead it. It is supposed to be faculty driven, so do not let it be a barrier against your students.
  - 3: Interdisciplinary capstones could be the most effective innovation in engineering education in the 1st half of the 21st Century
    - Some students are hired right out of school because they bring new thinking into the workplace.
      - Need to make sure that the learning curve for new graduates is not taking too long to develop and shorten in the professional workplace.
- Listserv Vision
  - Utilize slack & would like to have a channel in there for communication.
  - Some individuals are more comfortable with email, listserv made available for those individuals.
    - Posting special workshops, papers on interdisciplinary papers, etc.

- Overall, every capstone is structured differently. May be another way to get those sessions & capstone styles developed properly with further consultations & considerations.

- Optional Discussion:
  - In industry, what really matters is the innovation that comes out of interdisciplinary work. Need to create effective, innovative outcomes that are distinct from team dynamics.

- - ■ Innovation in terms of client perception & metrics of assessment. Difficult to replicate in an academic setting.
  - ○ New textbook Product Design & Development Handbook (available December). Developed around a mechanical engineering course, both authors come from professors of practice. Structured for interdisciplinary capstone, as well as just MEs.
    - ■ Developed in response to capstones having 50% unfinished projects as final results. Utilization of described structure has resulted in all projects being finished, with ⅔ of the project being built to leave final troubleshooting for the end of the academic year's semester.
    - ■ Embraced by many companies & utilized by industry teams as well.
    - ■ 44 textbook learning modules that allow students to learn to stay on schedule & budget. Work with sponsors to manage scope to have something that gets done & completed by the end of the semester.
    - ■ Find that by senior year, students have a lot of knowledge, but don't know how to use it. Course allows them to work on how to utilize their skills.
    - ■ Also addressing entrepreneurial mindset, making space for creative thinking, research skills, addressing weaknesses/ communication within team & work distribution, proof-of-concept testing, etc.
  - ○ Find out more information from: Steven W. Trimble, PhD.: Steven.Trimble@asu.edu, 623-229-9070 (cell).

Questions/Discussion:
Chat:
- ● Link to join Capstone Design Community Slack: https://join.slack.com/t/capstoneconf/shared_invite/zt-te5aqc0x-2rVr_wVeSjw5xgcv~cb3l g
- ● Susannah Howe, Smith: 2015 Capstone Survey Paper: https://scholarworks.smith.edu/egr_facpubs/9/
- ● Susannah Howe, Smith - from "Capstone to Work" study (NSF funded) - Self-directed learning and communication skills are top ones that transfer from capstone to work. (We have a workshop at 9 AM PST at ASEE on Monday 7/26.)
- ● Interest in international capstone exchanges (Joe Juarez has experience of IE to IE between ASU and Mexico)
  - ○ Courtney Pfluger (Northeastern) interested in doing something w/ Brazil.
- ● *Eli Patten, UW MechEngr*: re life-long learning and how to 'teach' it - we've had it where we dedicate one class to having someone from the engineering library come and demonstrate how to find journal articles and other resources, how to evaluate a source's trustworthiness, researching patents, etc
- ● *Gary Lichtenstein, ASU*:
  - ○ **H1**: Interdisciplinary capstones begin with inter- and/or intra-departmental communication between faculty. Those desiring to promote interdisciplinary capstones need to reach out.

- - - ***Dean Nieusma, CO***: H1: Yes, and… Faculty communication and alignment is important. So too is admin support. Our "experiment" was initiated by a dean, who then on-boarded the relevant faculty to create curriculum and delivery model.
    - **H2:** ABET criterion are not as much an obstacle to creating interdisciplinary capstones as are the structures and procedures for documenting ABET.
    - **H3:** Interdisciplinary capstones will be the most effective innovation in engineering education in the 1st half of the 21st Century
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Curricular Approaches:

Things that work:
- ***Jill Kaatz, UW:*** doing interdisciplinary for a while but still some concerns -- ABET, logistics (grading, getting a student from each discipline…)
- ***Gary Lichtenstein:* Question - is interdisciplinary in the curriculum?**
    - ***Jill Kaatz:*** Industry one of the first times they had made it happen.
    - ***Todd Polk (UT-Dallas):*** we are multidisciplinary by nature - we teach the Biomedical and Mechanical engineers together in a single class. 80% of our projects have both students on the team.
- ***Steven Trimble:* Question - textbook or syllabus?**
    - ***Todd Polk:*** no textbook and syllabus is vague - all info is in the employee handbook for capstone since we treat them like engineers and not students
    - ***Junichi Kanai:*** Introduction to engineering design and no textbook at capstone level, they have common syllabus and common grading scales. For ABET each department has different assignments to fulfill the requirements for different disciplines
    - ***Steven Trimble:*** syllabus example for how to evaluate the different criteria for the disciplines?
    - ***Junichi Kanai:*** communication, teamwork, skill based criteria in between disciplines to measure ABET -- instead of using assignments to fulfill ABET they use ABET rubrics to measure they are following the requirements outside of the grading rubrics
    - ***Steven Trimble:*** one of the challenges in inter university programs one engineer one business - difficult for the engineer if the project requires a different field of engineering - any curriculum design to help students with that challenge
    - ***Anthony Kuhn:*** scoping design, take broad topics and allow the students to come up with their own solution -- real world vs academic world. Positive if well guided to give the students the opportunities to learn new skills
    - ***Jill Kaatz:*** default to always have two different disciplines in each team as a point of failure -- maybe one student isn't as engaged and they can fall back on the other
    - ***Mike Mancini:*** does the same
    - ***Bob Rhoads, Ohio State:*** can be challenging to do because the team can

become too large
- ○ ***Anthony Kuhn, ASU:*** positive to have one engineer because they are more inclined to participate and they can't hide behind a large team of engineers
- ○ ***Mike Mancini, VCU:*** Each department likes to have a faculty advisor - having more than one student of each makes it worth it for the advisors
- ○ ***Steven Trimble, ASU:*** Some engineers like to fall back on just using CAD, how do they deal with that? Sometimes they have one engineer and they are better at different types of analysis and they might not have the necessary skill sets to complete the project
- ○ ***Bob Rhoads, Ohio State:*** challenge the students and let them know that this is the industry life and they have to be able to learn a new skill set
- ○ ***Steven Trimble:*** Does it work?
- ○ ***Bob Rhoads, Ohio State:*** Students struggle -- but they realize the challenge is worth it and they learned a new skill they can take to the industry
- ○ ***Anthony Khun:*** Regardless of what type of engineering you are you have to know how to use those skills for different jobs
- ***Gary Lichtenstein: Question- Interdisciplinary capstone as a part of ABET accreditation?***
  - ○ ***Todd Polk, UT Dallas:*** Multidisciplinary capstones by default but not necessarily in their accreditation
- ***Gary Lichtenstein: How did you achieve having multidisciplinary projects?***
  - ○ ***Todd Polk, UT Dallas:*** Getting together and meeting with directors monthly and converse and work together to interchange students to fulfill project needs -- grading is similar since most of the deliverables are submitted as a team
- ***Steven Trimble: Question- Advice you would give someone if they are starting multidisciplinary capstone?***
  - ○ ***Todd Polk*** - New dean who was all for it. Get to know the other instructors, align with them with concepts on what your plans are for the course, put the students in one project and teach the course together
  - ○ ***Steven Trimble, ASU:*** What soft skills do you teach?
  - ○ ***Todd Polk:*** All of them, very little technical things are taught project management, communication, teamwork -- business school teaches
  - ○ ***Dean Nieusma, CO:*** ABET is harmonized and all the students take the same course no matter what their discipline is - they take modules for their specific discipline 5 options and they have to take 3
  - ○ ***Anthony Khun:*** Where do you source your projects from?
  - ○ ***Dean Nieusma, CO:*** - About 100% Sponsored - stakeholders relations managers who does it which requires a lot of administrative work
  - ○ ***Anthony Khun:*** How do you scope and do you decide how many of each discipline you need?
  - ○ ***Dean Nieusma, CO:*** - Yes, we scope the project to decide. Sponsors pitch their projects and students get to pick their top 10 and usually give them one of their top 3

Grassroots Approaches:

- Interest in international partnerships and there are multiple models.

- *Shayne McConomy (FAMU-FSU):* did a master's capstone between industry, engineering department and art school. Logistics/soft skills with industry difficult and important. Looking at doing International also. One way is to look at faculty and see if they are already partnered with international universities. Also maybe through the study abroad office - your university study abroad program might be able to help you connect.

- *Dean Knudson (NDSU):* There is a website that will pair you with a project internationally
  - Probably between 20 universities in US and abroad; CS, ME, EE, different engineering.In their model, no requirements for travel so don't have the issue of costs, approvals, etc.

- *Shayne McConomy (FAMU - FSU):* even between state travel can be challenging. A lot of approvals.

- *Q - Courtney Pfluger (Northeastern Uni.)*: **can you post the website you mentioned about pairing projects and universities?**

  - *A - Dean Knudson (NDSU):* try https://icpe.cs.ndsu.edu/

- *Shayne McConomy (FAMU-FSU)*: Experience with inter-university teams they would "mom and dad" us between faculty and sponsor/mentor. Make sure the students know that your "bosses" will talk to each other. I want my students to make all their mistakes with me so they don't make them in the workplace. Treat it like a job - they accrue vacation days and they can "request" a vacation day to use for a late assignment (but have to ask ahead of time). But the logistics are complicated.

- *Susannah Howe (Smith)*: Building a culture of reflection and sharing perspectives across disciplines.
  - Students have different perspectives of how to work through problems

Susannah Howe (Smith): Have done an interdisciplinary capstone across non-engineering teams but the faculty helping did it as an overload to their normal load.

Q: what are the strategies of doing this sustainably?

Beth DeBartolo (RIT): Interested in that topic - have multidisciplinary teams, but have been trying to be more intentional about involving non-eng disciplines in our teams. It has to be the just right alignment but it is very labor-intensive.If we can find a student doing a senior thesis in another major, where the topics align and they've already got a faculty advisor for that anyway, it

works out really well. Senior thesis is a typical requirement for our college of science and college of liberal arts.

Joseph Juarez (ASU): Herberger Institute for Design and the Arts (HIDA) Professor Cheryl Heller coordinates between Fulton Schools of Engineering, Business College and HIDA to maintain interdisciplinary communication. Opened a children's museum designed and built exhibits by the three school collaborating Capstones. Success due to a Faculty operating at a higher level with Deans responsible for communication across colleges/departments is very beneficial for creating new opportunities and allows for more work to be completed between disciplines.

Cassie Bowman ASU:
Q: Are there any tips on trying grassroots approaches?

Kathryn Dannemann (RPI): Working to incorporate management students into the capstone program. Takeaway: once the students were not incentivized to drop the class in order to participate in the capstone students were not likely to join.

A couple types of sustainability - your role, buy-in from your department, whether people are having to do this out of the goodness of their hearts (rather than it being part of their regular role).

Shayne McConomy (FAMU-FSU): Make friends with your marketing department and work with them to tell the story of your efforts.

Beth DeBartolo (RIT): Be able to "toot the students' horn". W/ COVID we replaced the showcase with 2-min lightning videos that are great for sharing, helping to showcase the special projects.

Shayne McConomy (FAMU-FSU): Patent Law students also have to do a capstone and have to do a patent search and they can work with teams to see if they can submit a patent for their project.

Curricular Reporting Comments

Eli Patten (UW MechEngr): re life-long learning and how to 'teach' it - we've had it where we dedicate one class to having someone from the engineering library come and demonstrate how to find journal articles and other resources, how to evaluate a source's trustworthiness, researching patents, etc
    ^we actually looked to the AACU Value Rubric for Lifelong Learning to help identify the individual skills to work on with the students. I can't say we've done a good job of it yet, but it's a work in progress. https://www.aacu.org/sites/default/files/files/VALUE/LifelongLearning.pdf This was really helpful for us, and it's discipline-independent.

Next Steps/Actions:

Gary's hypotheses:

H1 Interdisciplinary capstones begin with inter- and/or intra-departmental communication between faculty. Those desiring to promote interdisciplinary capstones need to reach out.

From Dean Nieusma - CO Sch of Mines: H!: Yes, and… Faculty communication and alignment is important. So too is admin support. Our "experiment" was initiated by a dean, who then on-boarded the relevant faculty to create curriculum and delivery model.
Corollary to H1: in the grassroots breakout, we seemed to drift back to curricular solutions, or grassroots efforts that failed/paused when support stopped, so while reaching out needs to be the first step, the exit strategy is probably to get it institutionalized at your university. At least that was my take on the discussion in that session… (Beth DeBartolo, RIT)

H2 ABET criterion are not as much an obstacle to creating interdisciplinary capstones as are the structures and procedures for documenting ABET.
Shayne - yes - ABET should work for us and is designed to. Use it to your advantage.

H3 Interdisciplinary capstones will be the most effective innovation in engineering education in the 1st half of the 21st Century (we can't solve the problems of this century without breaking out of our silos).
- Todd Polk (UT-Dallas) Agreed! It is the way of the world. You rarely if ever go to work with just engineers from your major.
- Steven Trimble, ASU: New graduates are what companies are looking for. Due to the new ideas and ways of thinking that graduates bring to the table

Q - Dean Knudson (NDSU) : When people integrate CS, how do you keep them busy the whole time?
A - Cassie Bowman (ASU):
  - Be a sponsor & mentor for that team.
  - Have deliverables throughout.
A - Beth DeBartolo (RIT): They may go their separate ways for a while, but they work parallel and eventually bring it together
A- Shayne McConomy (FAMU-FSU): Plan out the timeline of what you need & where. Potentially have a spring project for CS & that program developed is then used by engineers in the fall.
A- Jill Kaatz UofWA: Heavy interest in interdisciplinary teams by sponsors, but need to make sure each student will have the full capstone experience.

Q - Eli Patten (UW MechEngr): In terms of the landscape of design of the textbooks out there, how do you think this fits in? What makes yours stand out?

A - **_Steven Trimble:_** - Those books are good talking about design but not good of keeping students on track for the timeline and budget. Students get lost and what we did is create structure for students.

Q - Ideal team size for an interdisciplinary team?
A - _Steven Trimble:_ I used to think 4 but 5 or 6 work well. It helps to have >1 engineers on an interdisciplinary team, or even 2 from same discipline on multidisciplinary team.