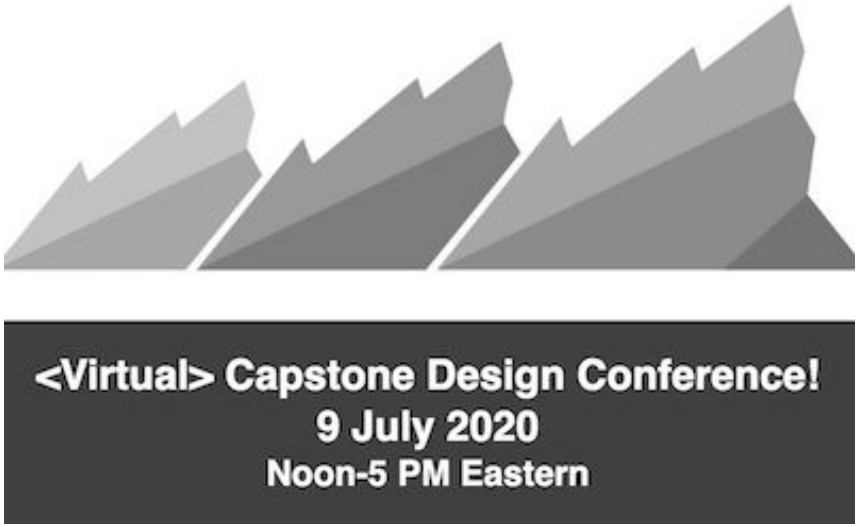



# Scoping Projects

*Facilitator:* Shraddha Sangelkar

*Zoom Host:* Beth DeBartolo

*Scribe:* Amy Hortop

*Chat monitor:* Laura Hirshfield, Libby & Alexis

*Panelists:*
Kris Jaeger-Helton
Steve Beyerlein
Dean Knudson

# Ground Rules

- Change your name to help us recognize you eg. *“Kamal Sarkar”*
- Use private chat *(recorded by default)* to connect with other attendees
- Zoom Polls to get attendees background
- Have questions or comments?
  - Add questions comments to this document
    - Separate sections for questions and comments
    - Use “@” to if you are following up on someone’s response
  - Or add your questions to the zoom chat
- The zoom chat is monitored and organized on the live notes
- Zoom features NOT monitored
  - Raising hand
  - Breakout rooms (not setup)

# Tentative Agenda

| **Timeline (approximate)** | **Activity** |
|---|---|
| 2:45 | Welcome* and ground rules |
| 2:48 | Introduce panelists |
| 2:57 | Audience Polls |
| 3:00 | Go! With previously submitted questions |
| 3:10 | Go! With live questions |
| 3:25 | Questions for the attendees |
| 3:40 | Wrap up, concluding thoughts |
| 3:45 | End |

# Session Introduction and Motivation

*Welcome everyone! … We love Capstone in part because it is applied, authentic, and dynamic. While the uncertainties of the Capstone Experience teach much more than just the technical elements of the projects, we are finding ourselves navigating more uncertainty than ever these days. How do we scope projects to satisfy client expectations, project requirements, academic timelines, and ABET as well as offer our students the rich, challenging, and rewarding opportunities that are unique to Capstone? We will present some fruitful discussions we should have with our clients ahead of course start-up, introduce some in-course methods and tools to remain agile, as well as suggest ways to finish strong when Capstone concludes. Our panelists will walk us through some ideas and strategies from their own experiences as well as share best-practices learned from others like yourself. While there are no magic answers, we are excited to get the conversation started and exchange ideas among ourselves. Thank you for seeding a thoughtful set of questions to get us started.*

# Panelist Bios

***Dr. Kris Jaeger-Helton*** *is a Teaching Professor in Mechanical & Industrial Engineering and Director of the Industrial Engineering Capstone Program at Northeastern University. She teaches Human-Machine Systems, Simulation Modeling & Analysis, and Facilities Planning, as well as Coordinates and Advises in Capstone. Kris has advised a variety of teams including international projects, healthcare-focused, community partners, and product design. At Northeastern this summer, she helped co-coordinate their first offering of all-online Capstone. While her doctorate was in Human-Machine Systems Engineering, Kris also minored in Cognitive Psychology. She has worked in industry and has done quite a lot of consulting in engineering design and forensic cases. Kris has a passion for empathetic design as well as any process that makes a system more usable and efficient for all. She loves getting to work with brilliant students, clients, and colleagues in Capstone and beyond.*

***Dr. Steve Beyerlein*** *is a Professor of Mechanical Engineering at the University of Idaho. He began teaching capstone design in 1996 and played an active role in shaping the current college-wide interdisciplinary program. Each year this program annually involves more than 30 externally sponsored, two-semester projects that engage more than 130 students, 8-10 faculty members, 6 graduate student mentors, and 3 technical staff. He has a long-standing interest in the design pedagogy and design assessment, having published several dozen articles in this area.*

***Dr. Dean Knudson*** *is an Associate Professor in the Computer Science Department at North Dakota State University. After 40 years in industry (Bell Labs, ITT - Advanced Technology Center, Honeywell - Systems and Research Center, Northrop Grumman, and Microsoft) he began teaching the Computer Science Capstone class at NDSU. This is a one-semester class with 85-90 students who work on 20-22 industry-sponsored software development projects each year. He has a strong interest in International Capstone Project Exchanges and his teams always take on some international projects every year working remotely.*

# What would you like to take away? (attendee responses) 1

## Getting ready for upcoming year, what others are doing?

- How the various institutions are handling project scoping during these unprecedented times.
- Best ways to conduct a Capstone class virtually
- Plans for Fall 2020
- Ideas on framing a capstone for mechanical engineering technology assuming completely virtual
- I simply want to see what others are doing to address this issue and maybe take away some ideas.

## Balancing Expectations

- How to get students to plan and execute projects to deliver a quality design or prototype, Balancing reduced scope vs project value to the sponsors.
- Managing students' expectations and helping them adjust to project modifications.
- Picking the right project from a sponsor perspective but also from a student development perspective
- Working with students to scope engineering projects such that we might be able to balance the course learning objectives with their learning situation (on-campus, off-campus, with access to equipment, without access, distributed or in-person).

# What would you like to take away? (attendee responses) 2

## Prototyping/ Hands-on

- Alternative approaches to creating prototypes, particularly for students who no longer have access to facilities;
- Improved ideas on ways for teams to prototype designs without travel - shipping parts and subsystems, remote guidance for "makerspace" staff, etc.
- Ideas for keeping some sort of hands on aspect for all students, even if they might be at home/online.

## Project Selection Criteria

- **Analytical Projects** Primarily interested in scoping analytical projects to lessen the burden on our shop resources.
- **Project Related to COVID-19** I believe the best projects will be related to Covid-19. What criteria and methods can be used to assess potential design team projects?
- Learning appropriate scoping for a relatively new (4 years) capstone program.
- General on scoping -- new to capstones
- Some ideas on how to scope for remote learning environments when students might not have computational backgrounds

# What would you like to take away? (attendee responses) 3

## Stakeholder interviews

- alternatives to customer interviews and field observations, particularly those observations that involve clinical projects.

## Adapt Deliverables

- Ideas to manage and adapt deliverables of projects in the current context
- establishing teamwork and communication remotely for class, advisors, and students

## Rubrics

- Understanding capstone rubrics

## Moving projects Online

- Ideas for how to move projects online, if required.

# Ask your Questions

# Ask your questions -pg1

For certain projects, the coordinator may do initial scoping work, but then find the client has different expectations once they actually meet with the team. Additionally, the client may have expectations that students will have access to facilities that are no longer available due to COVID. What are strategies for managing client expectations, both before the project team is assembled, and after? *-Thea Pepperl*

I can rarely convince our industry partners/ sponsors to consider analytical projects. If you have any advice during this time especially on creating the correct scope of analytical projects, that would be greatly appreciated! *-Sarah Oman*

Our students already selected their projects for next year. Do you think it is possible to still change them. *-Firas Hassan*

What are suggestions on adapting project deliverables if prototyping is not possible , or if a sudden switch to online mode only is needed. What is a good list of deliverables if the design project is only "on paper"?
*-Tim Guggisberg*

How successful were students in revising their project scopes last spring? Were "designs on paper" acceptable to sponsors?
*-Darin George*

# Ask your questions - pg2

We understand that some programs have strong industry connections and rely heavily on industry mentors for project ideas and working with student design teams. Some programs generate project ideas internally. Some programs have all student design teams work on the same project idea during a given year. There are challenges with assessing the appropriateness of project ideas when relying on industry engineers for project ideas. What are the approaches used by the panelists for finding project ideas and assessing their appropriateness whether from industry or internally generated? What pros and cons do they see with the different approaches for soliciting project ideas and relying on external mentors?
*-Kevin Janni*

Will the session go beyond scoping projects to discuss other ways a capstone course might compensate for uncertain constraints? *-Alan Cheville*

Easy to learn and relatively accurate computational models - does this exist?? *-Soraya Bailey*

"Thoughts on dynamically adjusting scope during a semester. Based on observed team performance, I find it necessary to ""dynamically scope"" projects on the fly, either raising the bar if needed or more commonly, ""bending"" it to better fit the team's observed interests / capabilities. *-Mark Anderson*

# Ask your questions -pg3

How do you ensure students communicate with the customer adequately?
*-Stephen Sundarrao*

What are some of the best ways to have Capstone teams meet virtually and have each member participate to the fullest.
*-Chuck Boehmer*

Are there any ways to encourage collaboration between design teams to help approach problems in new ways and create meaningful discussions? *-Ryan C Cooper*

I would love to know what other folks are planning in Electrical and Computer Engineering Capstone for Fall 2020 semester
*-Sid Deliwala*

How to manage student, sponsor and faculty expectations
*-Rachael Brown*

This will be just my second year teaching so I'm really just coming to learn. Heard that this is a great conference to attend, from my peers, so I'm bummed that we can't meet in person. However, thrilled that you all have still made this event possible. *- Monique Marquard*

How to scope projects in an interdisciplinary capstone program that isn't guided by accreditation, professional licensing guidelines, or a long history of practice? *- Natalie Hunt*

# Ask your questions - pg4 General

- Using the finished projects could be successful? If yes, What are the best method to make use of the finished project?

  **Reply @Steve:** Above and beyond supplying deliverables to your clients, whatever archiving system you use to capture project/team accomplishments, can be productively incorporated in course orientation with future students as well as recruiting future projects. Here is the URL for Univ. Idaho wikisite http://mindworks.shoutwiki.com/wiki/Capstone_Design_-_By_Year

  **Reply @Dean**: We do a similar thing where each team produces a 3-5 minute video describing/demoing their project. Here is the link to the NDSU site http://csprojects.cs.ndsu.nodak.edu/capstone/PreviousProjects/ These only add about 4 hours extra work since each student team must do a formal 30 minute final presentation to the sponsor, which included a demo of the end results. Students like having these videos since they can be used to show family/friends what they did as well as occasionally be added to their resumes.

# Ask your questions - pg5 General

- Any links to a comprehensive list of Capstone related rubrics? Especially to help with scoped projects (http://cdhub2.org/!) **Reply @Steve:** This is a great resource. Thanks Susannah and others for sustained effort in compiling these.

- We've also been looking at the AACU VALUE rubrics, which are surprisingly (maybe not surprising) relevant to capstone. **Reply @Steve:** Yes, these are well-grounded and a helpful starting point. I encourage you to customize for optimal stakeholder engagement. Starting with items from these as well as other sources, we have received excellent advisory board feedback on items/scales for various design review and presentation tools that we regularly use with our clients as well as in our end of year Design Expo.

# Ask your questions -pg6

@Dean: How do you get students to choose tasks that are an appropriate duration? I love the idea of delivering something completely rather than everything incompletely! **Reply @Dean:** It takes some work but I meet individually with each industry sponsor (20-22 per year) to go over their project for the coming year. We try to establish a "core" set of features that would be a minimum to satisfy the sponsor then add several "nice to have" features. All teams should be able to complete the "core" with the best teams finishing all features. We use an Agile process where something of value is completed at the end of each sprint. **Reply @ Kris:** No question, it's challenging as each project, sponsor and team is different; the teams will continue to focus on meaningful and measurable results for their project on a regular basis. Another strategy that has been helpful is the directive to deliver something early - at the end of Capstone 1. We are also mindful of selling short at the end of Capstone and an inclination by some to only do what can be finished. While tangible deliverables are key, staging for additional work and sustainability is also expected. Customized scoping involves both deliverables and planning for the future.

@Kris: I like the analogy discussion. I recently heard a podcast on handling "plan continuation bias." This tendency has led to many lost lives through shipwrecks, airplane crashes, etc. - Keith Stanfill **Reply @ Kris:** Yes, too much planning inertia has affected ability to pivot **Reply @Dean:** One thing we do is each team hold a postmortem at the end of each sprint. They reflect on what went well, what didn't go well and what they would do differently in the next sprint. That postmortem takes place before planning for the next sprint.

# Ask your questions -pg7

@all: How do you scope projects to be completed virtually? Are there easy to learn computational modeling tools that can help when scoping projects? (this is relevant for multi-disciplinary teams with various backgrounds) (thanks :) ) **Reply @ Kris:** Great question! No one size-fits-all for this, but creating milestones to be met and delivering on those is one method; another involves excellent hand-offs, training and facilitator material, as well as next-phase staging. **Reply @Dean**: Using an Agile process helps a lot. Each sprint is designed to deliver something of value so stopping after 4 of 5 sprints would provide the results of the first four. Also, we use formal configuration management systems to store versions of all documents and code, which is available at all times to students/sponsors/faculty. The most up to date documentation and code is always safe and secure.

@any I will love to see some survey regarding how much money is given per student or team, typically that is not an industry sponsored project? For U of Texas Rio Grande Valley it is $150 per student or typically $600 per team - Kamal Sarkar (Check Susannah Howe's papers on surveys of capstone instructors. **Reply @ Kris :** Also done during the session, thanks to Beth B

# Ask your questions -pg8

At the beginning of the project, often students think they know how to design/produce the product. However, as they proceed into analysis, they discover there are uncertainties that they are unsure how to address. At this point, the are **tempted to scale back the scope** to something that might be embarrassingly trivial and claim it will be sufficient. In Agile projects this is manifest in picking features they know how to address in early sprints/iterations while persuading the client it is okay to delay the difficult features until later (delay in this case is the deadliest form of denial). As a project advisor or mentor, how have you dealt with this?

**Reply @ Kris:** We have seen this happen. Some approaches include the expectation to deliver to the client on an ongoing basis, even if in increments. Also, letting the students know directly that this approach is not intended; rather we need to focus on the client's definition of success and any modification will need to be agreed upon by ALL involved stakeholders and Capstone leadership. Finally, while Capstone is meant to be a synthesis of all previously-learned material, we REQUIRE each team to learn something new to in order to contribute to the project. In some cases, this new competency is not used, but then becomes part of an informed decision to NOT use the tool.

**Reply @Dean:** By defining a "core" set of features and "nice to have" features the team should never be able to cut the core. We also require student/mentor meetings weekly where the mentor would be updated on changes and would have to approve them.

**Reply @Steve:** Begin the project by having students interview their client and jointly support them in writing specs at a high level of challenge. Don't lower the bar pre-maturely and without good reason.

# Ask your questions -pg9

- Any links to a comprehensive list of Capstone related rubrics? - S Zekri
  - Estell and Hurtig, "Using Rubrics For The Assessment Of Senior Design Projects" - https://peer.asee.org/486
  - Denny Davis, “Design Thinking: Practicing Design Competence”

- @Steve - What kinds of “machines” did you make remotely accessible? **Reply @Steve:** Personal copies of some software (like SolidWorks) can be supplied to students based on the size of our site license. Other software tools (MatLAB, EES, MathCAD) routinely used in campus labs are available through a Virtual Lab portal accessible by personal computers. Dedicated access to higher power machines for complicated SolidWorks, CATIA, ANSYS models is done by giving a small pool of students remote logon access to specific campus machines that would otherwise be idle (we will likely use this for extending lab hours in subsequent years). Jobs for 3d Printers, laser cutter, and CNC equipment are stored on a server and their implementation is mediated by graduate students who had building access (unavailable to the general public).

# Ask your questions -pg10

- we are thinking of merging two semester capstone into one semester (spring 2021), any thoughts (EE/Comp E/Systems)?
  - We went from a single semester to two semesters (actually a 2 credit course in Fall and 4 credit in Spring) years ago, mostly because doing all the things they need to do takes TIME, including some time to just mull things over.
  - we remain 1 semester as our soph course looks a lot like many first semester capstones - except for the disconnect on the projects. BUT - many (most) of our projects are multi-semester.
  - We've always had a one semester capstone, but we are building design-based, not product. - Z Rockow
  - Is going to one semester about making it easier on the students or on the instructors? Earlier it was noted that longer capstone experiences help students have a chance to take risks.
  - We get confirmations of projects in Spring, then get project scopes closer to the start of the school year. R Brown

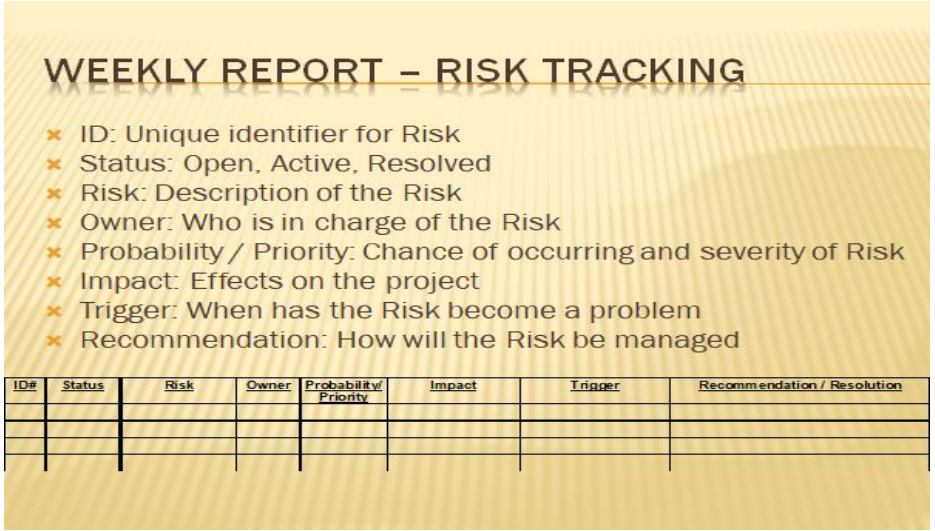
    **Reply @Dean:** At NDSU we have a one semester capstone in Computer Science. The projects (20-22 per year) are all industry sponsored development projects. The results are very often used as soon as they are delivered (sometimes after some fine tuning by the sponsor). Our sponsors generally like this model since they can define the project in Nov/Dec then get the results in May. Software projects that have to wait for a year are often considered too long.

# Ask your questions -pg11

- Question to ALL: If you find textbook/handbook that covers Capstone Design Process in a structured way, would you consider it for your capstone course? - A Shuaib
  - we use Ulrich & Eppinger Product Design for the soph class that teaches the design process and refer to that constantly in capstone - Mark @ RPI
- Is going to one semester about making it easier on the students or on the instructors? Earlier it was noted that longer capstone experiences help students have a chance to take risks. **Reply @Steve:** It is worthwhile to read the various national surveys that Susannah Howe's has done over the years, presented at past Capstone Conferences, and published in IJEE as well as ASEE. **Reply @Dean:** See answer to a previous question. One other thought. Since capstone is a required course, if we changed to two semesters, we would be under lots of pressure to remove a different course from the required list and there would be push back on that.

# Ask your questions -pg12

- Due to the uncertainty, has anyone considered having students do a "Business Continuity Plan" at the beginning of their projects?
  - Companies and design firms always have continuity plans to assist if “someone was hit by a bus” is the term my first construction manager used to say. - Z rockow
  - **Reply @Dean:** We don’t call it that but we do a formal Risk Analysis with in-class training which includes plans for what to do if a risk is triggered and turns into a problem. An example would be →
  - **Reply @ Kris:** At the beginning Of Capstone 2, we have all team Conduct a SWOT Analysis and Outline how to address the prospective weaknessnesses and threats related to the project. We don’t use a particular SW, but this is a good overview: https://www.projectsmart.co.uk/swot-analysis.php



# Ask your questions -pg13

- We will be requiring students to conduct a risk assessment of their project schedules and create risk mitigation plans to reduce risk and threats to their schedules. J Goldberg
  - I'm having student teams put design schedules that assumes 1) in-person/remote and 2) remote. - C Zapanta
  - Our projects are not about starting businesses. Our students will use the risk assessment approach described in the Harvard Project Management Manual. - J Goldberg
  - we have started doing this with our sponsors this summer. We are looking at how to integrate this in with the students - beyond our traditional risk mitigation plans. - Kotys-Schwartz
  - Also we train our students with NSF I Corps [TM] program - K Sarkar
  - **Reply @Dean:** COVID-related risks were added by all projects last year as they became more obviou (the risk tracking table mentioned above is included in the weekly report and thus updated weekly). This coming year they will show up in the first version of the weekly report.
  - **Reply @Steve:** Don't overlook traditional risk management/project learning issues in capstone design
    TYPE 1 Information known to instructor and/or sponsor, but not the students
    TYPE 2 Information unknown to instructor & students, but known to the sponsor
    TYPE 3 Information unknown to instructor/students/sponsors but known by global community
    TYPE 4 Information unknown to the larger global community
    TIP: Invest time with sponsors talking about managing these issues prior to course start-up.

# Add Ideas or Comments

# Add comments -pg1

We did project continuity planning as soon as news about Covid broke. I think we should do this at the beginning of the school year so that the students are already thinking about how to complete their project in a meaningful way if things change due to the pandemic. *-Rachael Brown*

don't give up and not ask students to build their prototype. *-firas hassan*

Generally, sponsors fill out a form to submit their projects to the program. And then the conversation follows about project scope. Adding more questions related to the current scenario to this form helps us understand the sponsors' side. *- Rachana A Gupta*

I think students' situations are going to be variable, so being flexible will be key. I'm currently thinking that this will mean that I need to identify multiple paths toward success in the engineering project. Helping students to identify realistic success criteria early in the project will probably be critical. *-Robert Nagel*

Do not expect a lot out of students till end of Fall 2020! There are so many unknowns and as I am meeting teams during summer, I realize that students are also worried about their family members health and they want to be useful if one of their parents fall sick. International students are particularly worried about the new directive https://www.ice.gov/news/releases/sevp-modifies-temporary-exemptions-nonimmigrant-students-taking-online-courses-during *-Sid Deliwala*

# Comments and Ideas pg 2

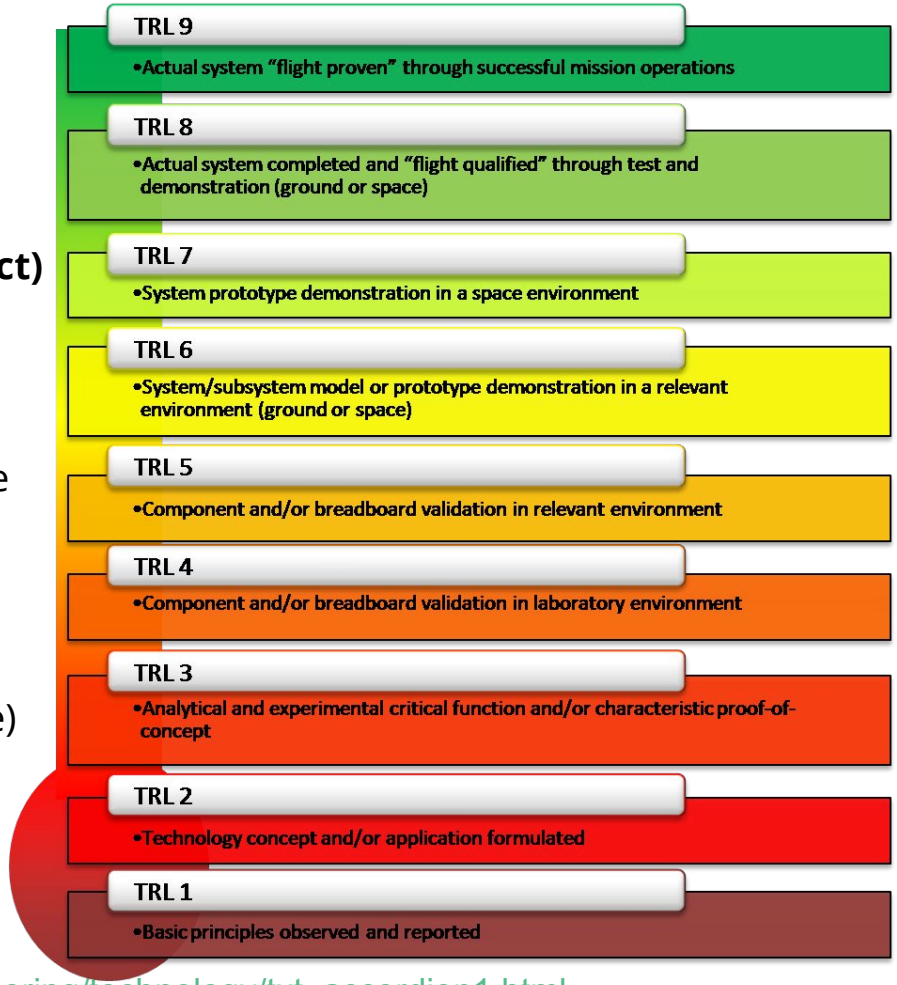
**TRL APPLICATION IN CAPSTONE PROJECT SCOPING (know the starting point/ending point for each project)**

**TRL 1-2:** hypothesis-driven research to understand key physics (not appropriate for capstone projects)

**TRL 3-4:** proof-of-concept experiments that demonstrate models (could include experimental fixtures that verify material properties, determine key variables, feasibility)

**TRL 5-6:** working prototypes that begin w/customer requirements and include some testing (typical capstone)

**TRL 7-8:** refinement/testing of prototypes with exacting specs applied in actual use environments (often the goal of multiple capstone cycles)




**NASA TRL** https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html

# Comments and Ideas pg 3

**TIPS FOR PROBLEM SCOPING DOCUMENT**
**(done w/client prior to course start-up & shared w/students in project selection)**

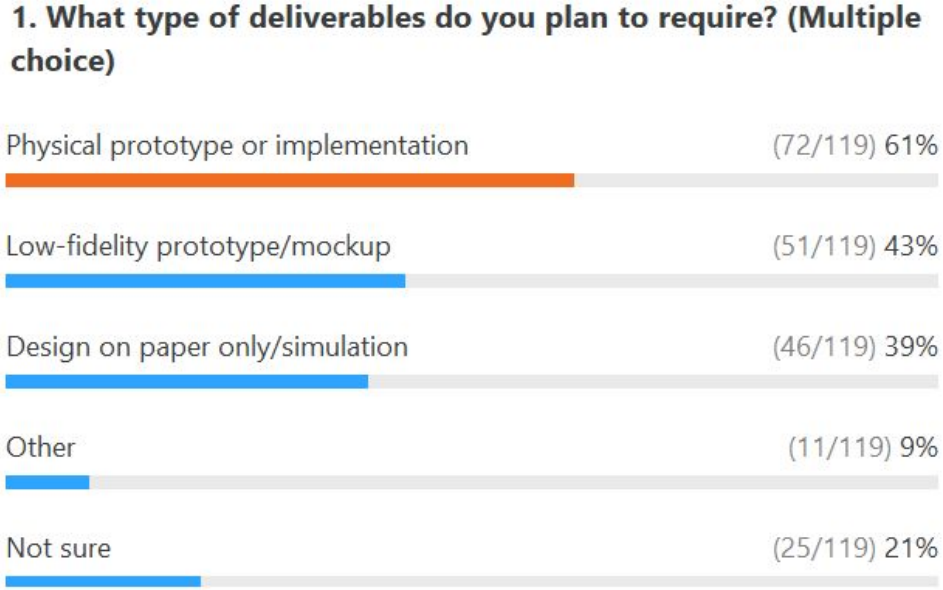
- **Short and to the point *(no more than one typed page)***
- **Descriptive, accessible, and attractive title *(especially to a student audience)***
- **Brief *profile of the sponsor* with whom students will be working**
- **Short statement surrounding the *context* surrounding the problem to be solved**
- **List anticipated *deliverables* and provide insight about the technology involved**
- **Consistent with other scoping write-ups so that students, if they are allowed to pick their project, can make an informed choice discriminating among different options**

**=> Remember that an important capstone instructor responsibility is coaching the client! This includes orienting them about your program/institution, your intended capstone course learning outcomes, and your professional development philosophy/process.**

# Add comments -pg4

What deliverables are required in your program?

- Most of our Civil and Env Eng students develop paper projects. Our ME, BioE and ECE students generally produce physical prototype - R Ryan
- We've had some civil engineering teams build scale models of their final design. Very useful when doing presentations, especially for the public. - S Howe
- Civil can do CAD prototype simulations - K Stanfill
- Agreed, in chemical engineering for designing whole processes are simulations but hard to make a prototype - C Pflunger
- This article might be helpful when determining what teams will be able to create for a prototype: https://www.embs.org/pulse/articles/finding-alternate-resources-for-completing-senior-design-projects-during-the-current-covid-19-pandemic/ J Goldberg
- ME students at Arizona State U Deliverables include: prototype that is tested and verified against technical requirements, Well documented notebook, final report, portfolio to show meeting ABET outcomes, final presentation in front of an committee of engineers and faculty. - A Shuaib

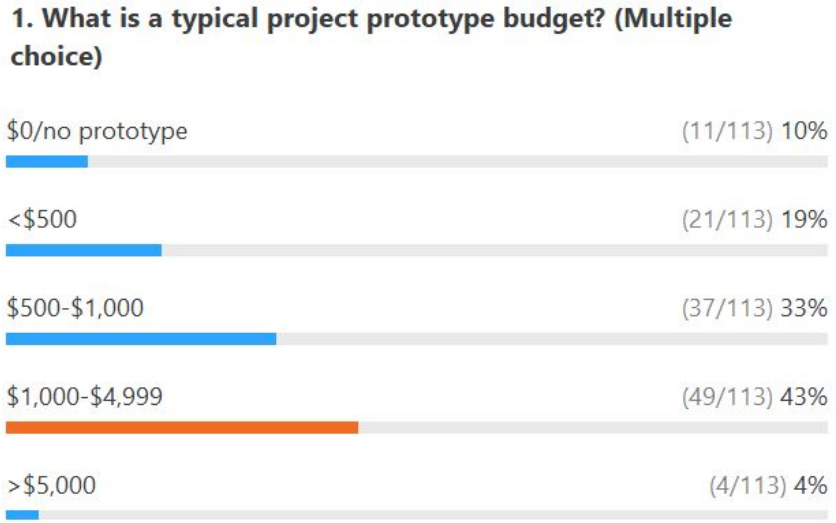


# Add comments -pg5

- Many instructors use CATME
  - https://info.catme.org/
  - I saw a demo of https://www.edusourced.com/ and seems like a great way for teams to work and mentors to check in - S Deliwala
  - C Zapanta emphasizes a student reflection on catme results
- Hype cycle: https://www.gartner.com/en/research/methodologies/gartner-hype-cycle
  - the IDEO Mood chart is analogous to the hype cycle A big U shape over time 1. Hope, 2. Insight, 3. Confidence - K Stanfill
  - ***REPLY @ Kris:*** *That's the idea, Keith!*
- On the notion of students "not pulling their weight" — there might be legitimate reasons that students are having difficulty contributing. - J Turns
  - Students in remote areas may not have access to prototype building resources or quality Internet connections, which can contribute to them not doing their fair share of work. - J Goldberg

# Add comments -pg6 Prototype budget

- Our course doesn't have a prototype - Z Rockow
- If students can create a design using SolidWorks or similar software, they can send the file to our machine shop for 3D printing. - J Goldberg
- For ME students in U of Texas, Rio Grande Valley I have abandoned paper work in favor of usb so that students can add reports, videos, technical papers, etc. - K Sarkar
- Funds are not always spent on building prototypes.  Sometimes funds are needed for activities such as benchmarking, product testing, travel, and learning about potential technologies and/or components. - R Nagel
- our campus has a Webex license... and we did what Steve just described.. - Mark @ RPI
- Budget info reported in S Howe's survey: Capstone Survey Data (1994-2015): http://cdhub2.org/links/capstonesurveys/




**I tell my teams they have a $1 Million dollar budget. But that I approve all purchases, so they're only getting things they can demonstrate legitimate need for.- Aren Paster**

# Add comments -pg7

- One student from each team was given an upgraded Zoom membership so they could have lengthy meetings as needed and set up as needed. - R Monfredo

- A 6 member team is given $600 and are required to spend 10-12 hrs/week/student. Projects are selected by teams based on satisfying certain checklist requirements. -Abderlrahman Shuaib

# Add comments -pg8

- Our ME program has always tended to have a lot more internally sponsored projects than externally sponsored, which makes coordination easier. When we do have competition projects like MiniBaja these are typically student proposed projects and are often some of our most well oiled teams.

- Expectation setting with clients has been a large part of our summer. Making sure that they are also ready to modify scopes in spring (for a 2-semester course) if needed.

- Students need contingency plans and preventive actions to reduce risk. In current environment, this includes a student getting ill or needing to withdraw for various reasons.