TE 390: Innovation and Engineering Design

Technology Entrepreneur Center
GRAINGER ENGINEERING

Spring 2024

- **2 credit hours**
- **Wednesday**
- **10-11:50am**
- **0018 CIF**

Instructor

Professor Mark Karasek
mkarasek@illinois.edu

Office Hours

Sign up available at
https://calendly.com/mark-karasek/15min

Professor Karasek has decades of experience leading innovation in the enterprise and years of experience coaching startups. The course content is based on real life experiences in developing and leading organizations that are the primary drivers of innovative growth in the enterprise.

Course Purpose

In this course, students will learn the tools and processes of engineering design. Teams of students will propose projects, including a “grand challenge” project proposal and an enterprise engineering project proposal. This course will frame the engineering design process as a well-structured intellectual discipline that harnesses creative energy for effective innovation and problem solving. Topics taught include: Problem identification, validation, and justification; Requirement’s identification, documentation, and verification; Decision making and prioritization; Quality Functional Deployment; Market analysis; Team building; Product cost documentation; Phase gate, agile, and lean startup process and leadership; Solution verification; Project monitoring, reporting, review, and revision; Technical presentation and persuasion skills; Ethics; Materials cost analysis; Project gates, resource allocation, and schedules; and Intellectual property.

Learning Objectives

Upon completion of this course, you will be able to:

1. Explain how engineering differs from science.
2. Explain how to identify and evaluate problem statements and demonstrate ability to create a problem statement justification.
3. Identify solution requirements and existing solutions for the identified problem.
4. Identify and evaluate potential new logical and physical solutions for the identified problem.
5. Summarize and utilize the necessary steps to create a physical and logical solution design.
6. Perform tolerance and risk/failure mode analyses and develop a verification test plan.
7. Utilize Quality Functional Deployment to translate customer needs into engineering requirements and specifications.
8. Define project proposal, project and solution cost, resources, schedules and review gates.
9. Compare and contrast the basic process and leadership differences between phase gate, agile and lean startup product development processes.
10. Explain and analyze a typical product lifecycle.

Course Site

Canvas: TBD

Grading Policy

Final presentations may be scheduled outside normal class hours in lieu of a final exam. The midterm project review will consist of a presentation of Problem-Validation and Requirements-Verifications pairs, along with the corresponding assessments of risks and uncertainties, associated with a 'global challenge" identified by the student team. The final project review will consist of a typical project pitch that might be done in a medium to large enterprise by a team seeking funding for a new product development project. The topics for the final project will be based on business cases assigned by the instructor. The presentations will include project scoping, quality functional deployment, product requirements and proposed project schedule.

Attendance, Effort and Participation	**20%**
Homework (Design Steps per Topics)	**30%**
Project Reviews (2 @ 25% each, Midterm and Final Presentations)	**50%**

Grading Scale

A+	97-100	B+	87-89	C+	77-79	D+	67-69
A	93-96	B	83-86	C	73-76	D	65-66
A-	90-92	B-	80-82	C-	70-72	F	Below 65

Expected Student Time Commitment

This class will have 50 minutes of faculty-led instructional time per week. There will be an additional 50 minutes for student-led activities during the instructional time per week. Students should plan on another 4 hours per week on average for homework and project activities.

Attendance Policy

Attendance at all classes is required and is crucial to your learning and success in the course. If you are unable to attend a lecture or workshop for any reason:

1. Don't panic! Everything will be alright.
2. Email Prof. Karasek ASAP with a brief explanation of your absence.
3. If you're ill, take the necessary steps to get better, your wellbeing is more important than homework. Get documentation of your illness.
4. Inform your teammates. Teams are inherently interdependent, and your team needs to figure out a plan to compensate for your absence.
   When you return from your absence it is your responsibility to catch up on content and work that you have missed. The course staff will help you and make reasonable accommodations, but you must be proactive and sincere about this. Please refer to the university's guidelines for additional information: https://studentcode.illinois.edu/article1/part5/1-501/.

Academic Integrity Policy

Your best guides to decisions around academic honesty in this class come in the form of two considerations:

1. Is your current course of action helping you learn the material?
2. Would you want your friends, family, and colleagues to know about your decision making?

Here are some specifics: This course includes 2 group assignments. During these assignments you will collaborate on several tasks. You are permitted and encouraged to discuss your findings and resources, and you will write your report as a group effort. Therefore, it is important to understand that you are responsible for the academic integrity of the entire report, including contributions of other group members. To avoid potential problems with academic honesty (and to more fully engage in the project), you should be involved in various aspects of writing the report, and you should verify that citations are correct and that all text is accurately cited and not plagiarized. At the end of the report, you are required to provide a clear statement of the contributions of each member of your group to the group activities. If you feel that problems are developing in your group project, you should come to see me early, so that I can provide general guidance to group members to set your activities on the right course. As you are responsible for the entire assignment, it is incumbent upon each of you to ensure the integrity of the project. When in doubt, talk to me, I am here to help.

The University of Illinois Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Course Content and Outcome Summary

Enduring Understanding:

- Engineering is an intellectual discipline defined by process.
- The design process is powerful, effective, and expands the abilities of those you practice it.
- Technical skills and technological resources must develop in step with a framework to understand, harness and direct them to desired ends.

Skills:

- The ability to identify and frame a problem and its solution through the problem-statement- validation paradigm.
- The ability to decompose a problem into requirements and synthesize requirements into a design.
- The analytical prowess to match tests to requirements in the verification process.
- The construction of a reasonable and ethical framework for risk analysis and mitigation.
- The presentation of a design in context of a sit-down design review.
- The presentation of a proposal for a project in a pitch-meeting.
- The ability to recognize the diverse skills and resources needed to solve a problem and build a team accordingly.
- The ability to translate customer requirements into product requirements and technical specifications.

Knowledge:

- The main elements of the design process.
- The elements and outcomes of a design review.
- The ethical code of at least one professional organization.
- At least one example of iterative design and the outcomes.
- Exposure to at least one realistic enterprise project proposal and plan.

Tentative Schedule, Topics, Content, and Assignments

Week	Topics	Learning Content	Assessments / Deliverables
1	• Course goals, syllabus and schedule • Relationship between science, engineering and technology • Design process • Problem statement and validation	**Readings** • None **Lectures** • Science, engineering and technology discussion. (synchronous) • Design process lecture (sync) • P-V part lecture (sync) • P-V Pair Examples (asynchronous) • Past TE 398 projects (async) **Active learning** • Breakout 1: Why did you take this class? • Breakout 2: Why are you studying engineering? • Breakout 3: Covid related problems? • Breakout 4: What are you curious about? • Breakout 5: What do you worry about?	**Team** • None **Individual** • Read Petroski Ch 1 – 4 and write short reflection • Create five P-V pairs
2	• P-V pairs. • Design goals and requirements.	**Readings** • Petroski Ch 1 – 4 **Lectures** • P-V Pair Examples (async) • Design specification and verification lecture (sync) **Active learning** • Breakout 1: Review what is engineering? • Breakout 2: Review critical questions that must be answered in a problem statement • Breakout 3: Review common approaches to problem brainstorming • Breakout 4: Review and edit problem statement in pairs • Present results from Breakout 4	**Team** • Select one P-V statement and develop 5 high-level requirements and matched verifications **Individual** • None
3	• Requirements and Verifications Pairs	**Readings and Videos** • Design Review example recordings **Lectures** • Capabilities assessment discussion (async) **Active learning** • Presentations: P-V and R-V statements	**Team** • Create a preliminary project proposal – part 1 **Individual** • None
4	• Problem Justification • Making a pitch	**Readings** • None **Lectures** • Problem justification lecture (sync) **Active learning** • Team Presentations: Project proposal part 1	**Team** • “As seen on TV” product assessment • Project Proposal - Part 2 **Individual** • None
5	• Defining potential solutions. • Creating a decision matrix to rank solution options.	**Readings** • None **Lectures** • Solution path lecture (sync) • Decision matrix lecture (sync) **Active learning** • Team Presentations: As seen on TV	**Team** • Solution proposal first draft **Individual** • P-V pair for wind turbine bridge case study
6	• Defining tolerances and risks	**Readings** • None **Lectures** • Tolerance assessment lecture (sync) • Risk assessment lecture (sync) **Active learning** • Team presentations: Solution Proposal first draft	**Team** • Tolerance and Risk Analysis assignment **Individual** • Peer Feedback on teammates Solution proposal first draft • P-V pairs for Gas Station of the Future case study
7	• Failure Modes and Effects Analysis	**Readings** • FMEA blog post: https://accendoreliability.com/fmea-2/ • Read FMEA Case Studies 1 & 2 **Lectures** • DFMA videos (async) • Review risk assessment (sync) • FMEA lecture (sync)	**Team** • Design Review #1 submission **Individual** • None

		Active learning • Team presentations: Tolerance and Risk Assessments	
8	• Engineering Design Ethics • Product costing	**Readings** • None **Lectures** **Active learning** • Team Presentations: Design Review #1	**Team** • None **Individual** • P-V pairs final project
9	**Spring Break (no classes)**		
10	• Engineering ethics • Intellectual property • Ecosystems • QFD	**Readings** • Wikipedia article on engineering ethics. • Stoll Ch 2 Reading **Lectures** • QFD video (async) • Ethics lecture (sync) • IP lecture (sync) • Ecosystem lecture (sync) • QFD demo (sync) **Active learning** • Team Presentations: None	**Team** • Final Project Customer Needs for PetsRUs or FishRUs **Individual** • Ethics assignment for Project 1
11	• Lifecycle assessment • Product costs	**Readings** • BOM article **Lectures** • Costing lecture (sync) • Product lifecycle lecture (sync) **Active learning** • Presentations: Customer requirements	**Team** • Project Proposal #2 – QFD first draft **Individual** • None
12	• Project Management	**Readings** • Phase gate overview article • Agile overview article • Lean Startup overview article **Lectures** • Project management lecture (sync) • Leadership characteristics lecture **Active learning** • Team Presentations 1	**Team** • High Level Project Schedule for Final Projects **Individual** • Phase gate case assignment
13	• Technical Presentations	**Readings** • None **Lectures** • Technical presentation lecture (sync) **Active learning** • Team Presentations: Project Schedules	**Team** • Final Design Review – Part 2 (due in 1 week) • Final Design Review – Part 3 Presentations (due in 2 weeks) **Individual** • None
14	• Challenges in delivering project in real enterprises	**Readings** • None **Lecture** • Project delivery challenges **Active learning** • Guest speaker: Larry Strait	**Team** • Review meeting with instructor on Final Design Review **Individual** • None
15	• Monitoring and reporting results	**Readings** • Project monitoring and reporting article Skoll **Lectures** • Project monitoring and reporting videos **Active learning** • Breakouts – team final pitch work	**Team** • Finalize project pitch **Individual** • None
16	• Final Presentations	**Readings** • None **Lectures** • None **Active learning** • Team Presentations: Final project pitches	**Team** • Final Presentation Submission **Individual** • Teammate assessment • Team presentation peer reviews

COVID

Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community. Students are also required to follow the campus COVID-19 protocols.

Students who feel ill must not come to class. In addition, students who test positive for COVID 19 or have had an exposure that requires testing and/or quarantine must not attend class. The University will provide information to the instructor, in a manner that complies with privacy laws, about students in these latter categories. These students are judged to have excused absences for the class period and should contact the instructor via email about making up the work.

Students who fail to abide by these rules will first be asked to comply; if they refuse, they will be required to leave the classroom immediately. If a student is asked to leave the classroom, the non- compliant student will be judged to have an unexcused absence and reported to the Office for Student Conflict Resolution for disciplinary action. Accumulation of non-compliance complaints against a student may result in dismissal from the University.

Emergency Response Recommendations

Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential. Other information about resources and reporting is available here: wecare.illinois.edu.

Academic Integrity

You are expected uphold the highest ethical standards, to be honest, and to practice academic integrity. **This includes doing original work and citing sources**, including the work of other students. Please give special care to prepare high-quality submissions with proper grammar and spelling. The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/. Academic dishonesty may result in a failing grade.
Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, email disability@illinois.edu or go to https://www.disability.illinois.edu. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting “Request an Academic Screening” at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Anti-Racism and Inclusivity Statement

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs.

The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (https://bart.illinois.edu/). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.