

ISD 522 –System Architecting, Concept Development and Embodiment Design

PROFESSORS:

Robert F. Bordley (rbordley@umich.edu) and Arthur S. Hyde (ahyde@umich.edu)

GSI:

Not Available

OFFICE HOURS:

Professor Bordley:

- On-Campus: 3PM-6PM EST Thursday
- On-Line: 6PM-7PM EST Thursday
- Email access: 8AM-2PM EST Monday through Friday

Professor Hyde:

- On-Campus: 9PM-10PM EST Monday
- On-Line: 8PM-11PM EST Thursday
- Email: 24 hour response

GSI:

- TBD

PREREQUISITES:

- ISD 520 Systems Engineering Overview (Recommended, but Not Required)
- ISD 521 Requirements & Objectives

CREDIT HOURS: 3 hours

COURSE DESCRIPTION:

This course focuses on lean systems engineering from systems architecting through systems embodiment. The class will be formed into product development teams of between 4-7 students to design a human powered enclosed vehicle. On these teams, students will be assigned to key roles such as:

- Body & Structure
- Interior & Climate Control
- Chassis & Power Transfer
- Product Integration

The teams will develop the product architecture and design proposal through key milestones during the semester. The class lectures will discuss the philosophy and methods for optimizing products as well as guide students through the use of lean system engineering tools leading to the ever more detailed design solutions each product team will propose, refine and evaluate against the requirements by the end of the semester. Each student will submit an Evidence Book of the work they have done periodically during the semester as homework. Each team will jointly prepare a mid-term project status review and present their project to the class at end of the semester.

LEARNING OBJECTIVE:

Through use of “Learn by Doing” competency development strategy, as a result of taking this course, students should be able to do the following:

- Understand how system engineering proceeds from a high-level mission requirement to a detailed set of component design specifications and how it verifies achievement of the requirements
- Apply foundational lean systems engineering tools like boundary diagram, functional decomposition, attribute robustness, value engineering, benchmarking, target-setting, QFD, decision matrices and evidence books
- Describe Local versus Global optimization, functional compatibility and concurrent product/process design
- Describe and use optimization disciplines such as zig-zag inductive/deductive design, target cascading, traceability modeling and set-based design
- Understand the role of model-based systems engineering in ensuring traceability between all parts of the system
- Use additive, multiplicative and multilinear rules for converging to optimum design solutions among a small set of alternatives
- Discuss risk management in designing a new product

REQUIRED TEXTBOOKS & MATERIALS:

- Lectures, requirements & key assumptions provided on Course Canvas site
 - **Note:** Professor Bordley and Professor Hyde do allow lecture recordings to be downloaded for offline viewing.
- TeamCenter, CAD and MBSE models in CAEN
 - This course requires that you have access to TeamCenter and XLDYN software. Historically, access issues are most common for online students and for any non-College of Engineering students. Here are the instructions for accessing the CAEN lab software: <https://sites.google.com/a/umich.edu/isd-public/remotesoftware/connecting-to-caen-remote-software-with-webclient>

- It is critical that you are able to log in to this software successfully PRIOR to your homework submission. As such, we require that all online students submit a screenshot documenting your access to XLDYN. This assignment will be counted toward your course participation grade and is due by class 2.
- If you have any issue connecting to the software, please contact isd-instructionalsupport@umich.edu and copy the professors on the message.
- Internet resources

GRADING:

- Grades will be based on the following:
 - 30% -- Final Project reports & presentations
 - 20% -- Submission of evidence books as homework per the class assignments
 - 20% -- Mid-term project status report
 - 10% -- Comparative achievement in efficiency and effectiveness as well as risk assessment of the vehicle designs by the student teams. Student staffing levels to be considered in this grade.
 - 10% -- Participation in piazza, class (campus students) and office hours (distance students)
 - 10% -- Teamwork

- Grading Scale (recommended)
 - This course follows a standard ISD grading scale of A, B, C, D, and E. Grades will be assigned as follows:

A+ 97-100	B+ 87-89	C+ 77-79	D+ 67-69	E 59 and below
A 93-96	B 83-86	C 73-76	D 63-66	
A- 90-92	B- 80-82	C- 70-72	D- 60-62	

Note: The minimum grade ranges may be adjusted based on class performance.

- Attendance Policy:
 - Campus students are expected to attendance 80% of the classes. A sign-up sheet will be posted in the classroom.
 - Distance students
- Make-up and Late Work Policy: Homework due dates and project submission dates will be posted on the Course Canvas site. Submissions late to the due dates will be reduced by 5% per day.
- Accessibility:
 - ISD faculty are committed to ensuring equal access to learning for students with disabilities. The University of Michigan SSD Office provides accommodations and services free of charge to students that register. Depending on the type and severity of the disability, the SSD Office makes every effort to provide the appropriate

accommodation for academic success. Registered SSD students can arrange to receive services through their disability coordinator. <https://ssd.umich.edu/topic/our-services>

- The College of Engineering Honor Code (recommended):
 - All students in the class are presumed to be decent and honorable, and all students in the class are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies appropriate to each piece of course work will be reported to the Honor Council, and if guilt is established penalties may be imposed by the Honor Council and Faculty Committee on Discipline. Such penalties can include, but are not limited to, letter grade deductions or expulsion from the University. As your course instructor, I reserve the right for additional deductions of points for anyone found guilty of an honor code violation.
 - Homework Assignments: You may discuss individual homework assignment with your fellow students at the conceptual level, but must complete all calculations and write-up, from scrap to final form, on your own. Verbatim copying of another student's work is forbidden. You may not consult homework solutions from a previous term unless they are made available in a publicly accessible form. All group work is to be completed only within your own group. Your group can receive help **only** from the course instructors. At no time may you receive help from someone who is not a current instructor. You cannot speak with other groups about the problems, conceptually or otherwise, and you may not at any time look at, borrow, or possess another group's work.

TOPICS BY WEEK

WEEK 1:

- a. Introductions
- b. Course Overview
- c. Project Description
- d. Lean Product Development Principles
- e. Required CAEN software review (XLDYN, TeamCenter & TBD CAD system)
- f. Team forming

WEEK 2:

- a. Confirm Student Teams and Assignments
- b. Project High Level Mission Requirements
- c. Project Basic Assumptions
- d. Product Architecture
- e. Project Planning/ Functional Decomposition
- f. Evidence Book & Expectations
- g. Boundary Diagram

WEEK 3:

- a. Target Setting Process Overview

- b. Transfer Functions
- c. Target Cascading/ Requirements Decomposition/ Zig-Zag Design
- d. Attribute Robustness & Reliability

WEEK 4:

- a. Benchmarking & Reverse Engineering
- b. Value Engineering
- c. Quality Function Deployment
- d. QFD1

WEEK 5:

- a. Concept Design & System Architecture
- b. Coarse Systems Modeling
- c. QFD2
- d. Coaching Student Project

WEEK 6:

- a. Mid-Term Project Status Report & Expectations
- b. Model-Based Systems Engineering (XLDYN)

WEEK 7:

- a. Mid-Term Review
- b. Project Target Setting
- c. Product/ Manufacturing Process Compatibility
- d. Developing CAD (TBD tool)

WEEK 8:

- a. Generation of Success Criteria
- b. Failure Mode Effect Analysis
- c. Decision Convergence & Decision Matrix Overview
- d. Set-Based Alternatives

WEEK 9:

- a. Screening Alternatives under Certainty & Uncertainty

WEEK 10:

- a. Set-Based Design and Local Optimization

WEEK 11:

- a. Global Optimization
- b. Traceability Modelling & Verification

WEEK 12:

- a. QFD3 Translation to Process Controls

WEEK 13:

- a. Coaching Student project completion

WEEK 14 (Final Exam week):

- a. Project Presentations