

Project Overview

As a way to practice and learn systems engineering processes, the course will guide students through a systems conceptual design project. The system to be addressed is intended to represent a complex problem which requiring consideration of the learning objectives for the entire course. While hypothetical, the problem reflects emerging real-world issues.

The team project divides the class into systems engineering working groups (aka learning teams). Each group will apply system engineering principles to a conceptual design project and are free to specify commercial-the-Shelf (COTS) sources, subsystem design and/or production outsources to other firms, and developed internally by the team's hypothetical organization. Note: the team is responsible for the overall design and must deal with feasibility and risks given COTS and outsourcing decisions. The task involves organizing and planning each element of the Systems Engineering Method including needs and objectives, requirements analysis, systems architecting, identification of subsystems and interface definition, data and information exchange requirements, risk analysis and mitigation, trade studies, software development and integration as well as non-functional elements, i.e. the "- ilities." Project output deliverables for each group is a conceptual design model in the form of a presentation and engineering report for the team's preferred systems concept. See the project presentation for more details about the report content.

A problem description, comprising the essence of a mission needs statement, notional operational requirements, and a concept of operations will be provided. The problem description is intentionally high-level and non-specific since this is often the case at the start of complex problems, especially given the trends towards evolutionary development where greater flexibility is given design firms to allow a more balanced solution between requirements and technical risk. **An interview with stakeholders in class session 3 will help expand on these requirements and concepts for your project.**

Project Objectives

The goal of the class project is to provide a "hands on" like experience in systems engineering. While a realistic complex technical problem is provided for this purpose, the problem is hypothetical as described, and the intention is not to become immersed in the technical solution. Rather, the overall purpose is to expose the student to the considerations given in approaching a complex problem, as taught in the introduction class and throughout this course. Accordingly, the primary and secondary objectives of the class project are:

- Primary Objectives
 - o Practice applying conceptual design principles to a representative system.
 - o Apply the Systems Engineering Method and "generally accepted" design practices to a complex problem.
- Secondary Objectives
 - o Gain experience working as a group on small-scale system with individual roles while depending on each other to complete the task.
 - o Address tradeoffs in requirements and technical approach.
 - o Gain experience in technical presentations

Project Context

Urban areas world-wide have become centers for economic growth. The acceleration of this development transcends the traditional purpose of large cities as financial centers and has diversified to fields and industries fueled by technological developments. This trend has accelerated population growth in metropolitan areas. Today, half the world's population lives in urban areas. One of society's challenges is to address issues of urban transportation congestion and find ways to mitigate and solve the strains growth has on this infrastructure.

Urban transportation infrastructure projects are among the most complex, expensive, and time consuming projects to plan, implement, maintain, and upgrade and become even more challenging as the population increase in these areas accelerates.

Your company has been tracking stakeholder interest in methods to implement short range air transport of people in urban areas where transportation congestion and gridlock causes millions of lost hours for travelers and commuters. The company president and vice-president for marketing are actively developing opportunities for system designs which exploit this underutilized transportation medium to enable sales of scalable solutions that can be quickly implemented and, over time, fully developed. After receiving a customer inquiry for a system concept, the company president has asked your team to develop a conceptual design. In the near future, your team will have an opportunity to interview urban transportation planners and related corporations that are potential customers for the product.

Organization and Groups

The class will be divided into teams of four to six individuals. Teams will work independently, and members will normally receive the same score. It is important for each team to distribute the task elements evenly to enhance learning, use individual strengths, and distribute the workload.

Approach to Grading

This is a team project. Your grade depends on the overall quality of the work of the entire team. The instructors' reserve the right to raise or lower the grade for each student based on extraordinary performance. The best approach is to do your assigned tasks well and to assist your teammates with their tasks. The roles of each student in their respective team presentation and reports should be highlighted in the documents.

Special Notes

Although conceptual in nature, this project requires independent research on concepts and equipment to fully develop your project deliverables. The concepts and subject matter includes (but are not limited to): air vehicle and air traffic control systems (including system autonomy), scheduling, dispatch, and operations, maintenance, and infrastructure. Be sure to cite your sources and assumptions and scope your project accordingly.

Several references are provided for initial knowledge of urban transportation, and a wealth of information is available on the Internet. Your team is expected to conduct research and compile a list of sources within your report.

Urban Air Transportation System (UATS) Needs Statement

Given the current state of urban transportation system designs and implementations, it is apparent that more rigorous systems engineering approaches are required to enable transport of significant numbers of people within and between metropolitan and suburban areas. Currently ground transportation systems are overused, congested, and requires costly and time consuming maintenance and upgrades. The ability to utilize the underused airborne transport medium will relieve pressure on other transportation systems, increase the user/customer productivity, and facilitate regional economic growth. As the needed systems and technologies are deployed, a well-designed system can be quickly upgraded to apply lessons learned and to evolve as new technologies are developed, matured, and implemented. A robust Urban Air Transportation System (UATS) has the potential to be an engine of technological and economic growth which creates new industries, markets, and unforeseen opportunities.

Your company president and marketing VP have reached out to potential customers for opportunities such as this one. Your company's marketing team has done a significant amount of research into UATS and is convinced there are several concept alternatives to address this need.

Your team is required to begin research to define the problem space and scope the conceptual design appropriately for potential customers. Since this topic has the potential to rapidly grow out of scope given multiple users and their needs, your systems engineering expertise is called upon to develop alternatives which address this problem.

UATS Top-level Needs (as of the start of class)

(Note that some of these needs are not complete (and may not be fully formed requirements), the purpose of the interview is to clarify these requirements prior to implementing your assumptions)

- The system shall be able to transport personnel economically and expeditiously across urban areas associated with normal commuting distances
- The system shall support scheduled and on-demand service requests for customers
- The system should be highly reliable and secure with a high factor of safety against internal and external disruptions caused by environmental, hardware/software errors, faults and failures, human errors, and inadvertent or deliberate negligence and tampering
(see: [http://sebokwiki.org/wiki/Disruption_\(glossary\)](http://sebokwiki.org/wiki/Disruption_(glossary)))
- The system should require minimal surface infrastructure upgrades
- The system shall utilize control systems that enable payment, scheduling, routing, and collision avoidance across normally occurring environmental conditions
- The system should be designed to reduce highly specialized and expensive to training and proficiency requirements for its operators
- The system should work on a continual basis
- Maintenance systems, processes, and scheduling should enable continuous monitoring capability without significant system degradation
- The system should be affordable and realize economies of scale that decrease operating costs and ticket prices while increasing access as it grows/matures
- Manned and unmanned systems and equipment may be used where appropriate
- The system may be used for alternative purposes including emergency and disaster relief

services

- Critical infrastructure requirements best supplied by the government shall be identified and coordinated with appropriate stakeholder organizations
- The system shall not adversely impact and preferably improve environmental conditions such as noise, pollution, congestion, etc.