USC ASTE 523

REINVENTING SPACE:
THE DESIGN OF LOW COST SPACE MISSIONS

THURSDAYS 6:40 – 9:20 PM AT USC
(ALSO AVAILABLE REMOTELY VIA DEN)

SPRING 2017 SYLLABUS

Course Instructor:	Dr. James R. Wertz
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COURSE SCOPE AND OBJECTIVES:

In the current fiscal environment, it is critical that the United States solve the combined problem of dramatically reducing space mission cost and schedule while achieving high performance and much better resilience. In this course, Dr. James Wertz, creator of much of the current interest in Responsive Space and Reinventing Space, takes you step-by-step through the complete process of creating dramatically lower cost, quicker, more resilient and very capable space missions for both civil and military applications.

"The Design of Low-Cost Space Missions" is a highly interactive course that will address the economic and programmatic issues that arise during the semester and questions and issues brought up by course participants, many of whom will be working engineers in the space business. The course is intended as a supplement or follow-on to the traditional Space Mission Engineering course, rather than a substitute for it. It assumes that most of the participants are familiar with space mission design and goes from there to specific methods of reducing cost and schedule and getting more work done for less resources.

By the end of the course, participants will be able to create and evaluate multiple methods for reducing mission cost and schedule and critically evaluate alternative ways of achieving mission objectives at dramatically lower cost and in much less time.

COURSE FORMAT:

Dates: Class meets on Thursdays, 6:40 to 9:20 pm
Location: OHE Room TBD
Project: There is no independent research project associated with this course, although additional work on independent research is possible with the consent of the department.

COURSE GRADING:

Class Participation:	15%
Homework:	25%
Mid-term Exam:	25%
Final Exam:	35%

Class participation input is turned in to both the instructor (wertz523@smad.com) and the TA (TA523@smad.com)
Homework is turned in only to the TA (TA523@smad.com)
The Mid-Term Exam and Final Exam are either taken in class or turned in via the DEN system.

RECOMMENDED TEXTS (NOT REQUIRED) AND MATERIALS:

- ***Space Mission Engineering – the New SMAD -- segments only***
- ***Reducing Space Mission Cost***
- Lecture Notes
- Various published papers and ancillary material as provided

REPRESENTATIVE OUTLINE OF TOPICS:

Note that this outline is only representative. The course content will be adjusted to address current space program topics that arise during the semester, such as the recent failure of the Falcon 9 launch vehicle or the change in administration that will occur during the time period of the course.

Primary Topics:

1. Why This Course is Needed – the Need to Dramatically Drive Down Space Mission Cost and Schedule and Improve Performance
What is the problem we're trying to solve? Can it be solved? Why is it hard?
2. Background
History of low-cost missions, the range of cost options, cost vs. reliability
3. Process Changes to Reduce Cost
The government perspective; radical techniques; people, processes, & programmatic methods; requirements driven vs. capabilities driven missions
4. Technology for Reduced Cost
Hardware, software, autonomy
5. Reducing Mission Cost
Mission and systems engineering, spacecraft, ground segment and operations, launch

6. Other Topics – 1
Cost modeling, reliability, case study experiences
7. Other Topics – 2
Responsive Space, Reinventing Space
8. Cost and Schedule Overruns
Traditional view, "solutions" likely to make it worse, radical view (i.e., mine)
9. Implementation Strategies and Problems
Reducing cost in new and ongoing programs, problem areas in implementation
10. Design Study
Development of a representative low-cost, large-scale mission -- a human lunar colony for 1,000 people

Supplementary Topics:

1. Money
Inflation, the time value of money, amortization, learning curves
2. The Iridium Experience
Iridium, GlobalStar, and ICO; the need for a systems approach
Orbital debris for a constellation of 4,400 satellites
3. Computational Spherical Geometry
4. Earth Geometry Viewed from Space
5. Error Budgets
Mapping and pointing error budgets; trading on error budgets to minimize cost
6. Cost Model of Reusable vs. Expendable Launch Vehicles
Background, analytic cost model, comparison of reusable vs. expendable launch costs, sensitivity analysis, conclusions
7. Methods for Reducing Launch Cost
8. Satellite Collisions – Mitigating the Problem of Orbital Debris
9. References and Bibliography
The 100 (or so) most important books in space technology; Reducing space mission cost annotated bibliography
10. Summary of Methods for Reducing Space Mission Cost
People, Process, and Programmatic; Technology and Systems
11. Reducing the Cost of a Large Lunar Colony
Background and Summary; Properties, Strategy, and Results

STATEMENT FOR STUDENTS WITH DISABILITIES:
Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301

and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

STATEMENT ON ACADEMIC INTEGRITY:

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: https://scampus.usc.edu/university-student-conduct-code/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.