ASTE 527 Graduate Space Architecting Studio

aka ASTE 527-Space Exploration Architectures Concept Synthesis Studio

Tuesdays 6:40-9:20pm, ONLINE USC DEN Webcast WebEx

Refine Creative Skills, Topic Oriented Team Project, Visiting Expert Lectures, and Reviewers

2020 Fall Studio Topic: Catalysts for ARTEMIS[See Section 8 for Outline]

Mandatory Real Time Midterm and Final Presentations – Midterms Sep29, Finals Dec08

M.Thangavelu, Conductor

1. Introduction

ASTE527 is all about creativity and ideation, the conception, birth or the origination of ideas. The area of investigation is complex space systems. Participants are taught to quickly create concepts and present them before a group of professionals and academics for review and feedback.

The core of the instruction is all about providing inspiration to create new products and processes. It is done primarily through engaging the studio with a variety of presentations by visiting guest lecturers who have created and continue to create innovative products. Debate and discussion are key to development and refinement of ideas. Graduate students from all disciplines of engineering, architecture, medicine and the law are encouraged to apply and participate in the studio. A basic appreciation of the sciences, space systems and the space environment are useful prerequisites for this course.

2. Course Mechanics – ONLINE USC DEN WebEx

This highly interdisciplinary course is all about the adumbration or early formulation and articulation of creative ideas. It is also about visionary and imaginative speculation; visualizing “big picture” future applications for space technology and space activity. Inductive and analogous processes, synthetic thinking, associative logic, metaphorical models and other system architecting tools are employed to quickly create alternative "concept architectures", which in essence, are rudimentary but global ideas or visions of a project. Besides presenting poignant, project specific, interdisciplinary scientific concepts and engineering theory behind space system architectures, participants will be introduced to architectural concept generation theory, methods, form finding processes, visualization and presentation techniques followed by a unique, hands-on studio approach that allows the participants to realize their own concept architecture project in a rapid manner.

Participants work on both a small individual mini project and a larger team project. These concept architectures are then presented to an expert panel of faculty, agency and industry professionals for feedback and discussion. The studio also feature lectures on relevant topics by visiting professionals who are experts in the field.

For the individual mini-project(due at mid-term) participants are free to explore creative, new ideas of their own choice as well for space transport and human and robotic facilities in space. Options for concept architectures include but are not limited to :

- Space Transportation systems and their evolution
- Orbital debris mitigation systems
- On orbit assembly of large scientific platforms, modular stations/vehicles
- Solar Power Satellites
- Innovative communication satellite architectures

- Solar System Exploration strategies and human expeditions to the Moon, Mars and beyond
- Space Tourism and Adventures
- Recreational vehicles/facilities, advertising in space and other innovative ideas

Fast-paced topic oriented studio. Strongly advise students to pay close attention to all class meetings. Active participation and feedback during visiting lectures and coordination proceedings recommended. Selected projects may be presented at various professional meetings and conferences.

3. Final Design Team Project Focus:

Using current NASA studies and ongoing as well as proposed space mission projects as baseline, studio participants will jointly create alternative system architectures (both robotic and human) for a variety of missions including lunar exploration and interplanetary mission technology development and verification. The Team Project will focus on a range of topics of interest to the space community and our nation including human and robotic exploration, commercial space activities and planetary defense. Merits and limitations of different architectures are discussed and documented.

Past team projects have included :

• Lunar Mission Concepts
• Mars Exploration
• Solar Power Satellites
• Visions for Human Space Activity
• International Space Station
• Planetary Defense Architectures

Past presentation materials may be accessed at: http://denecs.usc.edu/hosted/ASTE/527_20111/

4. Grades

Midterm Individual Concept Architecture Presentation – 20%
Final Team Project Presentation – 60%
Class Participation – 20%

All students must present their work in real time, either in the studio or via a reliable broadband link through USC DEN service to a panel of reviewers for evaluation and feedback on which the grades are based entirely.

5. Mid-term and Final Presentation Dates and Venue – ONLINE over USC DEN WebEx

Midterm Sep 29, Finals Dec 08. Presentations will happen during regular studio hours, 6:40-9:20pm, ONLINE. DEN students will present projects in real time via USC DEN WebEx service.

6. Textbook

- The Moon : Resources, Future Development and Settlement - Schrunk, Sharpe, Cooper & Thangavelu, 2nd edition, Springer/Praxis 2007, ISBN-13: 978-0387360553
- Space Systems Concepts Creation Class Notes - M. Thangavelu

7. Recommended References

- The Moon : Resources, Future Development and Colonization - Schrunk, Sharpe, Cooper & Thangavelu, John Wiley and Sons 1999, ISBN 0-471-97635-0
- Encyclopedia of Aerospace Engineering, John Wiley and Sons(2012) - ISBN: 9780470686652
- The Lunar Base Handbook – P.Eckart, McGraw Hill 2006, 2nd ed. ISBN-13: 978-0073294445
- Spaceflight Life Support & Biospherics –P.Eckart, Microcosm Press, 1996 ISBN 1-881883-04-3

- NASA Man Systems Integration Standards(MSIS STD3000/3001)
- NASA(2010) Human Integration Design Handbook(HIDH), NASA Johnson Space Center
- NASA(2001) International Space Station Users Manual, NASA Johnson Space Center
- Out Of This World:…Space Architecture, AIAA (2009), Howe, A.S etal - ISBN-10: 1563479826
- Space Vehicle Design, 2nd Edition – Griffin, M.D., French, J.R., ISBN-13: 978-1563475399
- Space Stations & Platforms, (1986)Woodcock, G.,
- Space Exploration: Mission Engineering, Woodcock G.(2011)
- The Dream Machines, Miller, R.G.(1993)Kreiger Publishers, ISBN-10: 0894640399
- Space Architecture Education for Engineers and Architects: Designing and Planning Beyond Earth(2016) Häuplik-Meusburger, S., Bannova, O. - ISBN 978-3-319-19279-6
- Current journals, topical magazines and space related periodicals are recommended

Textbooks prescribed for ASTE Astronautical Engineering and SAE System Architecting are useful. Class handouts will include pertinent material on Space Exploration, ranging from history of Space Exploration to programs and current thinking on the subject.

8. Fall 2020 Team Project Topic – Catalysts for Artemis

NASA has been clearly directed by the current US administration to return to the Moon and charged with an aggressive Mars forward agenda. Commercial space sector expertise and international involvement are at the core of this new strategy, aimed at economic viability and agility in mission manifest. Robotic missions are being reformulated to quickly return data to help mission planners make critical design decisions about factors including spacecraft systems, human factors and physiology maintenance during extended missions beyond the low Earth orbit environment, testing the capabilities and limitations of human-robot interaction, lunar orbit-to surface-operations, agile, reliable cislunar communications and the potential use of local resources to productively sustain long term human activities. Such hard data and advanced exercises and simulations on our Moon are vital to establish baselines and reference points for human activities on extraterrestrial bodies. Following policy directives of the current US administration, a new urgency to accelerate return to the Moon is being orchestrated by NASA. On March 26th, 2019, at NASA MSFC, Vice President Pence tasked NASA with a compressed, accelerated timeline : 2024 Boots on the Moon. See speech here : https://www.space.com/us-astronauts-moon-return-by-2024.html

On May 14th 2019, NASA Administrator Jim Bridenstine announced that the new program named Artemis after the twin sister of Apollo in Greek mythology. Per Space Policy Directive SPD#1, Mars goal by the 2030s is still the prime directive, with lunar missions and operations providing critical, vital data needed to evolve Mars mission vehicles & systems essential for reliably sustaining interplanetary human missions. NASA Project Artemis plans to land a woman and a man on the Moon by 2024. WH NSC SPD#1-4 & NASA Artemis Accords have laid out the vision, policy and plans for human return to the Moon. USC Fall Studio explored concepts in 2019 ARTEMIS:MAXIM project. https://sites.google.com/a/usc.edu/aste527/home

NASA has awarded contracts for commercial payloads(CLPS), lunar orbital Gateway systems and for the human landing systems(HLS). The Fall 2020 studio will create concepts to accelerate long duration human missions to our Moon and beyond, depicting potential launch and spacecraft systems including cislunar vehicles, orbiting stations, and surface elements including landers, rovers, habitats, EVA and advanced communication systems and associated infrastructure, essential to returning humans to our Moon by 2022, the 50th anniversary of Apollo 17, the last humans to visit and explore the Moon.

Instructor Bio

Madhu Thangavelu is the conductor of the ASTE527 graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering within the Viterbi School of Engineering and he is also a graduate thesis adviser in the School of Architecture at USC. He holds degrees in both engineering and architecture and has contributed extensively to concepts in space architecture, especially dealing with extraterrestrial development. He is the author or co-author of over 50 technical papers in space architecture, lunar base design and human factors, and co-author of the book The Moon: Resources, Future Development and Settlement (1999) published by John Wiley & Sons and second edition by Springer/Praxis in 2007. He is the invited author of the chapter "Living on the Moon" in the Encyclopedia of Aerospace Engineering, a major reference work published by John Wiley & Sons in 2010 and the on-line second edition updated in 2012. He is a member of the USC team that won the consecutive NASA NIAC Phase I award in 2011 and Phase II award in 2012. He is on the faculty of the International Space University, an international organization that educates promising leaders and space professionals in an interdisciplinary, intercultural, international environment. He is a director of the National Space Society.

Recent news on studio :

2008 - http://viterbi.usc.edu/news/news/2008/from-the-earth.htm

2008 - http://news.usc.edu/29302/Making-Space-for-Some-Big-Plans/

2011 – Aldrin Visit to studio http://viterbi.usc.edu/news/galleries/slideshow_20111220.htm

2011 – NASA: http://www.nasa.gov/pdf/716069main_Khoshnevis_2011_PhI_Contour_Crafting.pdf

2012 – Lunar Super Computer, Wired http://www.wired.com/2012/10/supercomputer-moon/

2012 – NASA NIAC Award USC Engg. and USC Architecture, https://arch.usc.edu/topics/nasa-research

2013 – 3D Printing Space Food, Wired http://www.wired.com/2013/02/3-d-food-printer-space/

2016 – MOBIUS Lunar Tourism http://spaceref.com/missions-and-programs/nasa/nasa-future-in-space-operations-mobius---supersynchronous-earth-orbits-for-lunar-missions.html

2018 – ADAM https://www.nextbigfuture.com/2019/01/usc-space-design-class-2018-final-presentations.html

Tentative Schedule for ASTE 527 Fall 2020 – ONLINE via USC DEN WebEx

Wk 1	Aug 25	Introduction	Student Introdution, Scope and Assignment
Wk 2	Sep 01	Library Research	No meeting
Wk 3	Sep 08	VL 1 and 2	Visiting Lecture
Wk 4	Sep 15	Alternate Ideas	present alternative ideas
Wk 5	Sep 22	Concept Development	Dry Run
Wk 6	Sep 29	Midterm	Reviewers present – Mandatory real time
Wk 7	Oct 06	Team project	Intro and Scope
Wk 8	Oct 13	Library Research	No meeting
Wk 9	Oct 20	VL	TBD
Wk10	Oct 27	VL	TBD
Wk11	Nov03	Concept Development	Alternative sections and order
Wk 12	Nov10	VL	TBD
Wk 13	Nov17	Coordination	Dry Run
Wk14	Nov24	No meeting	TG week
Wk15	Dec01	No meeting	Study Day
Wk16	Dec08	Finals	Reviewers present – Mandatory real time

Queries? Contact instructor at : mthangav@usc.edu