

# **ASTE 527 Graduate Space Architecting Studio**

**aka ASTE 527-Space Exploration Architectures Concept Synthesis Studio**

**Tuesdays 6:40-9:20pm, OHE100D DEN Studio, DEN Webcast**

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

**2017 Fall Studio Topic: Commercial Space & the Promise of**

**Self-Sustaining Human Space Activity[See Section 8 for Outline]**

**Mandatory Real Time Midterm and Final Presentations – Midterms Sep26, Finals Dec12**

M.Thangavelu, Conductor

## **1. Introduction**

ASTE527 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 is a useful prerequisite for this course.

## **2. Course Mechanics**

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/](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

Midterm Sep29, Finals Dec 12. Presentations will happen during regular studio hours, 6:40-9:20pm, Olin Hall Engineering OHE100D. 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 3000/3001)
- 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, 2<sup>nd</sup> 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 2017 Team Project Topic - Emergence of Commercial Space Companies & the Promise of Self-Sustaining Human Space Activity**

Space activity has traditionally been the domain of wealthy nations to project prestige, power and military might. Economics was not the concern for these government run programs. In the last decade, a brand new space industry has evolved that promises to change the way space missions are carried out. Private space companies have developed and continue to evolve technologies and operations methods that have changed the economics of spacecraft and operations.

This 2017 studio will create concept architectures based on this paradigm shift. Achievements and aspirations of this newly homegrown private space industry will be used to showcase what the future holds for human spaceflight.

#### **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 and 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 and 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 and international environment.

**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](http://viterbi.usc.edu/news/galleries/slideshow_20111220.htm)  
2011 – NASA: [http://www.nasa.gov/pdf/716069main\\_Khoshnevis\\_2011\\_PhI\\_Contour\\_Crafting.pdf](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/>

**Tentative Schedule for ASTE 527 Fall 2017**

Wk 1	Aug 22	Introduction	Student Intro and Scope and Assignment
Wk 2	Aug 29	Library Research	No meeting
Wk 3	Sep 05	VL 1 and 2	Visiting Lecture
Wk 4	Sep 12	Alternate Ideas	present alternative ideas
Wk 5	Sep 19	Concept Development	Dry Run
<b>Wk 6</b>	<b>Sep 26</b>	<b>Midterm</b>	<b>Reviewers present – Mandatory real time</b>
Wk 7	Oct 03	Team project	
Wk 8	Oct 10	Library Research	No meeting
Wk 9	Oct 17	VL	TBD
Wk10	Oct 24	VL	TBD
Wk11	Oct 31	Concept Development	
Wk 12	Nov07	VL	TBD
Wk 13	Nov14	Concept Development	Alternative sections and order
Wk14	Nov 21		TG-No meeting
Wk15	Nov28	Dry Run 01	Coordination
Wk16	Dec05	Dry Run 2	TBD Maybe on Dec 07 or 08(study day conflict)
<b>Wk17</b>	<b>Dec12</b>	<b>Finals</b>	<b>Reviewers present – Mandatory real time</b>

Queries? Contact instructor at : [mthangav@usc.edu](mailto:mthangav@usc.edu)