CubeSat and ThinSat – Introduction, Applications, and Methods for Mission Success

*Design, Build, and Keep Your Own Thinsat*

February 24-25, 2020
Plaza Tower One
Conference Center
Denver, CO

Includes a Customized Design, Build, and Flight Test With Live Data Feedback

LRA is authorized by IACET to offer 1.1 CEUs for the course
Summary

This 2-day academic course with a hands-on workshop provides an overview of the rapidly growing and disruptive small satellite space industry including overviews on multi-CubeSat and smaller ThinSat form factors. This short course will provide an outline of the systems engineering approach to develop a space mission using small satellites from Low Earth Orbit (LEO) (including reentry) to Geostationary Orbit (GEO), as well as interplanetary missions. Along with these objectives, attendees will also be given an overview of the space environment (plasma, charging, thermal, radiation, dose, etc...) and how it's effects performance. This is a new, one-stop shop for space stakeholders to learn how to mitigate design problems, design a satellite based on mission and specific requirements, and achieve flight lineage through mission success the first time.

Learning Objectives

- Review Technology trends in the Space Program and CubeSat and ThinSat concepts
- Landscape Assessment of the Space environment and environmental damage mitigation from LEO to GEO for satellite hardware
- Explore basics of Small spacecraft power systems design: Solar Cells, peak trackers, batteries, power management, inhibits, and related firmware
- Assess the Simplex unit, it's applications and advantages, and a comprehensive cost/benefit analysis of various satellite communication systems and room for improvement
- Review CubeSat mechanical and structure design fundamentals including manufacturing requirements, materials ODAR, simulations, and safety reviews
- Formulate a viable and customized satellite concept, build, and mission schedule
- Discuss how new Advanced Manufacturing (AM), miniaturization, and high-quality robotic mass production with many new and competitive launch opportunities make Cube/Thin Sats an affordable technology
- Discuss novel and successful Systems Engineering design practices for a small space mission
- Assess subsystem and sensor options: GPS, Black Box, Attitude Determination and Control, and Propulsion
- Discuss small spacecraft environmental testing, launch requirement documents and Launch Readiness Review
- Review orbits, launch, Con-Ops, ground segments, and data analysis
- Day 2: Build your own ThinSat, connect with a satellite network, and record your ThinSat data on a laptop in near real-time
ROI for Attendees

The material provided for the course will include a manual of all the slides presented, a reference list of small satellite companies, small satellite parts vendors and institutions that are recommended for additional graduate training. In addition, the lab portion of the class will include a full 3D printed ThinSat that will have a processor and sensor PC board that will be launched on a high-altitude balloon tether for collecting data for ground station display.

There will be a hands-on display of some of the current component technology that can be purchased from national and international vendors (Structures, Solar arrays, trackers, foldouts, Electrical Power Systems, Batteries, Communication systems, antennas, Globalstar, Attitude control systems, mechanisms, GPS, propulsion, and flight processors and software).

Audience

This course is intended for new engineers and managers that have a technical background but are not intimately familiar with the requirements of space mission design and design of small spacecraft. Further titles should include: Engineers, managers, and investors involved in spaceflight satellite systems or thinking about building a full CubeSat or a satellite subsystem, professionals interested in satellite technology or manufacturing, other technical staff, educators, and stakeholders.

Day 2 Technical Design, Build, Flight Test and Live Data Feedback

- Review Personalized Satellite Builds and Provide Feedback
- ThinSat Kit includes 3D printed structure, Solar Array Circuit Boards, Processor, Wi-Fi link, Ground Station software, Electrical power system, few Solar arrays with Peak Power trackers, Battery, magnetic attitude, and other subsystems. In addition, sensors include light, UV, IR sensors, energetic particle sensor, temperature, Inertial Motion Sensor (3-axis gyros, 3 accelerometers, and 3 magnetometers)
- Complete building of your individual EM ThinSat
- Testing and calibration of your ThinSat. Record live data on your ground station laptop
- One-on-one supervision and help from instructors
Course Agenda

MONDAY, FEBRUARY 24, 2020

8:00 – 8:30 am  Registration and Continental Breakfast

8:30 am – 5:00 pm  Course Timing

12:00 – 1:00 pm  Group Luncheon

Introduction
- General introduction to small satellite space industry
- Discuss key variables to a satellite project lifecycle including costs, timeline, and componentry
- Review CubeSat and ThinSat form factors
- Space environment
- Overview of space environment and mitigation from LEO to GEO for satellites
- Review technology trends in the space program and CubeSat and ThinSat concepts
- Space debris considerations

System Engineering Tradeoffs
- Understand novel and successful systems engineering design practices for a small space mission
- Preliminary Design Review (PDR) and Critical Design Review (CDR)
- Interface Control Documents (ICD)

Electrical Power Systems (EPS)
- Learn basics of small spacecraft power systems design
  - Solar cells - PV
  - Peak trackers
  - Batteries
  - Power management
  - Inhibits
  - Other related firmware

Communication and Antenna System Design with Licensing
- Various methods for satellite telemetry and comm coverage
- Tradeoffs with various communications systems:
  - Antennas, TX and RX link margins, EPS
  - FCC and ITU requirements
  - Data rates, resource requirements, and approx. costs
  - Coverage costs, latency, with different sat constellations
- Simplex Unit
  - Introduction to design, applications, and key contributions of a simplex communication unit
  - Transmission to ground station
  - Simplex vs. duplex attributes and analysis
Course Agenda

MONDAY, FEBRUARY 24, 2020 (continued)

Mechanical and Materials Requirements
- CubeSat mechanical and structure design
  - CAD software demonstration
  - Visual representation of successful mission features
- Manufacturing requirements
  - Compliance and vendor componentry expectations
  - Communication strategies for efficient collaboration between manufacturer and assembly team
- Materials for formulating Orbital Debris Assessment Report (ODAR)
- Simulations
- Safety reviews

Subsystems and Payloads
- Subsystem and sensor options
  - GPS
  - Black Box - Flight redundancy insurance
  - Communication (simplex, duplex…)
  - Altitude determination and control
  - Propulsion systems
    - Iodine hall thrusters
    - Pulsed plasma thrusters
    - Cold gas

Design a Customized Satellite Plan
- Design a personalized satellite concept and build timeline
- Put together milestone schedule for on-time mission plan
- Develop design pitfalls and identify necessary adjustments alongside instructors

Environmental Testing Requirements
- Small spacecraft environmental testing
- Launch requirement documents and Launch Readiness Review (MRR)
- Safety and license requirements review
- Structural testing methods
  - Radiation
  - Vacuum
  - Vibration

Orbits and Con-Ops
- Orbital satellite activation
  - Monitor points
- Orbits programs, two line elements
- Launch and con-ops
- Ground station segment data and data analysis
## Course Agenda

**TUESDAY, FEBRUARY 25, 2020**

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- ThinSat Introduction & Overview
  - 3D printed structure
  - Solar array circuit board
  - Processor
  - Wi-Fi link
  - Ground station software
  - Electrical power system
  - Few solar arrays with peak power trackers
  - Battery
  - Magnetic attitude
  - Other subsystems
- Assemble ThinSat Bus system in 3-D Printed frames
  - Work alongside instructors to develop customized, printed hardware for ThinSat
  - Review personalized satellite builds and provide feedback
- Calibrate Sensors
  - Connect bus and sensors with ground station laptop
  - Transmit and test data over the Globalstar network to ground station
  - Sensors include:
    - Light
    - UV
    - IR sensors
    - Energetic particle sensor
    - Temperature
    - Inertial motion sensor (3-axis gyros, 3 accelerometers, and 3 magnetometers)
- Complete Assemblage of Individual EM ThinSat
- Testing and Calibration of ThinSat
  - Record live data on ground station laptop
  - Receive feedback on data analysis and findings
- Closing Remarks and Final Q&A
Primary Instructor

Dr. Hank Voss
CEO and Chief Scientist, NearSpace Launch Inc. (NSL)

Dr. Hank Voss is an Emeritus Professor in Engineering and currently CEO and Chief Scientist at NearSpace Launch Inc. (NSL) located in Upland, IN. In the past 5 years NSL has created and launched 350 CubeSat subsystems and developed over 10 full satellites with 100% success in-orbit. NSL was also the first to demonstrate the powerful Globalstar satellite-to-satellite link for 24/7 anywhere-anytime global visibility of a satellite with low latency of a few seconds. He worked previously 15 years at Lockheed Research Labs in Palo Alto CA on many advanced NASA and DOD satellites and payloads. Dr. Voss worked with Prof. Twigg, Inventor of the CubeSats, in the early days of CubeSats at Stanford and was instrumental in developing the first 2U CubeSat with students. He has 22 years’ experience in teaching aerospace and engineering at Taylor University in IN and development of many small spacecraft in an academic environment while receiving the university Teaching Excellence award and Forman Research award. While in Indiana he launched Indiana’s first satellite and first commercial satellite. He is an inventor of the new ThinSat standard to significantly reduce cost for access to space and inventor of the new thin patch satellite Black Box for mission success, diagnostics, and space debris GPS tracking. He has been responsible for the development of eleven small satellites (1U to 6U) that were launched into LEO orbit with a 24/7 Globalstar communication link that needs no ground station since all the encrypted data is linked through the internet. NSL has developed 60 autonomous ThinSats that launched as a constellation in 2019 with Professor Twiggs as well as a CubeSat payload for Deep Space and lunar flyby on the EM-1 mission.

He has a BS in Electrical Engineering from the Illinois Institute of Technology and a MS and PhD in Electrical Engineering from University of Illinois. He has published over 150 technical papers in Space Science, Space Instrumentation and CubeSat results.

Secondary Instructor

Matt Orvis BS, MS
Project Engineer, NearSpace Launch Inc. (NSL)

Mr. Matt Orvis BS and MS in Physics/Engineering and a project engineer with NearSpace Launch. Matt has worked over 5 years with state-of-the-art satellite design and acted as the lead engineer for the THEEF subsystem, an electric field and VLF sensor. He has been involved in the design and build of numerous other small satellites ranging from ThinSats to 6Us and 12Us.
Course Support

**Bob Twiggs**  
*President and Founder, Twiggs Space Labs*

Bob Twiggs, president and founder at Twiggs Space Labs and widely regarded as the founder and instigator to the original CubeSat concept. Twiggs is presently a professor of astronomical engineering in the Space Science Center at Morehead State University in Morehead, Kentucky. Prof. Twiggs was a consulting professor at Stanford University Department of Aeronautics and Astronautics starting in 1994 where he established the Space Systems Development Laboratory.

**Matt Craft**  
*President, Craft Consulting, LLC*

Matt Craft has over twenty-five years of business experience with a specialization in new business startups, financing, business strategy and planning, including over nine years of experience in the legal and financial industries and sixteen years supporting and guiding numerous entrepreneurial ventures through the various stages of growth and acquisition.

Instruction Methods

Case studies, PowerPoint presentations, and learning exercises will be used in this program.

Requirements for Successful Completion

Participants must sign in/out each day and be in attendance for the entirety of the conference to be eligible for continuing education credit. Regular interaction with course instructor indicating comprehension of the subject matter being taught.

IACET Credits

EUCI has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET). In obtaining this accreditation, EUCI has demonstrated that it complies with the ANSI/IACET Standard which is recognized internationally as a standard of good practice. As a result of their Authorized Provider status, EUCI is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.

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Event Location

Plaza Tower One Conference Center
6400 S Fiddlers Green Cir.
Greenwood Village, CO 80111
*The EUCI conference center is conveniently located adjacent to the Arapahoe at Village Center Light Rail Station, allowing easy access to and from DIA, Downtown, and Local Area Attractions.*

Nearby Hotels

*Each of these hotels offers a complimentary shuttle to and from the EUCI conference center.*

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7900 East Peakview Ave.
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Greenwood Village, CO 80111
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**Hyatt Place DTC**
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Greenwood Village, CO 80111
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2.1 miles away

**Hyatt Regency Denver Tech**
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Denver, CO 80237
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2.8 miles away

**Denver Marriott Tech Center**
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Denver, CO 80237
303-779-1100
3.1 miles away
Please Select

- CUBESAT AND THINSAT – INTRODUCTION, APPLICATIONS, AND METHODS FOR MISSION SUCCESS COURSE

February 24-25, 2020: US $1595
Early bird on or before January 31, 2020: US $1395

Event Location

Plaza Tower One Conference Center
6400 S Fiddlers Green Cir. Greenwood Village, CO 80111
See nearby hotels on page 9

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OR Enclosed is a check for $ to cover registrations.

Substitutions & Cancellations
Your registration may be transferred to a member of your organization up to 24 hours in advance of the event. Cancellations must be received on or before January 24, 2020 in order to be refunded and will be subject to a US $195.00 processing fee per registrant. No refunds will be made after this date. Cancellations received after this date will create a credit of the tuition (less processing fee) good toward any other LRA Institute event. This credit will be good for six months from the cancellation date. In the event of non-attendance, all registration fees will be forfeited. In case of course cancellation, LRA’s liability is limited to refund of the event registration fee only. For more information regarding administrative policies, such as complaints and refunds, please contact our offices at 1 888-305-0392. LRA reserves the right to alter this program without prior notice.