

COE CST First Annual Technical Meeting:

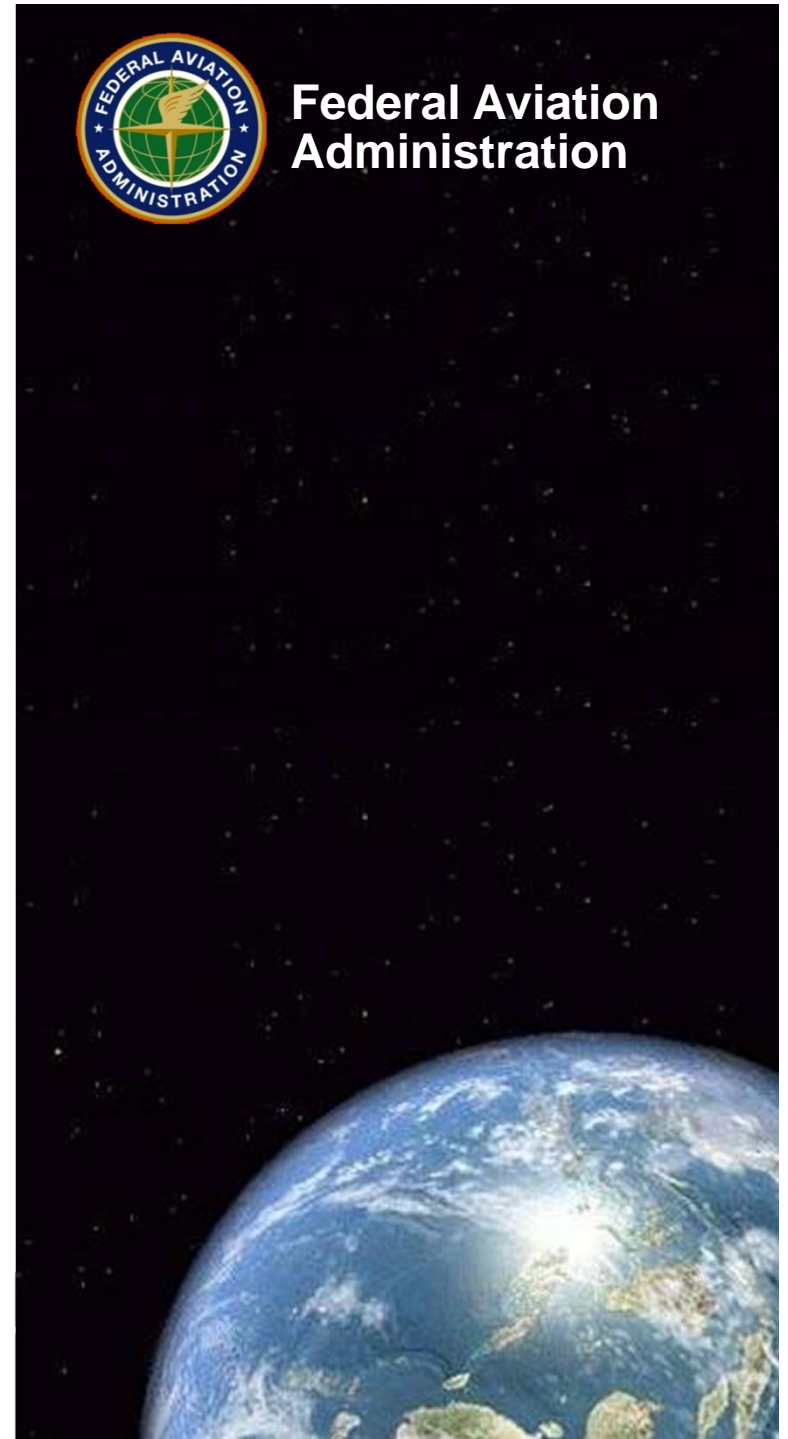
Commercial Spaceflight Operations Curriculum Development

Task 257: Masters's Ops Lab
George H. Born

11.09.2011



Federal Aviation
Administration





Overview

- Team Members
- Task Purpose/Objectives
- Process
- Results and Output
- Feedback
- Next Steps
- Contact Information



Team Members



- **George H. Born** – Director, Colorado Center for Astrodynamics Research
- **Bradley Cheetham** – Graduate Research Assistant, Aerospace Engineering Sciences
- **Jules Feldhacker** – Graduate Research Assistant, Aerospace Engineering Sciences
- **Emil Heeren** – Visiting Scholar
- **Jon Herman** – Visiting Scholar/Graduate Research Assistant



Partnering Organizations



SPACE FOUNDATION



COE CST First Annual Technical Meeting (ATM1)
November 9 & 10, 2011



Federal Aviation
Administration

Purpose of Task



- Objectives:
 - Develop one-semester course
 - Develop one-semester lab
 - Refine content based on student and industry feedback
 - Standardize and establish Graduate Certificate
 - Increase collaboration between academia and industry



FAA COE CST Objectives



- Research
 - Student research projects investigate current constraints and explore potential solutions
- Training
 - Preparing students to enter industry with commercial perspective
- Outreach
 - Educating academia about developments in commercial space



Process/Approach



- Draft academic objectives based on industry discussion
- Solicit feedback on academic objectives
 - AIAA Spaceflight Operations Meeting
 - Over 21 industry/partner organizations
- Define curriculum topics and solicit feedback
- Identify subject matter experts to develop and deliver content



Academic Objectives - Overall



Course shall serve as a bridge between theory and application to prepare real world problem solvers



Academic Objectives



- **Comprehension of total mission sequence**
 - **Mission initiation to end of mission**
 - **Course = overview**
 - **Lab = implement**
- **Constraints on design and operations (both understand and identify)**
 - **Technical – what can you do**
 - **Policy/Legal – what are you allowed to do**
 - **Business – what can you afford to do**
 - **Practical – how do you adapt**



Academic Objectives



- **Understanding of and insight into current industry practices**
 - **Comprehension of current industry practices**
 - **Past to present**
 - **Keep vs Change?**
 - **Critical review of potential improvements**
- **Overview of project management and team dynamics**
- **Cross cutting theme (through all objectives): RISK**
 - **Quantify and understand risk vs cost**



Course Schedule



Theme	Topic/Subject	Speaker	Date
Background			
Lecture 1	Course introduction	Cheetham/Born - CU	8.23.2011
Lecture 2	Industry & Government intro	Steve Lindsey - SNC	8.25.2011
Lecture 3	Industry & Government Challenges	Mike Gold – Bigelow Aerospace	8.30.2011
Launch	Topic/Subject	Speaker	Date
Lecture 1	Launch Overview - Technical Review	Matt Cannella - CU	9.1.2011
Lecture 2	Launch Vehicle Overview	Emil Heeren - CU	9.6.2011
Lecture 3	Launch constraints	Col. David Goldstein – Vandenberg AFB	9.8.2011
Lecture 4	Human launch considerations	John Reed - ULA	9.13.2011
Lecture 5	Suborbital flight	Jon Turnipseed – Virgin Galactic	9.15.2011



Course Schedule



Operations	Topic/Subject	Content	Date
Lecture 1	On-Orbit - Attitude/Rendezvous & Docking	Cancelled	9.20.2011
Lecture 2	Operations Overview	Bill Possel - LASP	9.22.2011
Lecture 3	S&MA	George Gafka – NASA JSC	9.27.2011
Lecture 4	Spacecraft Subsystems	Michael Begley - LMCO	9.29.2011
Lecture 5	Spacecraft Subsystems II	Scott Mitchell – Ball Aerospace	10.4.2011
Lecture 6	Industry Overview	Alan Stern - SwRI	10.6.2011
Lecture 7	Payloads	Martin Taylor/Michael Mahoney - GeoEye	10.11.2011
Lecture 8	Human Factors	Jim Voss - SNC	10.13.2011
Lecture 9	On-Orbit - OD	Jeff Parker - JPL	10.18.2011
Lecture 10	Conjunction/Debris	Dave Vallado - AGI	10.20.2011
Lecture 11	Ground station operations/design	Byron Miller – Clear Channel Satellite	10.25.2011
End-of-Mission	Topic/Subject	Content	Date
Lecture 1	Re-entry Overview/Review	Cancelled	10.27.2011
Lecture 2	End-of-mission options	Larry Williams/Scott Henderson - SpaceX	11.1.2011
Lecture 3	Quality Sciences/Cost-Plus vs. Commercial Contracting	Jeff Luftig - CU	11.3.2011



Course Schedule



Mission Planning	Topic/Subject	Content	Date
Lecture 1	Mission design	Mike McGrath - LASP	11.8.2011
Lecture 2	Construction/Integration Overview	David Termohlen – Orbital Sciences Corp.	11.10.2011
Lecture 3	Mission Assurance/Contingency Plans/Risk reduction	Wayne Hale - SAS	11.15.2011
Lecture 4	Financial/Contracting Overview	Clay Mowry - Arianespace	11.29.2011

Misc. Topics	Topic/Subject	Content	Date
Lecture 1	On-orbit Fuel Depots/Satellite Servicing	Jon Goff – Altius Space Machines	11.17.2011

Conclusions	Topic/Subject	Content	Date
Lecture 1	Overview/Summary/Current issues	Mark Sirangelo - SNC	12.1.2011
Lecture 2	Space Policy Overview	Bill Possel - LASP	12.6.2011
Lecture 3	Course Summary	Cheetham - CU	12.8.2011
Student Presentations	Individual research projects	Selected by students and assisted by industry	FINALS



Student Products



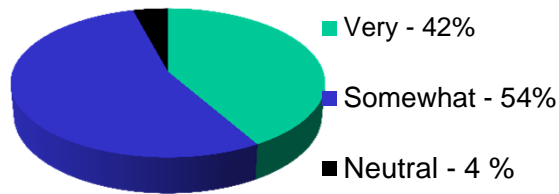
- Total students enrolled: 28
 - 19 on-campus
 - 9 off-campus (enabled by distance technology)
- Assignments
 - Weekly discussion
 - 4 Open Ended Assignments
 - 4 Labs
 - 1 Research Paper



Student Feedback

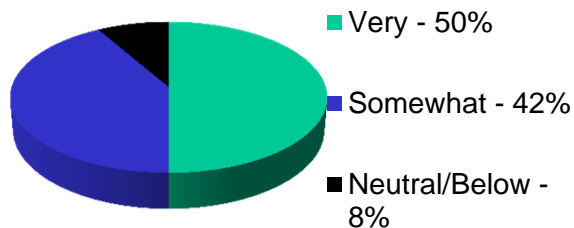


Course Content Overall



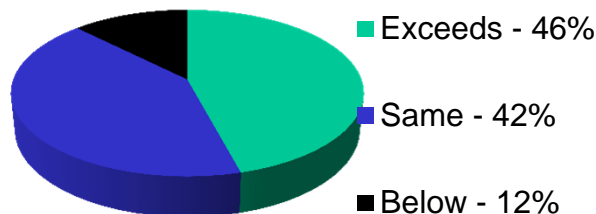
“I really enjoy this course. It is information that every aerospace engineer should know”

Lectures



“It is extremely valuable to gain insight from professionals, as opposed to the usually somewhat-limited academic presentation of material”

Comparison



“I am finishing my Master’s degree this semester and a lot of this information is useful to me in understanding how the industry works”

“I like the variety of topics that are covered”

“This course has really stood out to me so far in how everything is very investigative.”

Next Steps



- Spring-Summer 2012:
 - Continued development/revision of course
 - Initiate development of lab portion
- Fall 2012
 - Offer lecture for second time
- Spring 2013
 - Offer lab for first time
- Continue alternating course/lab
 - Formalize Certificate program

Contact Information



George H. Born

George.Born@Colorado.edu

Bradley Cheetham

Bradley.Cheetham@Colorado.edu



Questions

