Educate Utilizing CubeSat Experience (EdUCE) 
a Pragmatic Approach to Shatter Barriers to Space

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August 14th, 2012
EdUCE Background Information

**Advanced Space Technologies Research & Engineering Center (ASTREC)**

- Serves the space industry through **focused research**, significant **technology transfer**, and a strong **educational** program

- Performs R&D activities focused on advancing the state-of-the-art of small satellite systems, thus enabling their capabilities and functionalities
  - R&D portfolio defined in collaboration with industry and government partners to ensure relevance to the industry
  - On-orbit technology verification and validation using pico-/nano-satellites

- ASTREC Charter includes the development of a K-20 space educational program
  - EdUCE fulfills this outreach initiative
  - First Step: Pilot K-12 Teacher STEM Workshop
  - Complimentary Activities
    - High school summer seminar course (earns college credit)
    - Microgravity Flights
    - USA Science & Engineering Festivals
    - Small Satellite Design Club (SSDC) Activities
EdUCE Pilot Workshop Objectives

- A Teacher’s Engineering Experience Through CubeSat Interactions, a Prelude to EdUCE at the University of Florida was a critical step in establishing relationships with interested K-12 educators
  - Hosted a Teacher Training Workshop
  - Introduced the Merit of CubeSats to current educational portfolios
  - Focused primarily on high school (and middle school) level for initial implementation

- Content of Teacher Training Exercises
  - Provided a hands-on CubeSat experience with current research efforts
  - Provided with a prototype hands-on kit for the high school classroom
  - Emphasized “engineering” in STEM

- Collaboration / Presentations
  - Received Action Plans from EdUCE Pilot Teachers
  - Feedback – refine EdUCE activities to be more engaging
  - Identify other effective approaches to STEM which are consistent with EdUCE
EdUCE Pilot Workshop

- EdUCE pilot teachers were composed of Florida teachers from diverse middle / high schools
  - Bronson High School
  - C.H. Price Middle School
  - Hawthorne Middle / High School
  - PK Yonge Research Developmental School
  - Plantation High School

EdUCE Pilot Teachers in the integrated Design Engineering Verification Facility

Pilot Workshop Coordinators and Teacher Participants
EdUCE Pilot Workshop Activities & Outcomes

- Developed a week long agenda for the EdUCE pilot teachers
- Focused on engineering practices in particular to small satellites and the facilities needed to support these activities
- Established relationships with active teachers
- Provided hands-on training on a STEM kit
- Delivered Action Plans for their respective schools and districts
- Received feedback on EdUCE design
- Presented an Informal Science Education design, however teachers recommended a Direct Research K-12 approach

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<tr>
<th>Benchmark</th>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>MA.912.T.2.3</td>
<td>Precalculus</td>
<td>Apply the laws of sines and cosines to solve real-world problems using technology</td>
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<tr>
<td>MA.912.T.3.4</td>
<td>Precalculus</td>
<td>Solve trigonometric equations and real-world applications involving applications of trig equations using technology when appropriate</td>
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<tr>
<td>MA.912.T.4.1</td>
<td>Precalculus</td>
<td>Define polar coordinates and relate polar coordinates to Cartesian coordinates with and without the use of technology</td>
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<tr>
<td>MA.912.A.3.15</td>
<td>Adv. Algebra w/ Financial Applications</td>
<td>Create a graph to represent a real-world situation</td>
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<tr>
<td>MA.912.A.2.2</td>
<td>Adv. Algebra w/ Financial Applications</td>
<td>Interpret a graph representing a real-world situation</td>
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<td>MA.912.A.3.55</td>
<td>Adv. Algebra w/ Financial Applications</td>
<td>Symbolically represent and solve multi-step and real-world applications that involve linear equations and inequalities</td>
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<tr>
<td>MA.912.A.3.15</td>
<td>Adv. Algebra w/ Financial Applications</td>
<td>Solve real-world problems involving systems of linear equations and inequalities in two and three variables</td>
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Hands-on STEM Kit

- STEM Kit consist of:
  - Sensor, processing unit and communication equipment
  - Processing unit: Microcontroller (Texas Instrument MSP430f2012)
  - Communication equipment: antenna and transmitters
EdUCE Tour: iDEV Facility

New Engineering Building

High Bay

Avionics Laboratory

iDEV Facility Layout
EdUCE Tour: SwampSat Mission Control

- Gator Nation Earth Station (GNES)
  - Capable of digital satellite communications
  - Operational since August 2006
  - Recipient of three AMSAT awards

- Mission Operations Center (MOC)
  - “Headquarters” for the UF SwampSat mission
  - Large display for real time tracking of satellites passing over campus

AMSAT Satellite Tracking Awards

Satellite 2m and 70cm Circularly Polarized Yagi Antennas

Mission Operation Center

Mission Control Room

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Mission Operation Center

Mission Control Room
Student Science Training Program

- SSTP Research Lab Student (30 hrs/week for seven weeks)
  - Summer of 2009 Experience
  - Attended a local high school
  - Researched CubeSats (attended special visits)

- Introduction to Space Systems Seminar (18 contact hours)
  - Developed a summer course in 2010 and 2011
  - Experienced Hands-on CubeSat Research from Engineering Students
  - Designed, Built, and Launched High-Altitude Balloon (HAB) Experiments
HAB Project – SSTP’s Team SWAG

- The highlight of the SSTP-2011 Space Seminar class: July 25th HAB Launch

Prelaunch Environment in the Ben Hill Griffin Stadium student football section

Release of the High Altitude Balloon tethered with their experiments

The Parachute in rapid ascent

The Payload in rapid ascent
HAB Project – SSTP’s Team SWAG Results

- The team of high school students successfully designed and launched their payload with guidance from the engineering students.
- Students applied systems engineering and wrote their own code for capturing the images.
- The maximum altitude was recorded about 14,000 ft.
University of Florida MicroG Team

- A team of undergraduates participated in NASA’s Microgravity University program (with 14 other universities)
- The team tested CMG-based CubeSat attitude control using free floating test beds

UF MicroG Presenting their Tabletop CubeSat Hardware Built in the iDEV Facility
Other Activities

- USA Science & Engineering Festival
  - The world’s largest science and engineering festival in Washington DC (Oct 2010 and April 2012) – the University of Florida put together an exhibit entitled “Gators in Space”
  - Displayed 1U SwampSat and Control Moment Gyroscope control box
  - Exposed participants to the gyro chair to explain the gyroscopic motion for pointing a spacecraft

- Small Satellite Design Club
  - Participated in FUNSAT competition
  - Organized educational outreach activities at local schools and events (TEDx events, science & engineering festivals, small satellite seminar talks)
Summary and Future Directions

- ASTREC personnel successfully supported the following:
  - Pilot teacher workshop to train teachers through an engineering experience
  - High school seminar course on Space Systems Engineering including multiple high altitude balloon experiments flown
  - Microgravity flight
  - USA Science & Engineering Festival

- Future Directions
  - Host annual teacher training workshops
  - Continue K-12 lesson plan and curriculum mapping paired with EdUCE technology
  - Explore collaboration
Acknowledgements & Questions

Mayra Cordero
Michael Handler
Stephanie Handler
Jeanie Houk
Harriet Landers
Andrew Moon
Pam Rowland
Katie Cason
Sheldon Clark
Tzu Yu Lin
Moises Rivero

Dr. Jay Garlitz
Jeff Capehart
Dr. Janice McNair
Dr. Stephen Eikenberry
Dr. Tony Delisle
Dr. Bruce McFadden
Jeff Bell
Dr. David Miller
Dr. Ranga Narayan

A special thanks to Dr. Jaydeep Mukherjee, Director of the Florida Space Grant Consortium for their continual support

Questions?
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