The Role of Small Satellites in the Establishment of the Gulf Region's First Graduate Level Space Studies Program

Carlos Niederstrasser
Carlos.Niederstrasser@ngc.com
Northrop Grumman Corporation, United States

Dr. Prashanth Reddy Marpu, Adham Alkhaja, Thu Trong Vu
Khalifa University, United Arab Emirates

Dr. Efthymios Kontogiannis, Ahmed A. Alshaer
Al Yah Satellite Communications Company (Yahsat), United Arab Emirates
History & Motivation
The UAE Reaches for Space

"We have to ensure the new generation is equipped with knowledge and science so they can represent our competitive advantage in front of the whole world. Our only choice is quality." — His Highness Sheikh Mohammed bin Zayed, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the Armed Forces.

2015 declared UAE’s Year of Innovation

UAE SPACE AGENCY
Founded 2014

Launch 2020
Tri-Party Program Established
The Space Systems and Technology Program

Year 1
Critical Design
Table-top Prototype
(SmallSat Project)

Year 2
Flight Articles I&T
Launch & Operation
(SmallSat Project)

MSc Degree in
Engineering with
Concentration in
Space Systems &
Technology

Khalifa University
Yahsat
Northrop Grumman
Space Program Impact

- Understand all aspects of Space Systems engineering
- Learn to communicate efficiently with other students coming from different backgrounds.
- Gain significant experience in efficient project management
- Make quick and right decisions under a tight task schedule
- Improve problem solving skills faced with limited supply of required resources
- Emulate industry projects through working within a specific framework and fixed budget

The skills gained in designing and developing the CubeSat, are a crucial contribution to the development of human capital to further the growth of the Emirati space industry.
Space Systems and Technology Program
A Multidisciplinary Program

- Engineering Systems and Management:
  - Engineering Systems & Management
  - Critical Infrastructure

- Electrical Engineering and Computer Science:
  - Electrical Power
  - Microsystems
  - Computing Information Science

- Mechanical and Materials Engineering:
  - Mechanical Engineering
  - Materials science & Engineering

- Chemical and Environmental Engineering:
  - Chemical Engineering
  - Water & Environmental Engineering
The Space Systems and Technology Program

Curriculum

4 Program respective core courses (12 credits) for respective master program

- 1 Compulsory technical elective: SCC601 – Spacecraft Systems and Design (3 credits)
- 1 Space technology-related technical elective (3 credits)
- Spacecraft Systems Lab Course (SCC602, 603, 604): 2 credits/course

Space technology-related MS thesis work (12 credits)

Internship within space industry (No credit) (Optional)
Establishment of Yahsat Space Lab

- Established to support the CubeSat programs at Khalifa University and the greater UAE
- First of its kind in the region with the capability to design, build and test small satellites up to 6U form factor
Outreach is Part of the Mission
Small Satellites as Key Enablers
First mission from the lab mainly intended as an educational satellite.

It carries an experimental coin cell battery based on technology developed at Masdar Institute/KU along with a VGA camera integrated here.

Deployed into orbit on Feb 13, 2019 from Cygnus spacecraft.
MYSat-2

- Develop testbed for attitude determination and control
- Test the pointing accuracy of different ADCS pointing control strategies and validating them by taking a picture with a digital camera in the pointing direction
- Expected to Launch by Q2, 2020
MeznSat

* 3U CubeSat satellite
* Initiated and funded by the UAE Space Agency and in partnership with Khalifa University and the American University of Ras Al Khaimah (AURAK)
* Educational/scientific satellite program with the aim of enhancing space research and education
* Scientific outcome will include monitoring the Green-House Gas (GHG) concentrations above UAE.
* Expected to Launch by Q1, 2020
• Winning Mission of **UAE Mini Satellite Challenge: Design, Build, Launch**.

• Collaboration between New York University Abu Dhabi (Payload) and Khalifa University (Bus)

• Gamma-Ray Detector for the study of terrestrial gamma ray flashes

• Innovative detector utilizing Cerium(III) Bromide (CeBr₃) crystals coupled to compact, energy efficient silicon photomultipliers

• Expected to Launch by Q2, 2020
Conclusions
Lessons Learned

* A student-satellite is a hands-on project in arguably the ‘most attention-getting’ of engineering disciplines
* Interdisciplinary approach works!
* Establishing a new research program is challenging
* Publish or Perish
* Even minimal modifications to existing curricula are hard
* Industry participation is crucial to providing “real world” feel …
* … But industry and academia work by different rules
95% of the educational goals of this program are met the moment the satellite is delivered to the launch vehicle.
To date, 47 students have participated in projects hosted by the Yahsat Space Laboratory and the Space Science and Technology program

24 of the students have been female students.

Future CubeSat projects are expected to focus on education and training, technology demonstration, scientific research, communications, and earth remote sensing.

The combination of coursework, research, and spacecraft development prepares the students to contribute in the UAE’s rapidly growing space sector.
In today’s world, technology is changing rapidly. The space industry is not immune from this change. Technological change is impacting all areas, whether it is in the emergence of new small launch entrants, the growth of large communication constellations, the development of new cutting-edge scientific sensors, or the deployment of disaggregated systems for national security needs. To stay competitive, a country needs to invest in its most precious resource – human capital.
Thank you for your attention!

The authors would like to thank Masood Mahmood, CEO of Yahsat, and David Thompson, former CEO of Orbital ATK, who provided the vision for the creation of this program. We also acknowledge all the students, but especially the first cohort, who helped grow and shape the program during its first two years.