

***STATEMENT OF***

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## **Introduction**

Chairman Everett, Congressman Reyes, and distinguished members of the Committee, good morning to my esteemed colleagues here today. I am Dr. Robert A. Calico, Jr., Dean of the Graduate School of Engineering and Management at the Air Force Institute of Technology. It is my pleasure to be here today to discuss the education of this nation's military space professionals.

As the Space Commission highlighted in its 11 January 2001 report: "Military space professionals will have to master highly complex technology; develop new doctrine and concepts of operation for space launch, offensive and defensive space operations, power projection in, from, and through space, and other military uses of space; and operate some of the most complex systems ever built and deployed." Clearly, world-class scientists, engineers, and operators are required in the crucial and unforgiving business of operating both manned and unmanned assets in space. These individuals come from academia, industry, and government. The key difference between the military space professionals and those involved in civilian space programs is the military utilization of space, as highlighted by the Space Commission. Space science is fundamental to both communities. It is the fusing of space sciences with technology, doctrine, and tactics that allows the space professional to accomplish assigned military missions. AFIT understands this very well as it executes its own mission of educating military space professionals. In this respect, AFIT does not stand in the shadow of any civilian academic institution and is proud of its past contributions in preparing officers for the space profession and is prepared to continue this role into the 21<sup>st</sup> century.

## **History**

AFIT's history in providing leaders to the space community is long and proud. Included in AFIT's graduates are the father of the Ballistic Missile Program, General Bernard Schriever, two Mercury astronauts, Scott Carpenter and Guss Grissom, America's first African-American astronaut, Col (Dr.) Guion Bluford, and others.

As early as 1957, as the nation and the Air Force responded to the launch of Sputnik, space-related courses were added to existing curricula and the first class of the Astronautics program (later renamed Astronautical Engineering) began in 1958. This responsiveness to Air Force and national defense needs is just one example of many for AFIT.

Evolution of the space curriculum over the years mirrors that in other areas and is based on Air Force requirements. Beginning in the early 1970's, the Air Force developed a system for coding officer billets requiring Advanced Academic Degrees (AAD). Every officer position is coded as to whether or not an advanced degree is required. Positions requiring advanced education were assigned an Academic Specialty Code (ASC). For example, a position might be coded 4EGY, which would indicate that an astronautical engineer (4E) with a specialization in structures (G) was required for that position. The Air Force Educational Requirements Board (AFERB) meets annually to compare the educational requirements to the inventory of officers with those required degrees, to determine if additional officers require education and in what specific areas. This system, while able to track continuing requirements, was not designed to predict future trends. These trends are identified by AFIT working closely with its customer community. This frequently occurs through DoD organizations sponsoring student and faculty research projects. Active research by faculty working with students and sponsors identify new and emerging trends, which then translates into modified or new academic programs. This interaction is further enhanced by the fact that one-half of AFIT's faculty are military officers on four-year tours who bring their field experiences with them to AFIT, and subsequently take their AFIT experiences and connections back to the field.

An example of this process was the development in the late 1970s of the Graduate Space Operations program. Starting with the idea that a need existed for officers with experience in the operation of space systems who also understood the underlying engineering principals, a team of AFIT faculty traveled around the Air Force to organizations involved in space to define their needs. The result of this effort was the development of a curriculum that provided the critical interface between the operational organizations and the engineering community developing the systems. Instituted for the 13S (space and missiles) career field, this program provides a strong foundation of space systems to support military space operations, acquisition and policy

development. In addition, AFIT initiated the Graduate Aerospace and Information Operations (GAI) program in Fall 2001 as a direct response to an Air Force Space Command request to add information operations to the space operations program. The GAI program, part of the Air Force Space Command *Vigilant Scholar* program, retains the technical foundation of space science and engineering courses but also provides students with an understanding of how information is used, conveyed, assured, and denied.

While these programs are obviously relevant to space professionals, they are by no means the only AFIT programs that have served to prepare the Air Force's space cadre. The electrical engineering program has a thirty plus year history of providing education in navigation, space communication, space-based radar, remote sensing, and signal processing. The physics program has a similar history of providing graduates with expertise in space optics, spaced based laser systems, space atmosphere, and space power. Additionally the systems engineering program has provided hundreds of graduates over the past twenty-five years with expertise in space systems design.

### **Recent Developments**

Traditionally AFIT has been funded by the Air Force to educate Air Force officers in numbers determined by quotas through the AFERB process. The education of sister service officers, DoD civilians, and international officers was on a space available basis. That is, if the Air Force failed to fill a designated quota, these other students could fill the empty seat.

In December 2002, SECAF and SECNAV signed an MOA creating an alliance between AFIT and the Naval Postgraduate School (NPS). Subsequently, the Commandant of AFIT and the Superintendent of NPS signed a follow-on MOU in April 2004. The purpose of this alliance is to ensure AFIT and NPS meet the advanced education requirements of the Armed Forces of the United States. One of the oversight boards established by the MOA is the Joint Space Oversight Board, chaired by the Director of the National Reconnaissance Office, which is chartered to pursue opportunities and initiatives that provide focused, timely graduate level education to the space cadre.

## **Current Space Education Programs**

AFIT offers a wide range of graduate programs to meet the needs of space professionals. Until recently, 18-month Master's Degree programs and three year Doctoral Degree Programs were the standard for AFIT. In Fall 2003, AFIT expanded its offerings under the Graduate Space Systems (GSS) program. Students take a common space core, augmented with tailored sequences to meet specific Academic Specialty Codes, such as systems engineering, information warfare, and operations research. In addition to GSS, AFIT offers a traditional Astronautical Engineering degree, leading to an MS in 18 months and a PhD in 36 months.

Responding to the Air Forces new Force Development initiative, AFIT also developed a 12-month non-thesis Master's program aimed at high performing, mid-career officers. Execution of this initiative resulted in AFIT offering all degrees in a 12-month format as part of the Intermediate Development Education (IDE) program. The addition of IDE students will significantly increase the total enrollment at AFIT in space related disciplines.

Other initiatives continue to highlight AFIT's responsiveness to changing customer needs. AFIT developed a number of non-degree graduate certificate programs designed to provide focused graduate education over several weeks to months. The curricula for these certificate programs are managed through AFIT's Centers of Excellence: Systems Engineering, Directed Energy, Information Security, and Measurement & Signature Intelligence. All four centers have significant ongoing efforts in military space education and research. As an example, the Measurement & Signature Intelligence (MASINT) Certificate program is a ten-week, four course plus lab series, focused on the technical aspects of collecting, processing and exploiting non-literal, remotely sensed infrared (IR) and synthetic aperture radar (SAR) intelligence data. In this certificate program, the Space Physics specialty provides an understanding of solar effects on the near-earth environment and their ramifications to military systems and operations in space. As another example, the Operations Research (OR) program has an emphasis area in space systems analysis, in addition to five different OR course sequences having special relevance to the GSS program.

## **Curricula Development**

AFIT has a long tradition in space curriculum development, dating back to 1958, when it was the first in the nation to develop an Astronautical Engineering curriculum. AFIT's current initiatives continue to be influenced by space education needs through continuing faculty interactions with the military space community. This interaction is further enhanced by the fact that one-half of AFIT's faculty are military officers that come directly from DoD organizations, many of which are part of the military space community. Trends and requirements are identified by AFIT working closely with the space community.

The Graduate Space Systems (GSS) program is designed to provide officers with a broad knowledge of space systems engineering and space science. Education in the fundamentals of these areas will increase military officers' effectiveness in planning, executing, and evaluating space systems and operations. Each student completes a research thesis on some aspect of space systems (engineering, science, or operations). The Space Systems graduate is ready to participate actively in organizations responsible for the selection, planning, management, operation, and evaluation of space systems for DoD.

The GSS curriculum is comprised of the following elements:

- (1) Mathematics
- (2) Core Courses
- (3) Specialty Sequence
- (4) Elective Courses
- (5) Thesis

The core program assures that all students have a broad background in the engineering and science of space systems and operations. The core program includes courses in orbit and attitude dynamics, telecommunications, space sensor systems, space environment, spacecraft engineering, and military space programs.

For technical depth, AFIT also offers a wide variety of specialty sequences in space engineering and science. A partial list of the more common sequences are: Advanced Astrodynamics, Aerospace Robotics, Control and Optimization Theory, Mechanics and Control of Space Structures, Rocket Propulsion, Space Facilities, Space Navigation, Systems Analysis and Design, Structural Analysis, Structural Materials, Communication Systems, Navigation Systems, Radar Systems, Laser and Electro-Optic Systems, Stochastic Estimation and Control, Target Recognition, Signal Processing, and the Space Environment.

The Graduate Astronautical Engineering (GA) program is designed to provide astronautical engineering specialists for the Air Force. The program leads to a master's degree in Astronautical Engineering and is fully accredited. This master's degree program provides the student with a broad education in the scientific and engineering disciplines associated with astronautical engineering. It is expected that our graduates will be prepared to: 1) make direct contributions as a practicing engineer to the area of astronautical engineering, 2) evaluate, monitor, and administer astronautical research and development projects, and 3) synthesize their professional expertise with the needs of the Air Force to produce new systems in the space arena. There are several different options associated with the GA program, including: Aerospace Engineering, Guidance and Control, Instrumentation, Rocket Propulsion, Space Facilities, and Structures.

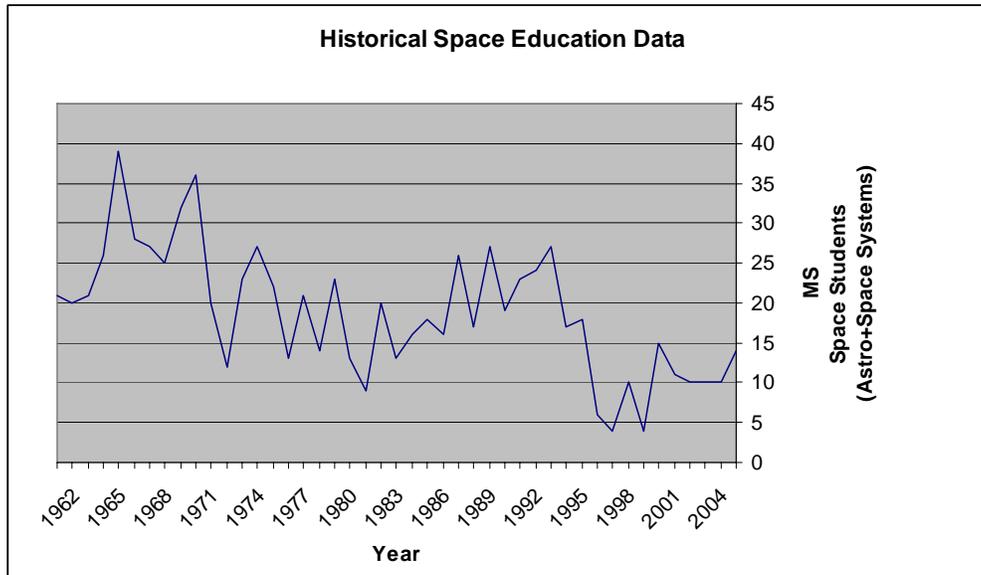
### **The Joint Space Academic Group**

The mission of the Joint Space Academic Group (JSAG) is to be an integrated AFIT/NPS-level working group in support of the Joint Space Oversight Board, and to ensure that graduate-level education of the National Security Space Cadre leverages the strengths of both NPS and AFIT through collaboration and partnering.

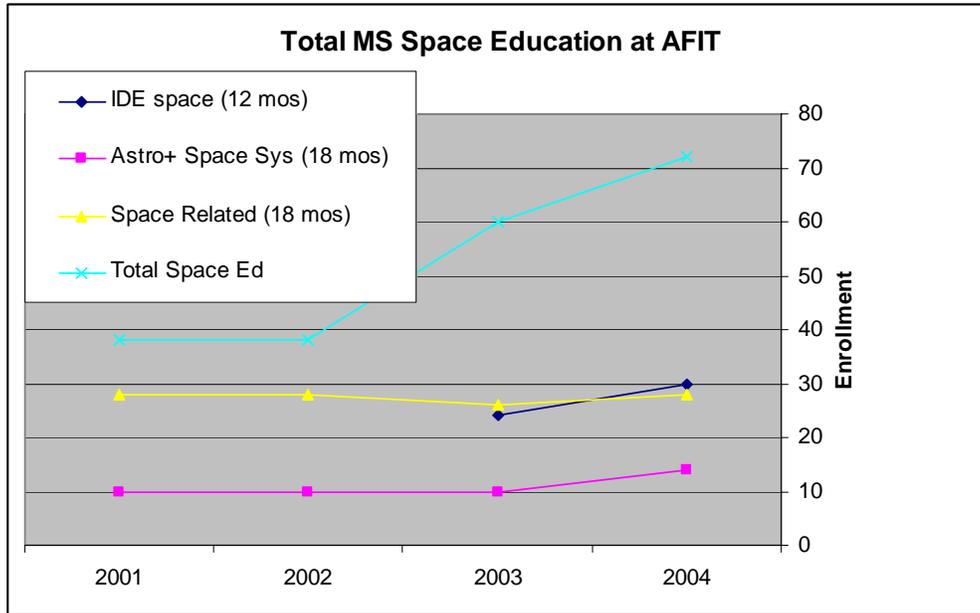
The JSAG is comprised of five members, two each from NPS and AFIT, and one outside member representing the National Security Space user community. The chair will alternate between the user community members.

## Enrollment Levels

The first chart (below) shows the historical data for the total number of space students (Aeronautical Engineering and Space Systems) who graduated with a Master of Science Degree. Not included are the students from other disciplines with a space related degree program.



The following chart shows the current enrollment in space education. In addition to the Aeronautical Engineering and Space Systems students as shown above, students enrolled in 18-month space related degrees and the 12-month IDE space related degrees are reflected. Space related degrees reflect students enrolled in engineering and science programs other than Aeronautical Engineering and Space Systems, but contain significant space related content. These programs include, but are not limited to, electro-optics, remote sensing, information warfare, space physics, global positioning system, and directed energy.



From the historical data in the first chart, the Air Force responded to Sputnik with a rapid enrollment in the space fields. Since then, there has been a steady decline. However, AFIT has benefited from a significant enrollment increase in the last few years in space education due to the Air Force's Vector Blue initiative, which will increase graduate education enrollment AF-wide up to four times its current level. The single largest enrollment jump is due to the IDE 12-month non-thesis students. The number of full time 18-month quota students has remained relatively constant since 2000, but will also increase significantly under Vector Blue. Bottom Line - there is still excess capacity in space education programs at AFIT.

### Conclusion

AFIT's long and distinguished history in providing space education has served the nation well. AFIT continues to be responsive to the changing requirements of the military space community, offering defense-focused programs taught by a highly capable civilian and military faculty. Historically, enrollment numbers are well below AFIT's capacity, and pale in comparison to the post-Sputnik years. However, the Vector Blue initiative has positively impacted enrollment and reversed this downward trend. AFIT is a flexible, responsive educational institution and well suited to provide relevant, defense-focused education for the 21<sup>st</sup> century space warrior.