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The Role of the U of M Aerospace Engineering Department in the Early U.S. Space Program and Training of Apollo Program Astronauts

R.M. Howe, Professor Emeritus

In 1916-17 the University of Michigan became the first US academic institution to offer a bachelor's degree in aeronautical engineering. It is therefore only fitting that in the 1950's and 1960's the U of M Department of Aeronautical Engineering made significant research contributions to the early US space program and the training of astronauts for the Apollo program.

In 1947, Willow Run Airport, 15 miles east of Ann Arbor and site of the World War II Liberator Bomber Plant, was deeded to the University of Michigan. A plan was devised for leasing the airport field and hanger facilities to the airlines to serve as the Detroit airport, while retaining space for a new and enlarged postwar program of aeronautical instruction and research. At the same time, through the U of M Department of Engineering Research, a contract, known as the Wizard Project, was negotiated with the Air Material Command for an engineering study of a defensive guided missile. To house this project and provide the necessary laboratory facilities, the Aeronautical Research Center was developed at Willow Run Airport. Another project, initiated by the Signal Corps, involved the measurement of atmospheric temperatures up to 60 miles altitude, as well as the determination of whether there existed diffusive separation of different types of upper air molecules. The research for this project was performed by a newly created High Altitude Engineering Laboratory in the Department of Aeronautical Engineering, directed by Professor Myron H. Nichols and located, together with other department facilities, in East Engineering Building on the main U of M campus.

In 1949-50 the newly created US Air Force, realizing that their officers had received no academic training in the emerging technology of guided missiles, established two-year graduate training programs in guided missiles in the aeronautical engineering departments at both MIT and the University of Michigan. The US Air Force paid double outstate tuition for officers enrolled in the U of M program. Approximately a decade later the designated program name was changed from guided missiles to astronautics. Upwards of 50 US Air Force officers were enrolled annually in the program, which also attracted substantial numbers of post-graduate students from both the US Army and US Navy, along with 4 RCAF officers annually from the Canadian Air Force. The importance of this program to the Aeronautical Engineering Department of the University of Michigan was dramatic. Not only did it increase the overall graduate student enrollment in the department by a large factor, but it resulted in the inauguration of new graduate courses in guidance and control of missiles, dynamics of linear and nonlinear systems, and random processes. To help staff these courses, Lawrence L. Rauch in 1949 and Robert M. Howe in 1950, with PhD's in applied mathematics and physics, respectively, were added to the department faculty. Professor Myron Nichols served as the initial director of the USAF Guided Missiles Program at U of M. The military students graduated from the guided missiles training program with two master's degrees, one in aeronautical engineering and the other in instrumentation engineering, later designated information and control engineering. In addition to the USAF students, US Army, US Navy, RCAF and other foreign air force officers were sent to the U of M for graduate studies in the guided

missiles program. The courses originated by the program were also elected by civilian graduate students, and during the 1950's and 1960's an ever increasing number of MSE and PhD degrees in instrumentation engineering were awarded to non-military students.

In addition to the lecture courses, the teaching program in instrumentation engineering included laboratory activities, with a strong emphasis on real-time simulation using departmental analog computer facilities. The development of these facilities, which were also an important part of research projects on flight simulation, began as part of the Wizard Project described above in the second paragraph and continued into the 1960's. As a side note, the department expertise in analog computers and real-time simulation led in 1957 to the founding, by several faculty members, of Applied Dynamics Incorporated. This well known company developed and marketed analog computers, emphasizing their engineering application to real-time simulation. The company continues to the present as Applied Dynamics International, marketing real-time simulation systems utilizing digital hardware and software.

Starting in 1957 a number of faculty members in addition to the three named above with non-traditional aeronautical background and interests were added to the aeronautical engineering department, including Frederick J. Beutler, Donald T. Greenwood, Edward O. Gilbert, Elmer G. Gilbert and William L. Root. In 1968 the graduate program in Information and Control Engineering was succeeded by the broader inter-departmental graduate program Computer, Information and Control Engineering, with Lawrence L. Rauch as the first chairman. Also, new aero faculty were added in the areas of dynamics and control, including Harris McClamroch, William Powers and N. X. Vinh, with the departmental name now changed to aerospace engineering. In 1984, with the reorganization of the Department of Electrical Engineering into the Department of Electrical Engineering and Computer Science, the interdepartmental program Computer, Information and Control Engineering was dissolved, with the aerospace engineering faculty members participating in it returning to full-time teaching in the Aerospace Engineering Department.

It is clear that the post World War II Guided Missiles Training Program in the aero department at the University of Michigan provided the impetus for the evolution and growth of the outstanding teaching and research program in flight dynamics and control in the U of M Aerospace Engineering Department. It also resulted directly in the major participation of U of M alumni in the manned US space program, including the first walk in space of a US astronaut, performed in 1965 by Col. Ed White in the orbital flight of Gemini 4, which was commanded by Col. Jim McDivitt. Both U of M aero alumni McDivitt and White returned to Ann Arbor after the mission to receive honorary doctorates in astronautical science from the University of Michigan. Col. White died in the tragic Apollo spacecraft flash fire during a launch pad test at Kennedy Space Center, Florida, in 1967. In 1969, Col. McDivitt was also commander of Apollo 9, a 10-day orbital mission that included the first flight of the Lunar module. Jim McDivitt retired from the US Air Force with the rank of Brig General in 1972.

All three astronauts in the Apollo 15 moon mission were University of Michigan alumni. Dave Scott, spacecraft commander, spent his freshman year at U of M before transferring to the United States Military Academy, while Jim Irwin, pilot of the lunar module *Falcon*, and Al Worden, pilot of the command module *Endeavour*, were both graduates of the U of M guided missiles training program. Apollo 15 was the first lunar mission with the lunar surface vehicle "Rover 1" in which Scott and Irwin made three excursions on the lunar surface and collected 166 pounds of lunar surface material.

Worden, who remained alone in the command module *Endeavour* in lunar orbit while Scott and Irwin were on the lunar surface, logged 38 minutes of deep space extra vehicular activity in retrieving film cassettes from panoramic and mapping cameras following the return of Scott and Irwin from the lunar surface to the command module. The University of Michigan was the first official visit for the Apollo 15 crew after their return from the moon. All three crew members received honorary doctorates in astronautical science from the University of Michigan; both U of M aero students and faculty were thrilled to engage in personal discussions with the astronauts about what the mission was like.

A recognition of University of Michigan alumni with major achievements as US astronauts would not be complete without including Col. Jack Lousma, USMC, who received a bachelor's degree in Aeronautical Engineering from U of M in 1959 and was selected by NASA as an astronaut in 1966. He served as pilot of Skylab 3 in 1973, which completed 858 earth orbits while accomplishing 150% of mission goals. He also was the spacecraft commander for the third orbital test flight of the space shuttle Columbia in 1982, landing on the lakebed at White Sands, New Mexico, after completing 129.9 orbits of the earth.

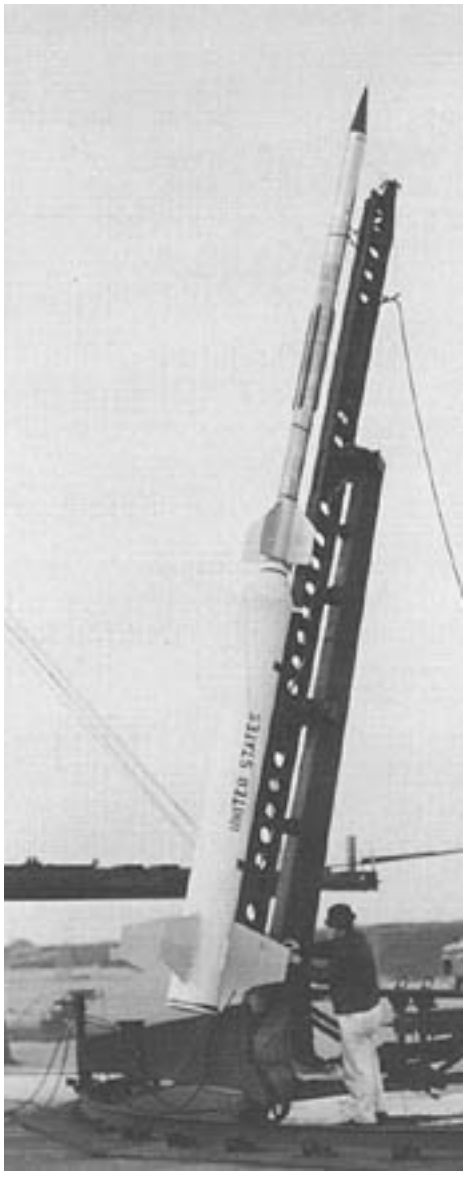
It should also be noted that Capt. Theodore Freeman, USAF, graduate of the U of M Guided Missile Training Program and selected as an astronaut by NASA in 1963, died in the crash of a T-38 jet on Oct. 31, 1964.

As noted in the second paragraph above, early University of Michigan research in the US space program was conducted by the High Altitude Engineering Laboratory in the Department of Aeronautical Engineering. The research initially involved the analysis of upper-atmosphere samples at altitudes between 100,000 and 300,000 feet collected in rocket-transported bottles returned to earth. Starting in 1947, captured German V-2 rockets launched at White Sands, New Mexico, were used to collect and retrieve the sample bottles. Later, because of the poor reliability and high launch expense associated with the V-2 rockets, they were replaced in the middle 1950's by the U-M developed Nike-Cajun two-stage sounding rocket. Both stages utilized already existing solid-fuel rockets, with the first stage the booster for the Nike-Ajax surface-to-air missile and the second stage a Cajun weather-sounding rocket. Fins were used to stabilize both stages of the rocket, which was capable of sending a 50 pound payload to an altitude of 100 miles. In the 1957 International Geophysical Year (IGY) more Nike-Cajun sounding rockets were fired than any other rocket type to gather upper atmosphere data, including the large number launched by the U of M High Altitude Engineering Laboratory.

The next sounding rocket developed by the University of Michigan High Altitude Research Laboratory was the three-stage Exos. Here the first stage used the US Army Honest John artillery rocket, followed by the Nike-Ajax booster and a third stage known as the Yardbird. The Exos was capable of carrying a 120 pound payload to 300 miles altitude. Finally, a third sounding rocket, named Strongarm, was developed by the U of M High Altitude Research Laboratory to take a 20 pound payload to 1100 miles altitude. The stages for this rocket were Honest John, Nike Ajax, Nike Ajax, Yardbird and Baby Sergeant, where the Baby Sergeant was the JPL rocket used for the last two stages of the first US satellite. In all of the multiple-stage sounding rockets there is a coast-period between stage firings to delay excessive velocity buildup at low altitudes. In the case of Strongarm, even with final-stage ignition at over 100,000 ft., there is enough atmospheric density to cause excessive aerodynamic heating of the solid-state rocket fuel. For this reason the final stage was coated with teflon, which oblates at a low enough temperature

to protect the propellant. In its first test firing in 1960, carrying an electron-density experiment developed by the U of M Electrical Engineering Department, the Strongarm sounding rocket broke the altitude record at the NASA Wallops Island Launch Facility.

Among the successful atmospheric research projects of the High Altitude Engineering Laboratory were the measurement of upper atmosphere density using a transit-time accelerometer and the determination of diffusive separation of upper atmosphere molecules.



A Nike-Cajun in Launch Position