MASSACHUSETTS AIR AND SPACE MUSEUM

HORIZONS

A publication of the Massachusetts Air and Space Museum

The Massachusetts Air and Space Museum inspires new generations to explore, experience, and pursue interests and opportunities in science and technology.

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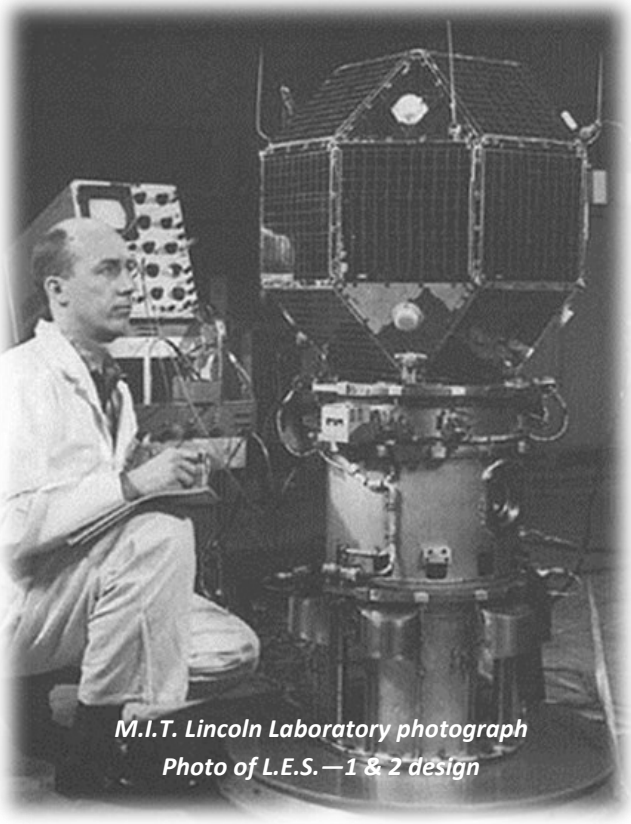
L.E.S. Was More

In the fall of 1962 the world came to the brink of nuclear war. As a result, President John F. Kennedy was compelled to look closely at what had transpired during the crisis and realized that there were many shortcomings with the command-and-control system that the president employed to maintain civilian authority over the military. He recognized that the commander-in-chief needed to be able to speak directly with a military unit leader in the field, right down to a second lieutenant holding a walkie-talkie. He called upon the scientific community to analyze the problem and find a solution. Prior to this, in 1958, scientists at M.I.T.'s Lincoln Laboratories at Hanscom Field in Massachusetts came up with a way for the military to send full duplex signals (in two directions simultaneously) without the risk of signals being jammed. The ionosphere had been useful in reflecting signals, but that ability becomes compromised after a nuclear detonation because the ionosphere is disrupted and remains so for a consideration length of time after an atmospheric blast. Recognizing that immediately following a nuclear attack would be the time when effective communications would be needed most, the team went about creating an artificial ionosphere. They launched into circumterrestrial space millions upon millions of tiny pieces of copper wire that enshrouded the earth. These three-quarter inch long pieces of copper would act as miniature dipole antenna allowing a signal to be reflected back and forth between ground stations. The big benefit was that an enemy couldn't jam either duplex transmission be-



M.I.T. Lincoln Laboratory photograph
Photo of L.E.S.—1 & 2 design

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cause they'd have to locate the exact piece of copper wire being used in order to conduct conventional jamming measures.

The scientists realized that any proposal to put vast numbers of any size object in orbit around the earth would be controversial, so the experiment was reduced in size. Although the first attempt at scattering dipoles in near-earth orbit failed, by the spring of 1963 they managed to succeed. The tiny satellites, though limited in number, remained in place until orbital decay eliminated them by 1966. The biggest problem with Project West Ford, as it was called, was it required substantial ground stations to both transmit and receive signals, and this was not practical for modern military operations. But the theory of reflective objects in space making communications possible had been proven.

The engineers at Lincoln Laboratories then rechanneled their efforts toward strengthening the *downlink* side of existing communications satellites; the downlink often referred to as the "weak link." A fact that had to be faced was that the existing satellites in orbit at the time were not robust enough to handle the downlink adequately, so Lincoln Lab started building a constellation of satellites known as L.E.S. (Lincoln Experimental Satellites). The concept was to place

these birds in geostationary orbits approximately 22,000 miles above earth where they could each envision almost half the globe. With any pair of LES birds, communications between two points on the ground could most likely be accomplished. The threat of jamming would still exist, but finding the right two satellites and narrowing down the frequencies being used would be a significantly more difficult task for even a technologically sophisticated enemy.

In 1965, what had been considered the back yard of the original Lincoln Laboratory building evolved quickly into a space development center. Aside from the clean room environment needed for constructing the

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Out and About

MASM Board of Director Al Mundo awards MASM's Pathfinder Plaque to David Carpenter and Richard Gorham of General Electric's Jet Engine at Lynn, Massachusetts for G.E.'s contribution to the creation of the Massachusetts Air and Space Museum

MASM board members paid a visit to the Lewiston-Auburn airport in Maine where Luftansa has built a facility where it is restoring a former Lockheed Constellation airplane that was once the most luxurious way to travel. Director Al Mundo has a special interest as he is a former TWA pilot who flew a "Connie"; a four-engine propeller-driven airplane that paved the way for the jet age.

A History of MASM

The Massachusetts Air and Space Museum (MASM) was founded as a 501c3 non-profit organization with the intent of cataloging and preserving the rich aviation history of the Bay State. Among the first undertakings was to develop a plan for acquiring a location and a facility that could house a museum. Toward this end, in 2007 the first design concepts were generated.

Armed with the overall concept and a preliminary design, MASM went about trying to raise the capital needed to finance the plan. In 2008 MASM received its first juried grant from the Wolf Foundation. This grant, along with a number of generous individual donations, allowed the board of directors to hire a consultant to evaluate their goals and make recommendations on how to proceed. To date MASM can boast of a cadre of over thirty Pathfinder donors ($5,000.00 or more) and scores more of individual, corporate and institutional donors. Total donations and pledges exceed $500,000.00.

In 2009 MASM engaged Arts Consulting Group (ACG) to undertake a study. In 2010 ACG completed a three-part study that validated the MASM concept, projected where to locate a facility, and identified the demographics with which the organization would likely be dealing. That same year MASM was awarded a multiyear grant from General Electric, and a grant from the Commonwealth of Massachusetts, Massachusetts Development Agency. In addition to the financial support that the Wolf Foundation, G.E., and the Commonwealth offered MASM, their participation helps legitimize MASM's existence and lends credence to it's mission.

With the guidance of the architectural firm of Fennick McCredie, and conforming to the LEED standard, a unique building concept was developed based upon the anticipated needs of the museum, and upon the anticipated land that would be made available for it at Hansom Field between 2011 and 2012.

In 2012, 2013 and 2014, the MASM executive board made certain that MASM was well-represented at the Smithsonian National Conference for Aviation and Space Museums.

Massport approved the site for the museum in 2012 and the lease terms were negotiated for the MASM museum site abutting Hanscom Field. The executive board of directors obtained a professional construction estimate for the project that was

Harriet Quimby—1st female licensed pilot in the U.S.

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A History of MASM

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developed by John Moriarity Associates. That same year the FAA gave its approval for the museum to be located on the land adjacent to Hanscom Field.

A tremendous donation was offered to MASM during the early stages of development of the museum. The Massachusetts Air National Guard donated one of two F15's that flew intercept missions over the skies of New York City following the 9-11-01 terrorist attach on the World Trade Center's twin towers.

The MASM executive board of directors obtained space and opened an office on the third floor of the main terminal building at Hanscom Field. It is from this office that all efforts toward the building initiative are being directed. 2014 was a banner year for the museum. The MASM project was a featured highlight in AOPA's "Pilot Magazine" in 2014, giving the museum project international attention. The museum also participated in AOPA's annual fly-in at Plymouth Airport. That same year MASM designed and opened an exhibit at Bridgewater State University entitled *"Moving Through Space"* which blended the Harvard Peabody Museum's meteorites with Massachusetts Air and Space Museum's space shuttle artifacts.

Dr. Robert Goddard
Father of modern rocketry

Members of MASM's educational development team

have been attending educational outreach programs and have begun finalizing the curriculum that will become the substance of the aviation education programs that it will soon offer.

MASM volunteers attended several secondary school STEM activities with institutions based in Southeastern Massachusetts. Under the Memorandum of Understandings with both the FAA and Massachusetts Department of Transportation, MASM has supported a number of joint initiatives , including mutlithousands of attendees at Logan Airport. In addition, the museum has undertaken steps toward financing scholarships for those students seeking careers within the field of aviation. In accordance with these initiatives, MASM has undertaken measures that will establish Memorandum of Understanding (MOUs) that will help develop on-going relationships with area educational institutions like Bridgewater State University, Northeastern University and the Massachusetts Institute of Technology.✈

Did You Know?

Massachusetts has lots of aviation and space history

Did you know that the special material that made up the heat shield of all of NASA's Apollo spacecraft was developed and produced by Avco Systems in Lowell, Massachusetts?

Did you know that America's first licensed woman pilot—Harriet Quimby—met her fate at a flying event in Boston? After being the first female to fly across the English Channel, her airplane suddenly pitched forward causing her and her passenger to be ejected and subsequently killed. Ironically, her airplane continued to fly and eventually landed by itself!

Did you know that the supersonic airplane "The Concorde" landed and took off from Logan Airport in Boston?

Did you know that computer language used aboard the manned space-craft vehicles, and the inertia guidance systems that directed the Atlas and Saturn V rockets was originally developed at MIT in Cambridge?

Did you know that in 1932 the Gee Bee R1 manufactured by the Gran-ville Brothers in Springfield won the coveted Thompson Trophy piloted by Jimmy Doolittle? It also set a new air -speed record of 296 MPH.

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birds, test facilities were also required to prepare each satellite for the rigors of space travel and for their operational lives. An elaborate and very large anechoic chamber was assembled in which the antenna systems of each LES were fine-tuned. An enormous vacuum chamber was also built in which the satellites could get used to the environment of space. In addition to being deprived of air, the little birds were bombarded with radioactive isotopes and particulate debris like sand, they were subjected to intermittent extremes of heat and cold, endured shock waves, vibrations and shaking the likes of which could rattle fillings from someone's teeth.

Above all, the sun is always the most significant factor in space. A solar simulator was developed that could emulate the rays of the sun as they appear in space. Here on earth, we enjoy an atmospheric filtering of the sun's rays. But in space, while solar light may be beneficial and used effectively for electrical power production, the side effects are brutal. Simulating the sun on earth is no simple task. The Institute of Environmental Sciences became a contributor toward achieving this goal, offering both experience and new ideas for making a solar simulator that would provide the appropriate environment in which to test each satellite.

LES-1, LES-2, LES-3 and LES-4 were all sent aloft in 1965. LES-5 and LES-6 were updated versions that flew in 1967 and 1968, respectively. LES-7 was cancelled outright in favor of a radical new approach that was embodied in LES-8 and LES-9. Unlike previous LES models, LES-8 and LES-9 utilized a radioisotope thermoelectric generator (RTG) for power and carried aboard no solar cells or batteries. This same power source was utilized on the Voyager spacecraft that launched in 1977 and has now gone far beyond the confines of our solar system with the RTG powering it and still going strong.

In addition to the innovative electrical propulsion system used in the latter LES satellites, one thing all of the LES units employed were innovative communications systems. The LES program proved that relaying signals from one satellite to another could not only greatly expand the distance of transmissions in both directions, but it could overcome the disruptions that occur when signals are unable to follow line-of-sight. The spherical nature of the earth necessitates bouncing signals off one or more stations in space, and the LES constellation of satellites made this possible.

In addition to providing platforms from which ground communications could be efficiently relayed, the LES program also proved to be more robust when it came to warding off jamming efforts. Not only did would-be jammers have to identify which pair of satellites were being employed in a transmission, they would also have to narrow down the frequency being utilized at any given time. Although the digital age has made this somewhat easier today, it still can be a daunting challenge.

As recently as a year ago, faint remaining signals from LES-1 were still received here on earth. More than forty-six years since it was launched into space, and decades beyond is programmed service life, LES-1's solar power array was still generating trace signals that were tracked.

The LES program from MIT's Lincoln Laboratory at Hanscom Field proved many theories and pioneered many technologies that have become mainstay in circumterrestrial space today. The scientific community learned a great deal more from LES that it had originally anticipated, and this knowledge has helped shape America's modern space-based operations.✈

Join Us Today!

The Massachusetts Air and Space Museum will soon come to life in Bedford, Massachusetts at historic Hanscom Field. Your help is needed to turn this vision into reality. Send your tax-deductible contribution to:

Massachusetts Air and Space Museum 200 Hanscom Drive Bedford, Massachusetts 01730.

Complete the form below and include it with your contribution to get on our mailing list. Your donation of $25.00 or more will automatically enroll you as a Member of MASM with the benefits as outlined on our web site. You will receive our electronic newsletter "Horizons" which will be emailed to friends of the museum free of charge. This publication is informative and interactive, and online you will find links that will connect you to an entire world of aviation and history.

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