
DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

The Department continued to devote considerable attention to the implementation of the revised SB program, initiated in the Fall of 1993, and the new MEng degree program in the Fall of 1995. Undergraduate student enrollment remains low during the post Cold-War period of restructuring for the aerospace field, Graduate enrollment has decreased slightly, but continues to be close to 200 students per year. The Department research program has maintained its healthy level of sponsorship and innovation. Once again, *U.S. News and World Report* designated Course 16 as the top aerospace engineering program in the country.

The Department was privileged to have two Minta-Martin lectures delivered by its two Hunsaker Professors for AY 1995. Professor John J. Deyst presented the Twenty-Third Minta Martin Lecture on "Information Systems in Aerospace Vehicles" on November 16, 1994. The Twenty-Fourth Minta Martin Lecture on "Issues Affecting the Future of Commercial Space" was delivered by Mr. Robert Lovell on April 27, 1995. Each lecture was followed by a festive dinner honoring the speakers.

UNDERGRADUATE PROGRAM

Undergraduate Enrollment over the Last Ten Years

	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
Soph.	106	120	96	103	75	76	61	33	36	36
Juniors	92	103	118	94	87	61	62	60	31	37
Seniors	106	98	105	130	104	104	73	66	66	38
Totals	304	321	319	327	266	241	196	159	133	111
% of women	18%	16%	19%	21%	25%	23%	27%	28%	32%	31%
% of Under. min.	11%	10%	N/A	14%	18%	20%	14%	12%	23%	19%

GRADUATE PROGRAM

A total of 250 applications were received for the Fall 1994 term. Out of this, 130 were admitted and 58 accepted the offer of admission. Enrollment for Fall 1994 included 133 S.M., 64 Ph.D., 1 EAA degree candidates for a total of 198. Total minority students: 9 (5 Ph.D., 4 S.M.). Total women students: 22 (3 Ph.D., 19 S.M.). In the Spring 1995 term we received 21 applications. We admitted 8 and 5 enrolled. Two women applied, 1 was admitted, 1 enrolled. No minority applications were received. Enrollment for Spring 1995 included 109 S.M., 75 Ph.D., 1 EAA for a total of 185. Total women: 22 (5 Ph.D., 17 S.M.). Total minority: 8 (5 Ph.D., 3 S.M.).

Degrees Awarded		S.M.	EAA	Ph.D.	Total
Summer	(Sept. 94)	13	0	3	16
Fall	(Feb. 95)	21	0	4	25*
Spring	(June 95)	40	0	2	42*
Total		74	0	9	83*

*(double degree awarded)

<u>FUNDING</u>	<u>Fall 1994</u>	<u>Spring 1995</u>
MIT Fellows/Tuition Awards	11	11
Outside Fellowships	11	9
Staff Appointments (Afrapt, Draper Fellow, RA)	126	128
Teaching Assistants & Fellows	9	4
Engineering Internship Program	3	2
Other Types of Support (Employer, Foreign, Self, Traineeship)	38	31
Total	198	185

FACULTY NOTES

Mr. Charles Boppe was hired as a Senior Lecturer to develop and teach the new core subject *Aerospace Product Development* for the Master of Engineering Program.

Professor Edward F. Crawley was awarded the Manned Spaceflight Awareness Award from NASA and received the Best Paper Award at the 1994 AIAA Structures, Structural Dynamics, and Materials Conference.

Professor Alan Epstein was awarded the Gas Turbine Award for “Outstanding Gas Turbine Paper of the Year” from the American Society of Mechanical Engineers and was elected a Fellow of the American Institute of Aeronautics and Astronautics.

Professor Edward M. Greitzer was elected to the National Academy of Engineering. He received the 1995 Aircraft Engine Technology Award from the International Gas Turbine Institute, and was awarded the Best Paper Award from the International Gas Turbine Institute.

Professor Nesbitt W. Hagood IV was promoted to Associate Professor without tenure.

Professor R. John Hansman, Jr. was promoted to Full Professor.

Professor Paul A. Lagace was the recipient of the Department’s Academic Advising Award and became a Margaret MacVicar Faculty Fellow “in recognition of sustained and significant contributions to teaching and undergraduate education at the Institute.” He presented the von Karman Lecture at the 35th Israel Annual Conference on Aerospace Sciences.

Professor James D. Paduano was awarded the 1994 Best Paper Award from the International Gas Turbine Institute.

Professor Emeritus Robert C. Seamans, Jr., received the Arthur M. Bueche Award from the National Academy of Engineering for “a lifetime career of technological leadership in aerospace and public service in guiding national policies and programs in the field of aerospace, defense, and energy”.

Professor S. Mark Spearing joined the Department as an Assistant Professor in the Structures Division and was the recipient of the Department’s AIAA Undergraduate Teaching Award.

Professor Stanley I. Weiss was re-elected to a two year term as Director-Academic, of the National Council on Systems Engineering.

Professor Laurence R. Young was awarded the Paul T. Hansen Award from the Aerospace Human Factors Association for 1995.

MASSACHUSETTS SPACE GRANT CONSORTIUM

Director: Professor Laurence R. Young

The Massachusetts Space Grant Consortium now includes MIT (Lead), Tufts University, Wellesley College, Harvard University, Boston University, University of Massachusetts, Worcester Polytechnic Institute and the

Charles Stark Draper Laboratory. The Wright Center at Tufts is responsible for education of pre-college teachers in space science and engineering, through summer workshops. The Program continues to support undergraduate research through the MIT Undergraduate Research Opportunities Program. It increased the number of companies involved in placing students for summer employment in the aerospace industry, supported students for the summer at the NASA Space Academy and the International Space University, and offered graduate fellowships. It sponsored a popular undergraduate seminar subject on "Modern Space Science and Engineering" with emphasis this year on humans in space and several astronaut guest speakers. The annual public lecture this year was given by Dr. Harrison H. Schmitt, Apollo Astronaut & Former U.S. Senator.

Massachusetts Space Forum

The first dinner meeting of the Massachusetts Space Forum was held in September 1994. The goal of the Massachusetts Space Forum is to favorably influence national planning and to stimulate regional cooperative activity in space education and business opportunities. Over 50 leaders from academia, industry and government attended the workshops and the dinner presentation by MIT President, Charles M. Vest. The next Space Forum is tentatively scheduled for early Fall 1995.

RESEARCH HIGHLIGHTS

Aeronautical Systems Laboratory (ASL) - R. John Hansman

The ASL has been involved in developing advanced alerting and flight information systems for aircraft, helicopters, and spacecraft. In these efforts, the lab attempts to integrate classical aeronautical engineering disciplines of instrumentation, control, and flight dynamics with the evolving techniques of "human centered design" and cognitive engineering. The laboratory also conducts fundamental research in flight safety related areas as well as applied research on human performance in space.

The laboratory has developed rapid prototyping techniques which employ graphical workstation technology to evaluate advanced cockpit information systems. Recent or current activities include: development of general methods to set threshold criteria in alerting systems; understanding and mitigating errors in advanced Flight Management Systems; applications of GPS navigation systems to aircraft and portable computer systems; increased airport capacity through close parallel approach systems as well as flight guidance methods to minimize community noise impact; and air-ground datalink of ATC clearances.

Computational Aerospace Sciences Laboratory (CASL) - Jaime Peraire

A program of research focused on the development of a distributed "flow simulation environment" has been established. The main thrust of this research is to integrate the various areas of expertise within CASL into a unified multidisciplinary capability that can be used for research, teaching and design. Research continues in the areas of aircraft wing optimization, plasma physics, parallel computing flow visualization, and chemically reacting flows.

Flight Transportation Laboratory (FTL) - Robert Simpson

The focus for research in FTL is on automation of processes involved in air transportation - for airlines, for airport operators, and for the operators of a proposed "Global Automated Air Traffic Control" system. A major educational activity for FTL over the last two years, and continuing into next year has been the transfer of 5 graduate MIT subjects to a new airline management option in the MBA program at University of Indonesia (UI). Faculty, staff, and graduate students have been preparing new materials in the form of course notes, videos, computer programs, and have been teaching and working with faculty at UI, Jakarta. The project is sponsored by Garuda Indonesia Airlines and the Ministry of Research and Technology, Indonesia.

Fluid Dynamics Research Laboratory (FDRL) - Kenneth Breuer

The FDRL is active in research concerning fundamental issues in fluid dynamics and aerodynamics. Current research projects include: an experimental investigation into roughness-induced boundary layer transition; the control of turbulent boundary layers using active wall motion to reduce drag and turbulent noise generation; the development of micron-sized shear-stress, pressure and velocity sensors for measurement and control of high Reynolds number, sub- and supersonic aerodynamic flows; analysis and simulation of the mechanics of fluids in micron-sized geometries, including fluid mechanics of a micro-gas-turbine engine; the development of theoretical models for the dynamics of near-wall turbulent flows; large-scale numerical simulations of unsteady transitional and turbulent shear flows; experiments and modeling of ice accretion on airfoils.

Gas Turbine Laboratory (GTL) - Edward Greitzer

An innovative research initiative has been launched by Professor Alan Epstein on the topic of “micro-engines”, gas turbine engines with flow path diameter of 1 mm. One application of high interest is that a micro gas turbine, with a micro electrical generator attached, can provide a highly compact power source. An award of \$5M has been received from the Army Research Office for this multidisciplinary program, with the aim of developing a working model of such a device.

The GTL has continued its close collaboration with industry: several students currently make use of the excellent facilities at engine companies for the conduct of their research; a number of joint projects are on-going or are being started; and a joint (university/industry/government laboratory) survey lecture on unsteady flow in turbomachines was written and presented. Further, we have started collaborative research in a new area for the laboratory, high cycle fatigue in gas turbine engines. This is being investigated in partnership with United Technologies Corporation, Caltech, and UCSB. Research linkages have also been strengthened with the Engineering Department at Cambridge University, in order to augment our computational fluid dynamics capability.

Lean Aircraft Initiative (LAI) - Earl Murman, Stanley Weiss

In conjunction with the Center for Technology, Policy and Industrial Development and Sloan School faculty, and funded by the Air Force and 19 aerospace companies, the LAI project's goals are to define the major change agents in acquisition, development, manufacture and related government and supplier regimes which can dramatically improve cost, schedule and quality in the U.S. aircraft industry. After approximately a year and a half of the full program, there appears to be high acceptance of early findings.

Man Vehicle Laboratory (MVL) - Charles Oman

Over the past year, MVL completed the analysis and initial publication of data from more than six different biomedical experiments on the very successful STS-58(Shuttle/Spacelab Space Life Sciences 2) mission. Professor Laurence Young returned to MIT after serving as SLS-2 Alternate Payload Specialist and heads the Space Grant Consortium. Professor Dava Newman has initiated a new research program in EVA dynamics, and the biomechanics of human locomotion, and is developing Dynamic Load Sensing Experiments for STS-71 and Space Station. Dr. Oman is Principal Investigator for a major experiment on the 1998 Neurolab Spacelab mission, utilizing a new NASA Virtual Environment system. MVL's research on expert systems for space experiments continue, and new research programs on visual-vestibular interaction, tactile cueing systems, spatial disorientation in virtual environments, and General Aviation pilot performance and workload using of GPS predictor displays were begun, working in collaboration with NASA Langley and Johnson, the DOT Volpe Research Center, and the Massachusetts Eye and Ear Infirmary.

Space Engineering Research Center (SERC) - Edward F. Crawley

SERC's objective is to develop and disseminate a unified technology of controlled structures and to develop and conduct research and education programs to meet this objective. Several projects were very active this academic year. The Middeck Active Control Experiment (MACE) was successfully completed on the STS-67 in March of 1995. Preparations for flight included finalizing the 0-g finite element model, designing on-orbit identification experiments, and design of pre-programmed controllers using the 0-g finite element model. A fundamental technology development program in smart structures is underway involving multidisciplinary collaboration between the departments of Materials Science and Engineering, Aeronautics and Astronautics (SERC), and Electrical Engineering and Computer Science. System Integration-Evolution Testbed (SIET) is a proposal to provide a systems focus for the development and integration of existing and new technology into a constellation of small identical satellites. The Stellar Interferometer Tracking Experiment (SITE) instrument is a two-aperture stellar interferometer. Ongoing work includes bench top optical control and isolation testbed experiments. The team continues to refine the structural design of the Precision Optical Bench (POB) and is beginning research into combined controls/structure design methods. The MIT/NASA Langley Active Wing has as its main objective the demonstration of new actuation technology for the suppression of vibrations and stabilization of transport aircraft wings.

Space Power And Propulsion Laboratory (SPPL) - Manuel Martinez-Sanchez

The SPPL continued this year developing theory and models of space propulsion and power systems and their interactions with the spacecraft. Ten graduate students and one Post Doctoral affiliate are currently active in the

SPPL. Continuing research topics include electric thruster plume modeling, dynamics of plasmas from gas releases, evaluation of alkali metal seeding in a hydrogen arcjet, application of a SPPL model of solar array arcing to the PASP+ and SAMPIE flight experiments, data analysis of the CHAWS test flight, Particle-in-Cell 2-D model of a Hall thruster, refinement of an advanced arcjet code, and computational modeling of several space plasma experiments. We have also continued the collaboration with the Center for Space Research on the design of a future gamma ray burst mission using electric thrusters for deployment. A study was performed for industry (Hughes) on the relative advantage of Low or Intermediate Earth Orbit versus Geostationary Orbit placement for communications satellites. A new program, in collaboration with Draper Laboratory, will attempt to build a very small electric thruster (50 W power), and several proposals have been submitted in the general area of microthruster technology. Some of the work planned in this area will be experimental, using mainly the ASTROVAC facility.

Technology Laboratory For Advanced Composites (TELAC) - Paul Lagace

Over 25 students were involved with TELAC during AY 94-95, including 11 graduate students, 14 undergraduates, and a number of students in 16.621/2 Experimental Projects Laboratory subject who performed their projects in TELAC. A highlight of the year is the arrival of Assistant Professor S. Mark Spearing who brings with him a strong background in the micromechanical and materials side of the composite materials and structures areas and “rounds out” the expertise in the laboratory ranging from behavior at the micromechanical to structural levels. Major research accomplishments during the year include the development of a model to determine the damage in composite laminates due to thermomechanical effects; the development of a framework for the understanding of fire damage to composite materials and structures; and the extension of the understanding of impact behavior in composite structures, particularly focused on shell and sandwich structures during the past year. In addition, the three laboratory faculty (Profs. Lagace, McManus, and Spearing) developed a course entitled “Failure and Durability of Composite Materials and Structures” which was presented at several locations in Europe on a trip sponsored by the ILP. This course is centered on a new philosophy which the faculty has developed to deal with the issues of failure and durability of composite materials and structures. This philosophy has been presented at several invited talks and will be formally presented in a series of papers in the near future.

Wright Brothers Wind Tunnel (WBWT) - Eugene E. Covert

The primary test activities fell into two classes. The first is the use of the wind tunnel for educational purposes. In the past year there was one 16.621-16.622 project “The Effect of Spiroid Winglets on Aircraft Performance” by Jonathan M. Protz and Alex Y. Lee.

The second was a completion of the phase I wind tunnel tests for the National Cooperative Highway Research Program. These tests were conducted in the period 10/3/94 to 11/30/94. A supplementary test on the effect of truck induced gusts was conducted in 6/5/95 - 6/6/95.

The report on the primary test program was reported in “Static and Dynamic Wind Tunnel Tests on Selected Stoplights and Signs and their Support” Wright Brothers Wind Tunnel Report 1306 of March 21, 1995. Wind Tunnel test results defined circumstances for which the assembly of cantilevered mounted signs and stoplights would flutter or gallop. Under these circumstances the maximum moment at the base could be several tons and larger than the static load.

DEPARTMENT AWARDS

Undergraduate

The James Means Memorial Award “for excellence in flight vehicle engineering” was given to B. Matthew Knapp, a senior from Poulsboro, WA, and Keith S. Jackson, a senior from Cambridge, MA.

The James Means Memorial Award “for excellence in space systems engineering” was given to Adam P. London, a senior from Castle Rock, CO, and Scott N. Carpenter, a senior from La Porte, IN.

The Henry Webb Salisbury Award was given to Jonathan M. Protz, a senior from Panama City, FL, “for achieving academic excellence in the most expeditious manner in Aeronautics and Astronautics while pursuing a minor in Economics.”

The Andrew G. Morsa Memorial Award was given to David B. Rahn a senior from Menlo Park, CA, “for demonstrating ingenuity and initiative in the application of computers to the field of aeronautics and astronautics.”

The Unified Engineering Award was given to Homero L. Gutierrez, a graduate student from McAllen, TX, “for outstanding devotion to and leadership of the team of student assistance in Unified Engineering.”

The Aero and Astro Leaders for Manufacturing Undergraduate Prize was given to Sanith Hettithanthrige Wijesinghe, a special foreign exchange student from Nedimala, Dehiwala, Sri Lanka, and Russell W. Pottrill, also a special foreign exchange student from Rayleigh, Essex, England. Both students received the award “for outstanding achievement in design and testing of projects related to the interaction between manufacturing and engineering.”

The Yngve K. Raustein Award was awarded to Bernard K. Asare, a sophomore from Accra, Ghana, “as the student in Unified Engineering who best exemplifies the spirit of the Norwegian Yngve Raustein, and for significant achievement in Unified Engineering.”

The David J. Shapiro Memorial Award was given to Robin L. Smith, a senior from Fair Haven, MA, “for the best student-initiated international technical endeavor in aeronautics and astronautics.”

The John F. McCarthy, Jr. Scholarship was awarded to Dennis A. Burianek, a junior from Bremerton, WA, “for superior scholarship achievement, breadth of interests, leadership skills, and deep sense of community.”

The General James H. Doolittle Scholarship was awarded to Robert L. Stephenson, Jr., a junior from Tellico Plains, TN, “for superior scholarship achievement, potential of being an admired contributor to the progress of American aviation, and an open attitude about life in general.”

The James E. Cunningham Scholarship was awarded to Robin L. Smith, a senior from Fair Haven, MA, “for superior scholarship achievement and hard work.”

Graduate Awards

Six graduate students were selected as the Departmental Teaching Fellows: Sonia Ensenat, Judy A. Resnik Teaching Fellow; Kathryn Fricks, Lester Gardner Teaching Fellow; Homero L. Gutierrez, Jr., Raymond Bisplinghoff Teaching Fellow; Rajesh Khan, Edward Taylor Teaching Fellow; Leonard Lublin, Charles Stark Draper Teaching Fellow; Richard R. Wickham, Jerome C. Hunsaker Teaching Fellow.

Earl M. Murman
Daniel E. Hastings