

The Aerospace Program at Boston University —and the origins of the College of Engineering

J. Baillieul*

Dept. of Aerospace and Mechanical Engineering
Boston University
Boston, MA 02215
E-mail: johnb@bu.edu

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During the first half of the twentieth century, as it became increasingly clear that aviation was an economically and strategically important technology, many of the American universities which offered instruction in engineering launched programs in aeronautics—usually beginning as a set of courses within mechanical engineering. Boston University's early involvement with aeronautics followed a rather different path, and contrary to what happened at other universities, what began as a program of instruction in aviation technology led eventually to the founding of Boston University's College of Engineering in 1963. While this article is intended to provide a short history of the aerospace program at Boston University, the people and events that are recalled are a significant part of the overall history of the College of Engineering. To keep the article of manageable size (and meet the deadlines given for the writing), I have chosen to focus exclusively on the people and events that were significant in establishing the College and Department. Because of a sense of urgency to record events that are only available from personal memories, the emphasis is on the early history of the program. Recent events and a recording of the intellectual and technical contributions made by a number of the people mentioned below will have to be presented on a different occasion.

Boston University was founded in 1839 by delegates of the Methodist Episcopal Church as a school for the improvement of theological training. Over nearly a century, it grew into a large liberal arts university under the stewardship of a succession of presidents who were also Methodist ministers. By the early 1930's, Boston University was suffering a great deal from the effects of the Depression. In 1931, University President Daniel L. Marsh asked all employees to take a "voluntary" five per cent pay cut. The following year, there was a ten per cent cut which was not voluntary, and the year after that an additional cut, bringing the total depression-era salary reduction to 19%[1]. In this context, the operative University policy was that there would be no expansion, and in particular there would be no new academic departments. Not having foreseen the economic strain of the times, however, in the late 1920's, President Marsh hired Hilding N. Carlson and Arthur G.B. Metcalf to start an Aeronautical Engineering Department.

In 1928, Carlson, who Marsh had appointed Professor of Science and Mathematics in the B.U. College of Business Administration, began conducting evening classes in aeronautical engineering at Boston's Logan Airport. ([4]) According to Kathleen Kilgore's account ([1]):

"Carlson and Metcalf, both M.I.T. trained engineers and pilots, began an ambitious four-year program that included design, shop in a hangar at [the] airport, meteorology and navigation, and even salesmanship. In addition to a full teaching load, Metcalf was working on two of his own projects. The first was a new type of fighter plane that would attain what *The Boston Globe* called the "amazing speed"

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Figure 1: Dean Sheley (seated at the right) with visitors at the Logan Airport facility.

of 350 miles per hour. The second was the “Aeromobile,” a plane whose operation would require the same amount of training and skill as would an automobile...” “...Depression economics prevailed over the dream of creating an aeronautical engineering school, and in 1937, Marsh was forced to drop the aeronautics program. Metcalf had, in the meantime, founded his own Engineering Research Company on Newbury Street. [Soon afterward] Carlson organized his own private New England Aircraft School.”

In 1940, Carlson and a colleague, Professor Walter J. Goggin, left B.U. to found the New England Aircraft School in a building he acquired at Logan Airport.

With World War II creating great demand for personnel with knowledge of aviation technology, Carlson’s school prospered. He was contracted by the U.S. Army Air Corps to provide ground training for a large body of Air Corps personnel. According to Kilgore’s account, the enrollment in the school was about three hundred by 1950. The facilities included an airplane hangar, machine shop, welding shop, metal-working shop, and wood-working facilities. In 1943, after the death of his business partner Walter Goggin, Carlson approached B.U. President Marsh “with the proposition that Boston University absorb his school as a separate department, appoint him its dean, and appoint him once again as professor in the College of Business Administration. In exchange, the building at Logan Airport would be leased to Boston University and all the equipment donated... The trustees finally approved the arrangement in December 1950.”

The newly acquired school was called the College of Industrial Technology. Carlson served as the founding Dean, and the old Aircraft School’s Registrar, Mr. B. LeRoy Sheley, was appointed Assistant Dean. The College’s course of study appeared for the first time in the University Bulletin (Course Catalogue) of the academic year 1951-52. The opening paragraph read: “The College offers a variety of courses, both day and evening, which are adapted to the skills and abilities of all types of young men. The Aeronautical Engineering Courses train young men for engineering and design positions with aircraft factories and airlines, as well as with the manufacturers of aircraft accessories. The Aircraft Maintenance Engineering Courses are for those interested in maintenance, overhaul, and repair of aircraft and aircraft engines.” Reflecting its vocational school roots , the College opened with three programs: “a four-year program leading to the Bachelor of Science in Aeronautical Engineering, a two and one-half year program in Aircraft Maintenance Engineering leading to the degree of Associate in Science, and a two-year Certificate Course in Aircraft Maintenance.”

Within a few years the College had changed its offerings to include the following three programs: (1) a four year program in Engineering Administration leading to a B.S. degree, (2) a four year program in Aeronautical Engineering, also leading to a B.S. degree, and (3) a two and one-half year program in Maintenance Engineering leading to a Civil Aeronautics Authority Federal Certificate. This certificate program was notable for its requirement that students take a semester of social science and humanities classes on the main campus. In 1954, the College of Industrial Technology awarded its first degree in aeronautical engineering.

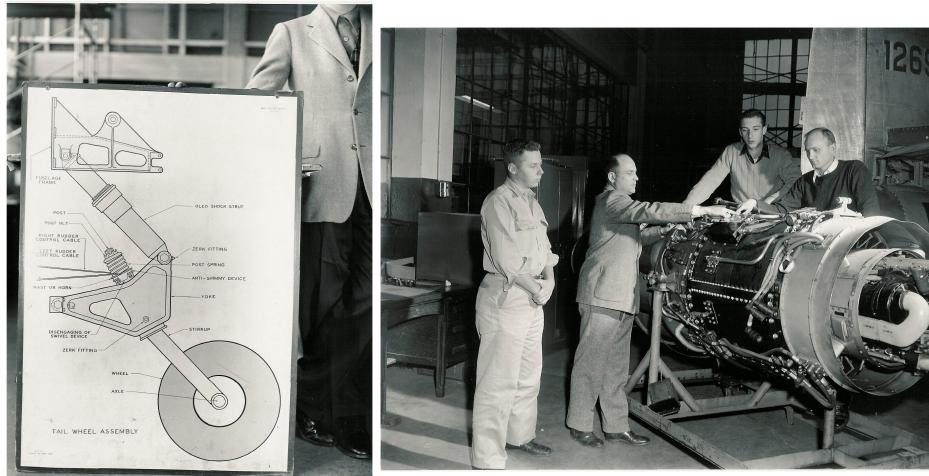


Figure 2: An archived photograph of one of the many posterboard instructional aids at the airport facility of the College of Industrial Technology. Also, what was an up-to-date jet engine of the period. While there was significant technical content in the early program of instruction, it retained many of the vocational aspects of the predecessor curriculum at the New England Aircraft School.

While the programs in the 1951 course catalogue may have been “adapted to the skills and abilities of ... young men, such gender bias soon disappeared, and program publications referred to opportunities for both men and women. In the early 50s, the College admitted its first woman student, Anne Everest (BS 56), who went on to also become the Colleges first woman graduate. Also in 1956, Sheley was promoted to Dean of the College—a position he held until his death in 1962.

During the period 1951 through 1963, the College of Industrial Technology divided its operation between space allocated on the main (Charles River) campus and facilities at Logan Airport. In 1958, the on-campus portion moved from the top floor of 680 Commonwealth Avenue (now the College of Communications) to the basement of 775 Commonwealth Avenue (now the School of Fine Arts).

Arthur T. Thompson was appointed Dean of the College of Industrial Technology in July, 1963. The University Administration under President Harold C. Case had recruited him from Penn State, where he was an Associate Dean of the College of Engineering and Architecture. Thompson immediately began a vigorous effort to broaden and deepen the technical scope of the College. He petitioned Case and the Administration to change the name from the College of Industrial Technology to the College of Engineering. The petition was granted and the name changed in 1964. During a sabbatical leave from Penn State, Thompson had worked in manufacturing with the Crane Company while getting an MBA at the University of Chicago. Based on this experience, he envisioned a new engineering discipline in manufacturing, and he set out accordingly to redesign Boston University’s B.S. program in Engineering Management (the successor of Engineering Administration). The program was renamed Manufacturing Engineering, and in the fall of 1964, it was placed under the leadership of the newly appointed Assistant Professor Merrill Ebner. Ebner was one of two assistant professors appointed that year, the other being Richard F. Vidale, who would go on to be in charge of the Systems Engineering program.

In 1965, new B.S. degree programs in Systems Engineering and Information Engineering were started, and Aeronautical Engineering was renamed Aerospace Engineering. As conceived in 1965, Aerospace Engineering was to be a nine-semester program. This was scaled back a few years later to a more standard eight semesters in response to criticism from an accreditation team that visited the College on March 10,11, 1969. Although the formation of a curriculum in Information Engineering appears to have been forward looking from a contemporary vantage point, the program attracted few students and was terminated a few years later (partly in response to criticisms from the 1969 accreditation visit). In 1966, a B.S. program in Bioengineering was initiated, and the year after that, two M.S. programs—Manufacturing Engineering and Systems Engineering—were started. Continuing the programmatic expansion, in 1968, the College created a joint Masters degree program in Manufacturing Engineering and Business Administration, and in 1969, Bioengineering was renamed Biomedical Engineering.

Thompson’s vision of engineering education was that there should be a universal “liberal engineering” degree for all undergraduates with specialization provided through several focused topical programs. Conver-



Figure 3: The opening of the College of Engineering Building at 110 Cummington Street in January, 1964. Left to right are, Merritt A. Williamson, Dean of the College of Engineering and Architecture at Penn State, B.U. President Harold C. Case, and B.U. College of Engineering Dean Arthur T. Thompson. Williamson gave the Convocation Address at the inaugural ceremony of the College. The building had been a stable for carriage horses at the beginning of the twentieth century.

sations with people responsible for accrediting undergraduate programs in engineering, however, persuaded Dean Thompson that separate discipline-specific departments were needed. The programs were duly placed within distinct departments in 1969, and the College underwent an accreditation review in 1971. The B.S. programs in Aerospace, Manufacturing, and Systems Engineering were awarded accreditation in 1972, following the 1971 review. The Manufacturing Engineering program was the first to be accredited in the U.S., and it is a tribute to the ingenuity of Thompson and Ebner that they were able to persuade the Accreditation Committee of the Engineers Council for Professional Development that manufacturing was such an important “golden disciplinary” core of Industrial Engineering that it should be able to stand on its own as an accredited program.

It was not until 1974 that the College started B.S. programs in Mechanical Engineering and Computer Engineering. The Mechanical engineering program was introduced within the Aerospace department, giving rise to a renamed Aerospace and Mechanical Engineering Department. Computer Engineering and Systems Engineering were joined with a newly approved Electrical Engineering program in 1976, creating a Department of Electrical, Computer, and Systems Engineering (ECS). Electrical Engineering was the final undergraduate program for which approval was sought, and with its addition, the Boston University College of Engineering assumed its present form. One footnote to be added, however, is that Systems Engineering was eliminated as an undergraduate major in the academic year 1995-96, and the parent department was renamed Electrical and Computer Engineering.

As the decade of the 1960’s ended and the 1970’s began, the University found itself in the midst of social unrest and once again felt economic distress. In 1967, Arland F. Christ-Janer became the sixth president of Boston University. It was a tumultuous time. In the University records of past presidents we read that “The week of his inauguration, the Students for a Democratic Society declared a Stop the Draft Week. Soon after, an African-American student organization issued a list of demands and staged a non-violent sit-in in the President’s Office. President Christ-Janer agreed to all their demands, but campus demonstrations and radical student actions continued. After serving for three years, President Christ-Janer resigned in July 1970. Commencement that year had been canceled because of the threat of violent protests.” The University operated in the red for several years, and a search was begun for a new president who could bring the operating budget back into balance. John R. Silber, a Kant scholar and former Dean of Arts and Sciences from the University of Texas, was appointed president in 1971. That year, the budget showed a deficit of almost \$2.5M, which while only a small fraction of the operating budget, could not be sustained for more than a very few years. Silber knew that anything he hoped to accomplish at Boston University would depend on his being able to run the organization within a balanced budget.



Figure 4: Professor Merrill Ebner, who with Arthur Thompson created the first Manufacturing Engineering Program in the country—which later evolved into the first accredited Manufacturing Engineering Department—served as Dean *ad interim* from 1974 to 1975.

Like all academic and business units in the University, the College of Engineering came under budgetary scrutiny, and Dean Thompson was asked to make significant cuts. With his three department chairmen, (Ming Chen, Aerospace, Merrill Ebner, Manufacturing, and Dick Vidale, Systems), Thompson drafted a budget that would go as far as possible to meeting Silber's directive. During one of President Silber's 8:00am Sunday morning budget hearings, the Dean presented his budget to an assemblage of University Administrators. There is no written record of the discussions that ensued, but the severe cost-cutting measures of the Thompson budget were deemed to be adequate by the University Administration. The College was kept open—although it became a challenge to keep it running on the meager budget that had been agreed to. Apparently President Silber liked Thompson's management style well enough that he asked him to serve concurrently as the Dean *ad interim* of the College of Business Administration. He served as Dean of both units from 1972 through 1973 when he agreed to take charge of the Boston University Overseas Program in Heidleberg, Germany. At that point, Professor Ebner became Dean *ad interim* of the College of Engineering, and a search was launched to find a new permanent Dean.¹

In 1975, President Silber and the Board of Trustees selected Professor Louis N. Padulo from Stanford University as the next Dean of Engineering. Padulo had prior administrative experience as a department chairman at Morehouse College and had been named Associate Dean of the Stanford Graduate School when recruited to B.U. by Silber. He was charming, self assured, and interested in the job. He had recently published a well regarded control theory text with the computer scientist Michael Arbib ([2]), and he was known and respected by academic colleagues at leading universities. Dean Padulo's mandate was to grow the small College of Engineering into a visible and respected institution. Padulo was Dean from 1975 until late 1986. He was a brilliant recruiter of faculty and students, and the College enjoyed a phenomenal period of growth during these years. There had been 163 students (graduate and undergraduate) registered in 1973. By 1987, the year after Padulo stepped down, there were 1,933 full-time students (mostly undergraduates) and 548 part time students (mostly masters degree students) with the first doctoral students fleshing out the new graduate and research programs. Padulo also increased the size and quality of the faculty. Ming Chen, who was Chairman Aerospace and Mechanical Engineering when Padulo arrived, had been the first

¹Arthur T. Thompson remained active in academic administration for many years. From 1974 through 1978, he served as Boston University Associate Vice-president for Overseas Programs and expanded the University's operation in Europe from 15 to 44 educational centers. He later became Provost and member of the Board of Trustees at the Wentworth Institute of Technology, from which he retired in 1988.



Figure 5: From left to right: an unnamed visitor, Dean Louis Padulo, and Ming Chen, Chairman of the Department of Aerospace and Mechanical Engineering.

faculty member in the College who had been hired with a PhD. Although others had followed, Padulo began a drive to recruit faculty who could be expected to become distinguished researchers as well as good teachers. Some idea of the change that occurred in the faculty size and quality may be found in comparing the record of 1968-69 (when the College's first accreditation visit took place under Dean Thompson) with the corresponding data in the Fall of 1986, the final year in which Lou Padulo served as Dean. In 1968-69, there were fewer than 20 full time faculty, and only six held a doctoral degree of some kind. By 1986-87, there were 67 full time engineering faculty, all but four of whom held doctoral degrees.

From 1987 through 1989, Carlo De Luca, a Professor of Biomedical Engineering served as Dean *ad interim*. Taking note of Padulo's accomplishments, De Luca wrote: "We have reached an appropriate plateau in undergraduate enrollments. . . . Our most immediate challenge is to develop our growing graduate/research program so as to bring the College to national and international prominence." After a lengthy national search, Charles Delisi was recruited from Mount Sinai School of Medicine to be the next Dean, starting in 1990. Trained as a physicist, but also having once been an undergraduate history major, Delisi was widely regarded as an intellectual visionary. He was credited for his work several years earlier, at the U.S. Department of Energy, to launch the government's efforts to map the human genome. Just as Padulo had greatly increased the size and quality of the undergraduate student population in the College, Delisi recruited a star studded array of new faculty—including a number of members of national academies and other senior faculty with large and highly visible research programs. During the decade in which Delisi served as Dean, the level of sponsored research in the College increased by a factor of four. In August, 2000, David K. Campbell, former Director of the Center for Nonlinear Systems at Los Alamos National Lab and Chairman of the Physics Department at the University of Illinois, assumed the position of Dean of the College. He continues in this post.

The records of those serving on the faculty and administration of the Department of Aeronautical Engineering during the earliest days of the College of Industrial Technology are difficult to trace. During the first part of Dean Thompson's term, Charles L.D. Chin was the Chairman. He served until the academic year 1967-68, when Ming Chen was appointed Chairman. Daniel Udelson succeeded Chen in 1981, and served for a decade until 1991. The author joined the Department during this time, in 1985. After this, a number of important faculty appointments were made by Udelson. In 1988, he recruited Tom Bifano, who is presently Chairman of Manufacturing Engineering and an internationally recognized authority on micro-electromechanical systems (MEMS). He also hired Don Wroblewski who currently serves as the Department's

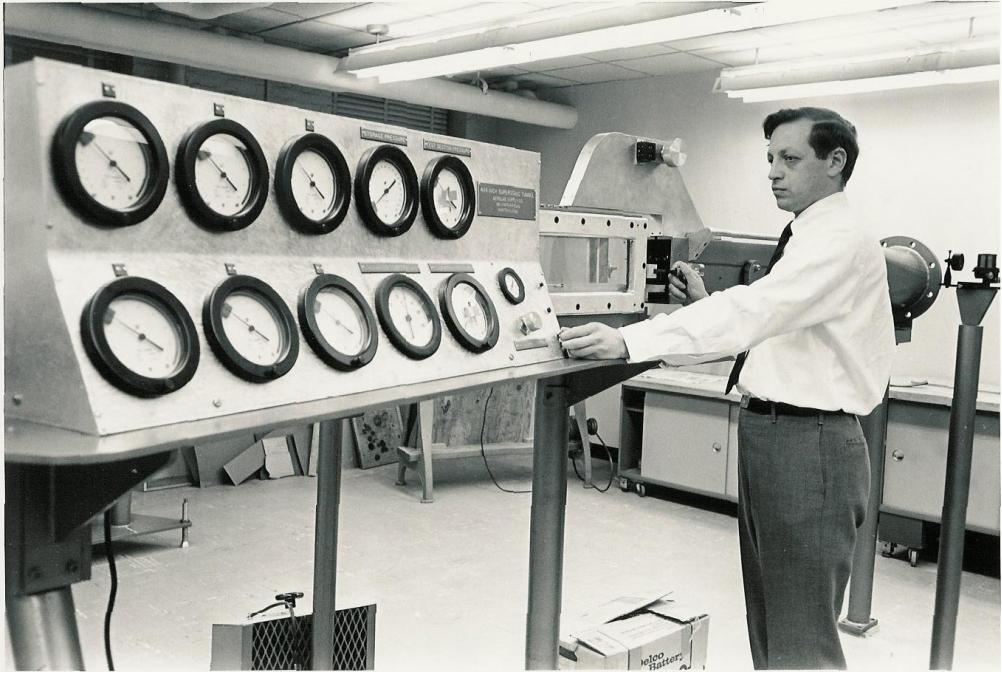


Figure 6: Professor Daniel Udelson, Chairman of the Department of Aerospace and Mechanical Engineering from 1981 to 1991, with the supersonic wind tunnel.

Associate Chair for the Undergraduate Program in Aerospace. Toward the end of his tenure, in the Fall of 1991, he recruited Michael S. Howe, a distinguished and prolific authority on the acoustics of fluids, and the late Charles Speziale, who was one of the world's leading authorities on turbulence modeling. It should be added that this appointment established turbulence modeling as an area of excellence that would be sustained going forward with the appointment of Victor Yakhot and later the more junior Assad Oberai.

Following Udelson's term, the department had two interim chairs: Jeffrey Forbes, from Fall 1991 through Spring of 1992, and the author from 1992 through July, 1993. On August 1, 1993, Allan D. Pierce became Chairman. A distinguished acoustician, Pierce, was recruited from Penn State, as Dean Arthur Thompson had been thirty years earlier. During his term as Chairman, a number of people of prominence in acoustics were recruited. It was also at this time that National Academy of Engineering members Donald C. Fraser and Leopold B. Felsen joined the department.

As I write this short history in the summer of 2003, a fair summary statement seems to be that the aerospace program has undergone a phenomenal transformation from its origins at Logan Airport in the 1930's to its present state of being part of a highly regarded department in a major research university. As it has flourished, the department's needs for space have grown. In 1999 it was finally able to claim the entire building at 110 Cummings Street on the (main) Charles River Campus of the University, the same building that housed the entire College of Engineering in 1964. (See Figure 3.) The building has undergone multiple major renovations (including a recent investment of approximately \$2M to upgrade faculty office space and undergraduate teaching labs), but its space is already too limited to house all department operations. The department now uses classroom facilities in the adjoining Photonics Center (an \$80M building completed in 1997) and the Arthur G.B. Metcalf Center for Science and Engineering (Figure 9) which was dedicated in December, 1985.

While the department maintains a healthy respect for the kind of entrepreneurial abilities displayed by its Depression era forebears Carlson and Metcalf, the tendency in recent years has been to recruit faculty based on their technical creativity and intellectual stature. Research active faculty members are no longer expected to teach the three courses a term that were the norm during the terms of Deans Thompson and Padulo. Among the current 24 full time faculty members there are two members of the National Academy of Engineering, present and past editors-in-chief of leading technical journals in various subdisciplines (the *Journal of the Acoustical Society of America*, the *IEEE Transactions on Oceanic Engineering*, and the *IEEE Transactions on Automatic Control*), and a solid corps of active researchers who in some cases average more

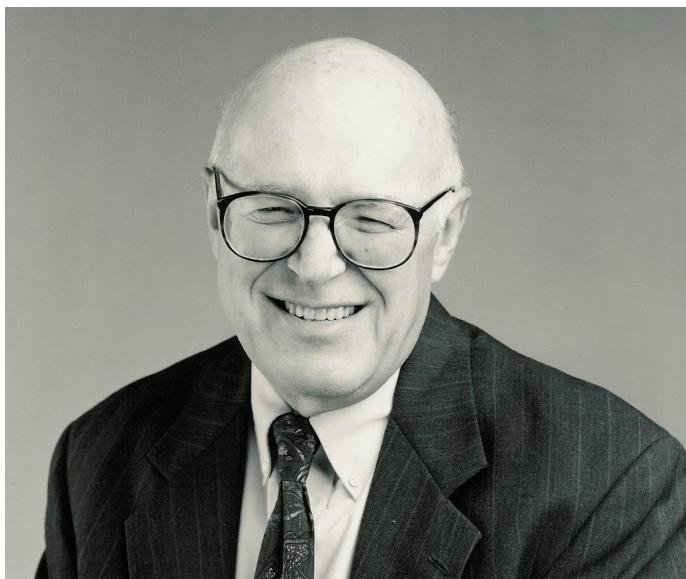


Figure 7: Professor Allan D. Pierce, a major figure in acoustics, was chairman from September, 1993, through June, 1999. Pierce recruited a number of very bright junior faculty members, and during his term, two members of the National Academy of Engineering joined the Department.



Figure 8: Professor John Baillieul, current chairman of the department was hired by Dean Lou Padulo in 1985. Padulo wanted him to create a robotics laboratory, and Baillieul is shown in this 1987 photo with a graduate student and one of several industrial robots that were used in early laboratory experiments. (The student, Richard Goldenberg, received a masters degree and became a patent attorney.)

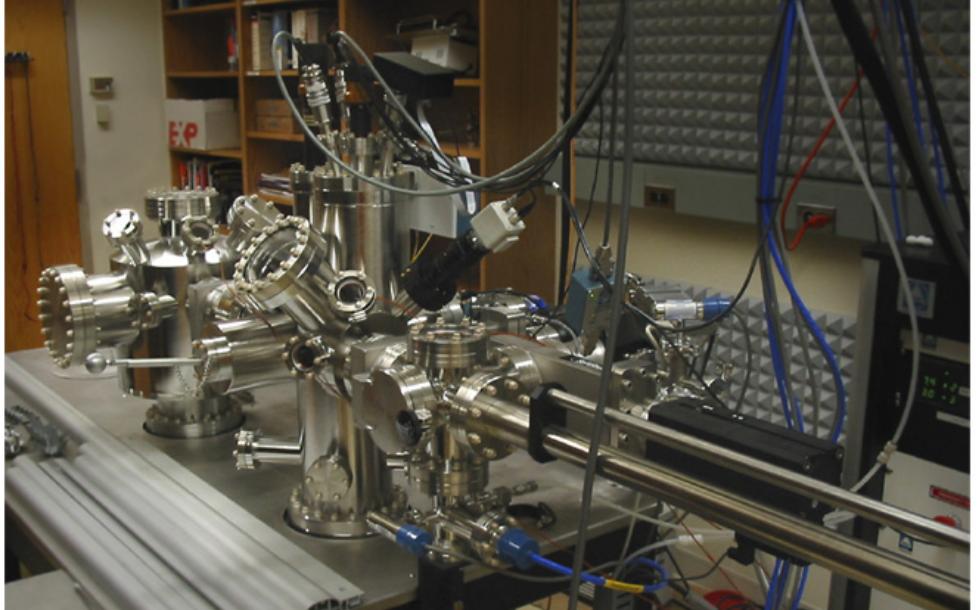


Figure 9: The entrance (left) to the Arthur G.B. Metcalf Center for Science and Engineering, which houses the department's Laboratory for Nanometer Scale Engineering (right).

than \$1M per year in funded research projects. It is widely recognized that contemporary engineering has become an interdisciplinary endeavor, and most of our current faculty are not uniquely specialized in either aerospace or mechanical engineering. Both research and instruction supporting both disciplines are focused on a wide range of enabling technologies which make fundamental use of electronics, information technologies, and modern physics. The research thrust areas² which the department has targeted in its current five year plan are on the one hand nontraditional while at the same time being similar to the focus areas found in a number of forward looking aerospace and mechanical engineering programs at leading universities.

The growth and advancement have been a part of the wider success and growth of the College, which for the first time this year was listed among the top 50 graduate schools in engineering by U.S. News. There has been a long period of sustained investment in the department by both the College and University. With continuing support, a number of superb new faculty appointments have been possible during the past few years. The University now seeks to appoint its ninth president, and it is notable that the leading candidate holds a degree in Mechanical Engineering and has held a very public position in aerospace. Encouraged by the remarkable institutional transformation that has continued for many decades, there is a sense of optimism that the Aerospace program will continue its prominence within the larger Aerospace and Mechanical Engineering Department, which in turn will be increasingly recognized as a technical leader in the thrust areas mentioned above.

Chronology of Department Chairmen						
From 1964 to the present						
Charles L.D. Chin	Ming Chen	Daniel G. Udelson	Jeffrey Forbes	John Baillieul	Allan D. Pierce	John Baillieul
Until AY'66-'67	1966 - 1981	1981 - 1991	<i>ad interim</i> AY'91-'92	<i>ad interim</i> AY'92-'93	1993 - 1999	1999 - Present

²Without going into detail, we list the five current departmental thrust areas: 1. Nanotechnology and ultra-small structures, 2. Dynamics, Control, and Mechatronics, 3. Acoustics, 4. Fluid mechanics, and 5. Biological and medical applications of mechanical engineering. Details of faculty involvement, recent recruiting, etc. are available in [6].

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- [7] All pictures are thanks to the Boston University Office of Photo Services.