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From Biplanes to Spaceplanes: The History of the University of Washington Department of Aeronautics and Astronautics

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Introduction

This paper is an updated and expanded version of a paper that appeared in *Aerospace Engineering Education During the First Century of Flight*, a book published by the AIAA (American Institute of Aeronautics and Astronautics).[1] The work contributed in this paper is part of an on-going effort to continually update and document the history of the Aeronautics and Astronautics Department at the University of Washington. Added material includes early curriculum, Fredrick Kirsten's teaching philosophy and greater detail of the past two decades, including the recent complete remodeling of Guggenheim Hall.

The Department

The University of Washington's Department of Aeronautics and Astronautics was one of the first aeronautical engineering departments in the nation, and one of the seven originally established with the help of the Guggenheim Fund for the Advancement of Aeronautics. It offers the only aerospace degree program in the Pacific Northwest, a region whose aerospace industry has been a major contributor to the technological development, economic vitality and the security of the United States. Educators and researchers in the Department over the years have made numerous contributions in all major areas of aerospace engineering. Graduates at all degree levels, have been successful and valued in industry at the local, national, and international levels, as well as in government organizations and institutions of higher learning.

Bill Boeing and the Early Years

In 1903, the year of the Wright Brothers' first powered flight, a man interested in establishing a timber business on the West Coast moved to Seattle after leaving Yale. Little did he know it at the time, but he was destined to change the face of aviation and the Pacific Northwest forever. His name was William E. Boeing. It is with this man that the story of aeronautics at the University of Washington begins.

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The first airplane flight in Seattle took place March 11, 1910, when Charles K. Hamilton flew a Curtiss Reims Racer before a large crowd of eager onlookers at what was then called The Meadows, a low-lying strip of land by the Duwamish River, south of downtown.[2] This location is now occupied by Boeing Field. It is not known whether Bill Boeing was present at this event, but what is certain is that he witnessed flying demonstrations in Los Angeles that same year, and was fascinated by what he saw.[3] For the next few years he tried to hitch a ride in an airplane, finally getting his wish on July 4, 1915, in a two-seater float plane on Lake Washington. Boeing caught the flying bug, and soon decided to start producing his own airplanes. Together with Navy Lieutenant Conrad Westervelt and Herb Munter, Boeing designed and built his first airplane, a float plane named the B&W. Shortly thereafter, on July 15, 1916, Boeing incorporated his aircraft manufacturing business as Pacific Aero Products Company, a name he changed to Boeing Airplane Company the following year. In early 1917, Boeing hired two students, Clairmont L. Egtvedt and Philip G. Johnson, from the University of Washington, to be his engineering staff. Though Egtvedt and Johnson were trained in mechanical engineering, and eventually became two of the most influential men in aviation history, their lack of formal background in aeronautics started Boeing thinking.[4]

Fig. 1 March 11, 1910, the first airplane flight in Seattle, at The Meadows. Aircraft is a Curtiss Reims Racer. Pilot is Charles K. Hamilton. (http://www.historylink.org)

To build a successful airplane company, Boeing realized that he needed trained aeronautical engineers and a facility to test new airplanes. Boeing devised a way to kill two birds with one stone. He decided to donate a wind tunnel to the University of Washington on the condition that the University develop an aeronautics curriculum.[5]

Design and construction of the new wind tunnel started in 1917, supervised by Assistant Professor John W. Miller, then of the Civil Engineering department. At the time, Miller was the University's flight expert. Miller's interest in flight dated back to before the Wright brothers' famous flight. He had started experimenting with gliders in 1895 and developed his first powered airplane in 1909, later claiming to be the first man to have flown west of the Mississippi.[6] Miller later became the first person to take an aerial photograph of the University of Washington campus.[7]

Miller had also previously dabbled with aeronautics instruction. In 1915, he decided to offer a lecture class on aeronautics at the University. It proved a difficult sell however, and the administration did not go for it. Miller was not deterred by this obstacle, and decided to offer the lectures clandestinely. He posted flyers on bulletin boards and lectured without compensation. The result was astounding. Held in a room that could only seat 25, as many as 35 or more students regularly filled his lectures to overflowing. It was the Boeing agreement with the University that finally brought Miller's course out of the shadows.

As a first step toward fulfilling the University's end of the bargain, the Civil Engineering department offered an airplane structures class in the spring of 1917. Taught by Miller, this was the first official aviation-related course offered at the University.[4] This class, however, was not destined to go any further. As a result of his work with Bill Boeing on the wind tunnel project, Miller resigned from the University in the summer of 1917 to become Chief Engineer at the newly renamed Boeing Airplane Company.[6]

Fig. 2 The Boeing Wind Tunnel at the University of Washington (c.1918). Clairmont Egtvedt is third from left. This facility is still in use but with a modern 3'x3' wind tunnel inside.

Concurrent with this turn of events, the Mechanical Engineering department began a search for a new faculty member to implement and instruct a complete aeronautics curriculum. This search led to the hiring of Frank McKone for the 1917-1918 academic year. The curriculum that McKone organized was essentially dictated by Bill Boeing. Boeing looked at what other aeronautics programs were offering, and considered what his own needs were.[6] The curriculum that was developed consisted of four courses. The first was an introductory class entitled "Aviation" that taught the basics of aircraft and aerodynamics. The second course, called "Airplane Design," stressed the application of aerodynamics, stability, and structures in the design of an airplane. The theory and design of propellers was covered in "Airial (sic) Propulsion." The final course, "Aerodynamic Laboratory," slated to start in spring quarter was a class that would let students take advantage of the new wind tunnel. The University ensured that they got their money's worth out of McKone; he was also assigned to teach some of the regular mechanical engineering courses in addition to the aeronautics curriculum.[8] He taught these classes for just one year before leaving the University.[6]

The gap created by McKone's departure lasted for three months and was filled by McKone's predecessor, John W. Miller. The University had been desperate for an aeronautics professor, and with the end of World War I, Miller, who had been loaned to Boeing, became available again. To sweeten the deal, Henry Suzzallo, president of the University, apparently promised Miller that, although he would initially be an Assistant Professor, he would be almost immediately promoted to the rank of Associate Professor. For some reason, this promise was not fulfilled, and Miller was not promoted. As a result, Miller again resigned from the University after teaching for only two academic quarters.[4, 6]

Miller's second tenure with the University was not without a moment of significance, though. During this time it was decided that the courses no longer would be listed as mechanical engineering classes, but that they should be given an aeronautical engineering designation. Thus was born the official A.E. program.[6]

With Miller's departure, the University was again left with no one to teach aeronautics. As a result no classes on this topic were taught for the next two years. Little did anybody know at the time, but the man to fill this void was already right under their noses, teaching electrical engineering. As it turned out, this individual was destined to not only fill the aeronautics teaching void, but also to play a key role in the development of aeronautics at the University of Washington for the next 30 years; a man whose legacy continues to be felt even today. His name was Frederick Kurt Kirsten.

Enter Fred Kirsten

Born in Germany, Kirsten came to America in 1902 aboard an old sailing schooner.[9] At the encouragement of a friend, he began studying electrical engineering at the University of Washington, graduating *magna cum laude* in 1909.[4] In 1915, he joined the faculty as an Assistant Professor in Electrical Engineering. By 1923 Kirsten had been promoted to full Professor.

By nature Kirsten was an inventor. His most famous aeronautics-related invention was that of the paddlewheel-like cycloidal propeller. Unlike a paddle wheel, the device's eight blades spun about their own axes as they orbited the axis of the wheel. Kirsten spent over 20 years trying to perfect the concept for use on airplanes. At one point, he teamed up with Bill Boeing to further develop cycloidal propellers for both aeronautical and marine applications. Boeing put up $175,000 of his own money to start a company with Kirsten. However, the concept eventually proved to be impractical in aeronautical applications, and the Kirsten-Boeing company failed. It should, however, be noted that cycloidal propellers were viable as a marine propulsion system.[3] Even today, some tugboats are equipped with them.

Outside of his contributions to aeronautics, Kirsten invented everything from lights for airports to World War II air-raid sirens. Although he took out more than 100 patents, many of his non-aeronautical inventions[10] are now forgotten. There is, however, one exception, the "Kirsten Pipe." Kirsten had been a cigarette smoker and, while visiting his doctor about a persistent cough, he was told to quit smoking cigarettes. Kirsten went home and decided to design a pipe. The heat-absorbing aluminum stem of this pipe delivered a "delightfully cool, clean smoke." Kirsten demonstrated the pipe to his doctor who is reported to have told Kirsten that he could smoke it on one condition: that he made one for him. Kirsten started a company to manufacture his "perfect pipe,"[11] and over the years made a substantial amount of money selling them. They are still manufactured today, in Seattle, and the company is still in the family.[12]

Kirsten's personality was one of extreme confidence. According to one of his former students, "Kirsten was a great man, you could just ask him." An article in *The Daily*, the University's newspaper, stated that Kirsten was "about as meek as a General Sherman tank."[13] Kirsten was extremely proud of his work and very dedicated to it. He could be the best of friends to those who took interest in his work, and a powerful adversary to those who criticized it. It was Kirsten's personality that gave him the driving force that would enable him to accomplish so much.

Founding a Department

Kirsten began teaching aeronautics courses at the beginning of the 1921-1922 academic year. He dove into his new duties with characteristic zeal. Miller's A.E. curriculum was still on the books, and Kirsten used these classes as a guide. Kirsten studied hard to bring himself up to speed on the state of the art in aeronautics. The content in the courses evolved as Kirsten's knowledge of the subjects improved. One extreme example was in the "Airships" class, to which Kirsten added topics such as helicopters, ornothopthers, autogyros, and cyclogyros (aircraft powered by Kirsten's cycloidal propellers) to align the class with his knowledge and interests. In early 1926, the University opened a dialog with Harry Guggenheim and the Guggenheim Fund for the Advancement of Aeronautics, in an attempt to procure funds to establish a school of aeronautics. At that time the Guggenheim Fund, founded by Harry's father Daniel, had already provided grants for similar schools at New York University, Caltech, MIT, Stanford, and the University of Michigan.[14] In its communications with Guggenheim, the University stressed its strong ties with Boeing and Naval Aviation, the Boeing Wind Tunnel on campus, and the promising development of Kirsten's cycloidal propeller.[4]

In 1927, a proposal for a $450,000 grant was submitted to the Guggenheims. They balked at the large amount of the request, but kept the matter under consideration. The University again approached the Guggenheims in 1928. This time, the University's approach was highly organized. After the first request, the Guggenheims had been given time to investigate the University's background and existing facilities. Bill Boeing wrote to the Guggenheims on behalf of the University. Most importantly, in the 1928 proposal, the University was asking only $290,000, just enough to construct a building to house the new department. The Guggenheims were sold. On June 15, 1928, the trustees of the Guggenheim Fund approved a grant of $290,000 for the construction of an aeronautics building on the University of Washington campus. This grant was contingent on receiving funding from the State of Washington to properly equip the new building. The state legislature approved this funding in early 1929.[13] Construction began soon thereafter.[15]

The 1927-1928 academic year saw the first evidence of the preparations for the new department. Design work had begun on the new aeronautics building. John W. Miller had again returned to the University, and for the first time the aeronautics faculty consisted of more than one man. With two professors, the course offerings were expanded from five to eight. Support from the Boeing Airplane Company was evident, as some of these courses featured supplemental lectures from some of Boeing's best engineers, such as Claire Egtvedt and C.N. Monteith.[6] In July 1929, Professor Everett O. Eastwood was named the head of the department, thus marking its official beginning.[16] The building was completed in the spring of the following year.[17]

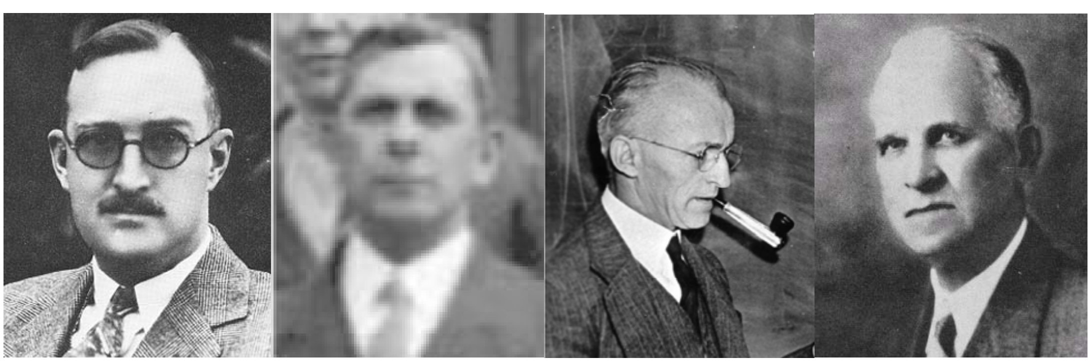

Fig. 3 The Department's Founding Fathers. Left to Right: William E. Boeing, John W. Miller, Frederick K. Kirsten, Everett O. Eastwood.

Eastwood was the very model of a "modern" mechanical engineer. He had a hand in almost everything. Educated at MIT, he joined the University of Washington in 1905 as the head of the Mechanical Engineering Department. He had developed the first master plan for the

University of Washington campus, and served as the University's engineering consultant. Eastwood's appointment as head of the department was to have originally been one of expedience. Unable to find a suitable aeronautics man to run the new department, Bill Boeing put forth the name of Eastwood as a possible candidate, to at least get the department up and running until a suitable aeronautical engineer could be found. Harry Guggenheim approved of the idea, stating "It would be far better to have a first-rate mechanical engineer and executive…than an aeronautical engineer without the qualifications of leadership."[14] . In fact, Eastwood never actually taught any aeronautics classes at all. This fact would later become a matter of some controversy. While these concerns led to two attempts to replace him as head of Aeronautics, he remained head of both departments until 1946, a year before his retirement from the University

On October 5, 1929, the Department of Aeronautical Engineering officially opened its doors.[18] There were four original faculty members: Miller, Kirsten, Eastwood, and Fred Eastman, who was hired earlier that year as an instructor, but would soon be given a professorship.[*] Twelve different courses were offered in the 1929-1930 academic year, leading to a degree in Aeronautical Engineering.

Fig. 4 Guggenheim Hall in 1931.
(CF Todd Coll., PNW Coll. UW #14680)

The Daniel J. Guggenheim Aeronautics Hall was dedicated. on April 11, 1930. In the words of the University of Washington's newspaper, *The Daily*, the Tudor-Gothic building was "architecturally perfect."[19] The building included room for six small instructional wind tunnels in the basement, only one of which was ever built. It was known as the Venturi Tunnel and was in operation until 2006. The building housed a large laboratory with two full-sized airplanes and a number of aero-engines so that students could have hands-on experience with "the real thing." The building also sported a 355-seat auditorium which was designed not only to hold classes, but also to enable the Department to host large public lectures on aeronautics.

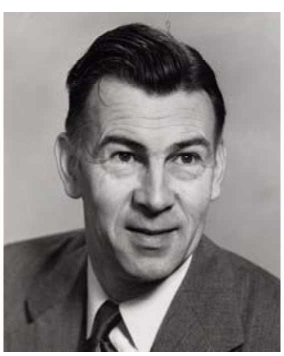

Fig. 5 Fred Eastman

Everybody wanted a piece of the new building. In addition to being the home of Aeronautical Engineering, Guggenheim Hall also housed the College of Engineering Administration, the Engineering Library, and parts of the Civil and Electrical Engineering departments.[20]

The early 1930s were a time of evolution for the new department. Changes to the curriculum were constantly being made. In 1930, the Department awarded its first five Bachelor of Science in

[*] Fred Eastman served the department until his retirement in 1970. He was the department head from 1946 to 1952. In 1986 he received the Pathfinder Award from Seattle's Museum of Flight, and on February 10, 2004, he celebrated his 100th birthday in excellent health. Eastman passed away on August 5, 2006 at the age of 102.

Aeronautical Engineering degrees; in 1931 there were 11 graduates and by 1933 this number had jumped to 28. However, the Depression took its toll, and from 1933 to 1939 an average of about 16 students graduated per year. Unlike other Guggenheim schools, such as Caltech and MIT, most of the Department's emphasis at this time was on teaching rather than research. The research that did go on was mostly applied research, such as Eastman's work on wind tunnel balances and Kirsten's cycloidal propellers.[13]

As a side note, Boeing took interest in the new Department. In a 1928 letter addressed to Prof. C. C. More and the Department of Civil Engineering, Boeing Chief Engineer Charles Montieth wrote: "… aeronautical personnel are divided into four main classifications:

1. The research man
2. The airplane designer
3. The production manager
4. The operator of the airplane

Montieth went on to point out that "it is the airplane designer for whom the course in Aeronautical Engineering must be prepared. First of all, he must know enough of the work of the research man to be able to summarize this work and convert the results to terms which can be used directly in practical airplane design. He must know enough of the shop methods to understand how his designs are to be built. He should, if possible, get as much time in the air as he can, either as a pilot or as an intelligent passenger. The lack of any of these bits of experience is something of a handicap."[21]

The Wind Tunnel Years

The years from the mid-1930s until 1960 can best be characterized as the Kirsten Wind Tunnel years. Although the tunnel still is used regularly today, it was this period that established it as a world-class facility. Throughout this era, faculty and students played a key role in operating the wind tunnel. Faculty had played a major part in its construction, and students were hired to operate the tunnel. In some cases, students who worked in the tunnel continued as technical staff and later were hired as faculty.

Fig. 6 Kirsten with his "Cycloplane" in the wind tunnel that now bears his name.

During the early 1930s, Fred Kirsten was eager to test his "Cycloplane," his cycloidal propeller aircraft concept. In 1934 he approached the Graduate Aeronautical Laboratories at the California Institute of Technology (GALCIT) to use their wind tunnel for this purpose. He was quoted a price of $200/day, which was much more than he could afford. At the time, GALCIT had the only wind tunnel of any practical size on the west coast. So, in 1935, Kirsten proposed a new wind tunnel for the University of Washington.[22]

The proposal, "An Aero Dynamic Laboratory (Wind Tunnel) on the Campus of the University of

Washington, Seattle, Washington," was for a wind tunnel with an 8x12-foot test section and a maximum speed of 250 mph. When completed, the tunnel would be one of only two capable of such speed. The proposal was for $120,000, of which $54,000 was requested of the federal Public Works Administration (PWA). The remaining $66,000 would come from other sources: $40,000 from the Washington State Budget Relief Administration, and $26,000 from Boeing, given as a loan against future rentals, at $15/hour.[20]

It is interesting to review some of the salient points made in the proposal. One was a barb aimed at GALCIT's high cost to other universities and its essentially holding a monopoly for testing on the west coast. Another was the training of students and staff for research. The wind tunnel would "allow them to contribute in considerable measure to the advancement of a new engineering field." Also it was pointed out that the department could not support graduate students because they had to go elsewhere to find facilities to do their research. Finally, it was added that Boeing was sending its work to the east coast and GALCIT at considerable cost. It is interesting to note that the tunnel was envisioned to operate with a student crew, as it still does today.

Construction began in January 1936 and, due to mild weather, progressed rapidly. The tunnel was completed in early autumn of that year. However, it needed much work before it would be ready for serious testing. In order to reduce cost, a decision was made to build a dual return tunnel that used two 500-hp motors rather than a single return with a 1000-hp motor. Much of the design, supervision and construction was done in house; an ingenious electromagnetic balance was designed by Fred Eastman and the 14 wooden fan blades were carved in Guggenheim Hall's machine shop. Kirsten's dedication was so great, he even had his son sanding fan blades.[10]

No formal records appear to exist regarding the work done between the fall of 1936 and early 1939 but a "diary" indicates Boeing tested their model 307 Stratoliner extensively.[23] It appears that a shakedown period was going on concurrently with the Boeing tests. Notes indicate a few startup glitches, such as the loss of one set of seven blades due to a loose spinner. There are some interesting articles that were published in *The Daily,* the University's newspaper: one article, dated January 28, 1938 had the headline "Wind Tunnel Air Goes Wrong Way," and alluded to flow problems due to the merging of the two return streams. Formal test records did not start until March, 1939, when a test on the North American AT-6 "Texan" became the first entry in the official run log.[23]

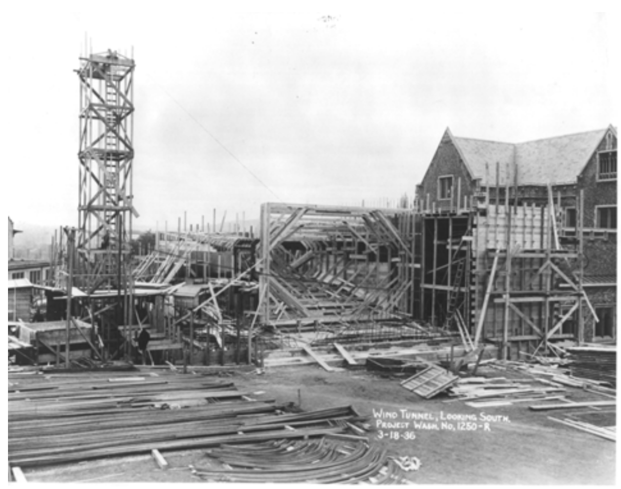

Fig. 7 The Kirsten Wind Tunnel under construction, March 1936.

The University of Washington Aeronautical Laboratory (UWAL), as it has come to be known, began testing furiously once it was open for commercial use. In 1939, a total of 21 test programs were performed, which included Boeing, Lockheed, Davis, and Consolidated. Two vehicles that occupied the facility for much of the year were the Lockheed Constellation and the

Boeing 307 Stratoliner. An interesting historical test from an aerodynamics standpoint was the testing of the Davis wing, used and tested on the Consolidated B-24 that year. The Davis wing was a poorly understood laminar flow wing, which performed exceptionally well in the wind tunnel but not in flight. It was not until years later that it was understood that the peculiar behavior in the operational environment was due to the flow becoming turbulent due to surface irregularities.

In 1940 the tunnel had 39 tests, with Boeing, Lockheed, North American, Consolidated, and Grumman all paying visits. The bulk of Boeing's testing was on the B-29, with some testing of upgrades to the B-17. Lockheed tested the XP-49, which was an upgraded, pressurized version of their P-38. North American brought a model of their P-51 wing in secrecy from southern California. Throughout WWII, the tunnel saw constant action. The only breaks from military testing were in 1941 to perform post-collapse analysis of the Tacoma Narrows Bridge and then in 1942 to finally let Kirsten test his Cycloplane. It is somewhat of an irony that it took until 1942 for Kirsten to get testing time after starting with GALCIT in 1934. A big moment for UWAL occurred in July 1941, when, the construction loan from Boeing was paid off.[24] It took only two years of operation to fulfill the commitment of the $26,000 of testing to Boeing.

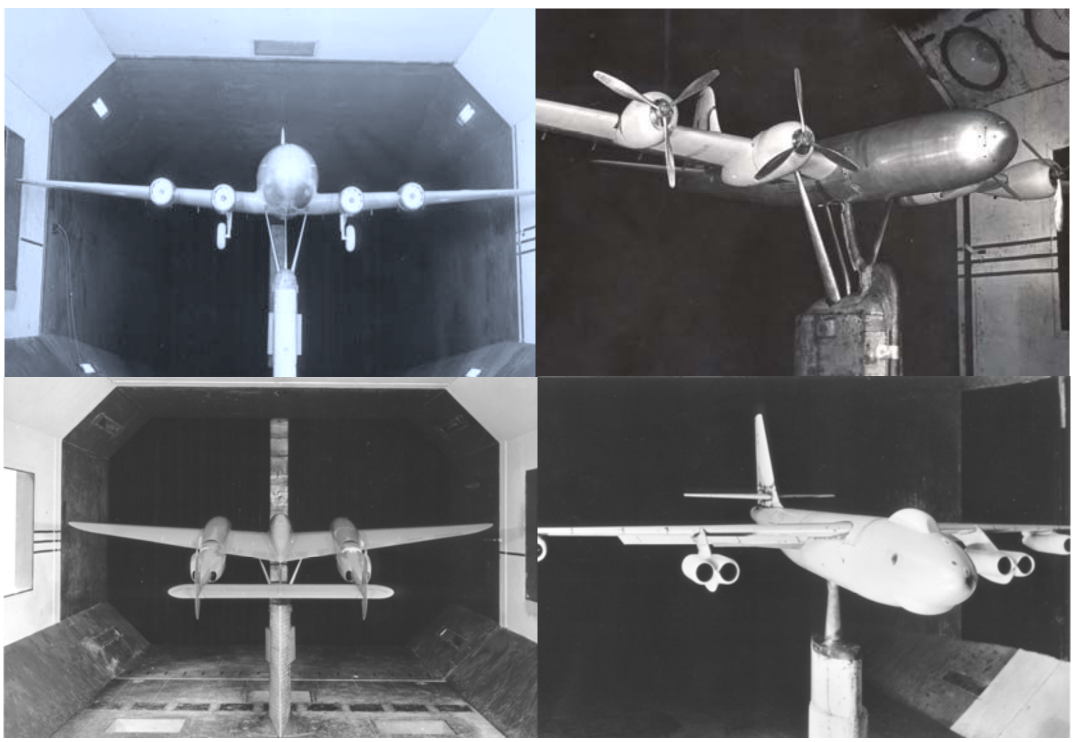

Fig. 8 Famous early UWAL Tests. Clockwise from top left: Boeing Model 307 Stratoliner, Boeing B-29, Boeing B-47, Lockheed XP-49.

Military testing dominated the run logs of UWAL throughout the late 1940's. Some notable tests include the B-47 and the P-85 "Goblin". Boeing and McDonnell show up extensively in the tunnel logs. In 1948, the wind tunnel was officially named the Kirsten Wind Tunnel, after the man who had worked so hard to get it built.

As the 1950's progressed, Boeing started to become the exclusive customer in the tunnel. Aircraft such as the B-47, B-52, KC-135 and 707 were tested. By the end of the decade it is rare to find an entry in the run logs that is not a Boeing test. A strong relationship between Boeing and the Aeronautics Department blossomed during this period. For the next 30 years, UWAL would host most of Boeing's low-speed wind tunnel testing.

Interestingly, Fred Kirsten, who had been so instrumental in procuring the wind tunnel for the department, was never its Director. Edmund L. Ryder, an instructor, was appointed as the first director, but held the post only briefly. He left the University in 1937 to help start the Boeing Aeronautical School in Oakland, California. Ryder was replaced by Fred Eastman, who had designed the tunnel's balance. Sometime during the mid- to late 1940's the directorship of the tunnel transferred to James Dwinnell, a 1939 graduate of the department who had joined the faculty in 1941, and who later went on to a distinguished career at Boeing.

Kirsten, the Professor

By the late 1930's and early 1940's Professor Fred Kirsten was known for his strong views on education. On May 26, 1936 the school paper reported on Kirsten's "Guess your grade and take no exams" policy. The "student choice" grading system started in the fall of 1935 and worked by allowing students to guess their grade to opt out of the grueling three-hour final exam. If their own estimates agreed with Kirsten, they did not have to take the final. "So far", Kristen said, "I have agreed with one half of the students in my classes. And to my great surprise, most of the students with whom I did not agree verified their own estimates in an exam."[25]

Kirsten advocated a three-grade grading system; excellent, passing and failing, or A, C, E. "People are graded in much the same manner during their entire working career," he was quoted. He believed that "every student should earn an 'A' in each course he studies. Universities should make provisions for students to take courses over again until they master the subject... the subject matter of a course is lost unless the student has gained complete mastery over it," which meant they should retake the class until they achieved an A"[24]

Professor Kirsten expressed that many students were working for grades and not knowledge. "Everyone is secretly trying to get a grade from the course, even though he disputes the fact." Kirsten believed that the grading system was an unfortunate part of "mass production" in education.[24]

In 1943 Kirsten was interviewed for an article in which he said "Specialized education has put American youth into a groove, beyond which they are unable to see. We have been so anxious to teach our students everything from A to Z in their chosen field, the average pupil is graduated without any personal philosophy, with little appreciation of the delicate balances and symphonies of nature's forces, an ignorance of the fundamental ethics of the good life and a complete disregard for that which is not in his text book." Kirsten believed that western culture was becoming lost because all students are taught is "to solve equations and draw straight lines."[26]

Later, Kirsten added that engineering students were taught "how to make a living instead of how to live." But, he was just as critical of the liberal arts majors who were allowed to graduate with "no ideas relative to physics, chemistry, mathematics and the biological sciences.

They exist in a scientific age, without the slightest appreciation of the methods and aims of science."[27]

Up and Running

Although the Kirsten Wind Tunnel dominates the period from the mid 1930's to about 1960, there were other changes in the Department. In the late '30s the department began to offer flying courses under the sponsorship of the Civil Aeronautics Administration. In 1939 there were 350 applicants for 30 flight training spots.[28] After the U.S. entered WWII, the Navy sponsored the flight training. Throughout the war, the department trained 1200 people for the war effort, including 25 women.

In 1937 the Department received a loan of two government airplanes for the Senior Aero Room. The two airplanes were a 1918 Curtis Pursuit ship and a 1925 Vought built for the Navy for observation. These airplanes provided hands-on instruction for the students, as they were dismantled and reassembled as part of their training. While both airplanes were capable of flight, the agreement for the loans was that they would not be flown. Several piston engines were also available for instruction. Boeing donated parts, such as spare wings and propellers, for instruction. The senior lab, which was in a high-bay lab in Guggenheim Hall had the appearance of an aircraft maintenance hangar.[29]

Unfortunately, on May 1, 1944 an acetylene torch ignited the canvas covering on the wings of one of the two airplanes, burning it down to the bare metal. The fire burned itself out by the time fire fighters got to the scene, but the damage to both airplanes was extensive.[30]

Courses toward a Master of Aeronautical Engineering (MAE) degree were first offered during the 1946-47 academic year as a "fifth-year" program. However, the first graduates with MAE degrees did not appear until 1948. The Master's program grew until it represented approximately one third of the student body by the end of the 1950s. The Ph.D. degree was offered for the first time during the 1959-1960 academic year. Eight students entered this new program that year. Curricular changes toward the end of the 1940s included the introduction of courses on gasdynamics, motivated by the advent of supersonic flight. In 1948 the department built and installed a supersonic blow-down wind tunnel, using a vacuum pump and large tank that were donated by the U.S. Air Force. The wind tunnel was capable of producing ~25 sec of steady Mach 3 flow in a 3x3-in. test section. A smaller test section (1x2 in.) allowed Mach 5 to be attained. This facility played an important educational role for nearly 60 years, until it had to be dismantled in 2006 for the renovation of Guggenheim Hall. The wind tunnel was also used at various times for research purposes, especially toward the end of its life.

The size of the Department during this time can be best characterized by "slow growth". The Department had a regular faculty of five throughout the period 1935-1945. Eastwood stepped down as department head in 1946 and retired in 1947, and Kirsten retired in 1951 (he died shortly thereafter, in 1952, at the age of 67). A faculty position was added during the late 1940s reflecting the addition of the MAE program in 1946, and then two more during the next 10 years, probably due to the growth of the graduate program. Course offerings for undergraduates increased slightly during the period, while the graduate program increased course offerings dramatically during the late 1940s.[31]

Following the departure of James Dwinnell for Boeing in 1950, the management of UWAL was taken over by Robert G. Joppa, a 1945 graduate of the department. Joppa had stayed on after graduation to work at the wind tunnel, and in 1949 was hired as a part-time instructor and part-time research associate at UWAL. He went on to teach many courses, including flight testing and airplane design, until his retirement in 1988. In 1967 the helm of UWAL was handed to William H. Rae, Jr., ('53, M.S. '59) who had started as a research instructor in 1956. He continued as head of UWAL until his untimely death in 1993. Rae was co-author with Alan Pope of the 2nd edition of the well-known book *Low Speed Wind Tunnel Testing,* and was a founding member of the Subsonic Aerodynamic Testing Association (SATA).[32]

Fig. 9 Robert A. Joppa

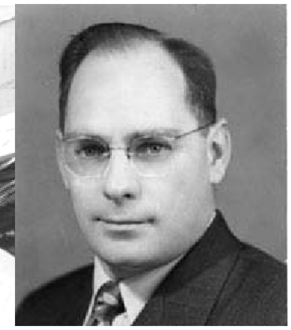

Fig. 10 Victor Ganzer

Another faculty member of note during this time was Victor Ganzer, a 1941 graduate of the department, who first worked at NACA on the P-38 and later at Boeing, where he contributed to the aerodynamic design of the B-47. In 1947 he accepted a faculty position in the department and taught here until his retirement in 1977. It was he who initiated the department's course in engineering flight testing. In 1953 Ganzer acquired a surplus NACA single-engine Fairchild 24W for the department. This airplane was later replaced by a Beech D18, which the department continued to own and operate for the flight test course until the late 1980s. Today, the course still exists, but an airplane is leased. From 1953 to 1957 Ganzer served as department head.

Finite Elements

Fig. 11 Harold C. Martin

During the 1950s new airplane configurations, using swept and low aspect ratio wings, strained the capabilities of classical structural analytical methods. At the same time, computing power was first becoming available to engineers. In the mid-1950s two senior structural engineers at Boeing, M.J. Turner and L.J. Topp; a visiting professor from Berkeley, R.W. Clough; and Prof. Harold C. Martin, from the UW Aeronautics Department, began a collaborative effort to make use of the computer in structural analysis. Their concept was to divide a complex wing into many simple triangular or rectangular pieces and construct a global solution for deformation and loads on the wing. Their pioneering research paper "Stiffness and Deflection Analysis of Complex Structures," was published in 1956, in the *Journal of the Aeronautical Sciences.*[33]

Martin continued to work on the method, expanding it to a wide variety of problems. Students of Martin also continued to expand the concepts, and courses were offered on the subject. In the abstract to the 1956 paper, Martin and his coauthors state: "Considerable extension of the material presented in the paper is possible." That prediction has come true beyond their wildest dreams. What they developed became known as the finite element method (FEM), and is the basis for a majority of the commercial structural analysis tools available today. FEM is also found in commercial tools for heat transfer and fluid dynamics.

Explosive Growth

In late 1960, with eight faculty members, the department initiated an external search for a new head. John H. Bollard, a member of the aeronautics faculty at Purdue, known for his work on aircraft and spacecraft structures, came to the forefront. Bollard, a native of New Zealand, impressed everyone with his expertise, enthusiasm, and people-skills. He was offered the position and accepted, taking up his new post in August 1961. He was only 34 years old.

Fig. 12 John H. Bollard

Bollard immediately set out to build and expand the department. Times were good: the state's economy was healthy, support for the University in the Legislature was strong, and NASA was burgeoning as a result of President Kennedy's May 25, 1961 speech before Congress, committing the nation to land a man on the Moon before the end of the decade. They were heady days, indeed, and Bollard took full advantage of the situation. During the next nine years, with Bollard at the helm, the department doubled the size of its faculty, greatly increased the annual research budget, secured new equipment for the instructional labs, revamped the curriculum to include space-oriented courses, added the word "Astronautics" to the department's name, and initiated the planning for the Aerospace Research Laboratory (ARL) to be housed in a new building bearing that name. This laboratory was to be devoted to advanced, multidisciplinary aerospace engineering research. Bollard and Ganzer approached NASA for the funds to build the new facility and, in early 1966, began the search for its director. NASA granted the University $1.5 Million for the new building.

The search for the director of ARL netted the Department's most notable hire during this period, Abraham Hertzberg. Already well-known internationally for his work in high-energy gasdynamics and re-entry physics, and his development of shock tubes and shock tunnels, Hertzberg was head of the Aerodynamics Research Department at the Cornell Aeronautical Laboratory in Buffalo, NY. His name was first put forward by Arnold Goldburg, of the AVCO Everett Research Laboratory (Goldburg soon thereafter moved to Boeing to head the Flight Sciences laboratory at the Boeing Scientific Research Laboratory). Hertzberg was unhappy with his situation at Cornell, and was looking for a new position. The chemistry between him, the department's faculty, and Dean Charles H. Norris worked, and Hertzberg started his new post in the summer of 1966.

Fig. 13 Abraham Hertzberg

Initially, ARL, as a program, was located in Guggenheim Hall, as was Hertzberg; he had a staff of one, himself, but that didn't last long. Not only did he dive into the new building project but he also brought on board several new faculty, starting with David Russell and Walter Christiansen from JPL, both of whom would later go on to serve as department chairs. Construction began in 1967 and was completed in 1969. The new building was located adjacent to Guggenheim Hall. All the laboratory spaces in ARL were windowless because so much of the research that was to occupy it for the next two decades was oriented around gas-dynamic and chemical lasers, and other optical research. Three of the four floors of the building, plus the basement were occupied by research directed by Hertzberg and his colleagues. The third floor was assigned to the University's budding Bioengineering Program.

Fig. 14 The Aerospace Research Laboratory (ARL), later renamed to Aerospace and Engineering Research Building (AERB).

A spacious basement laboratory was devoted to a large shock tube installation. Other lab spaces housed Ludwieg tubes, chemical lasers, gasdynamic lasers, shear layer test facilities, and a picosecond laser facility that one of the new faculty used for bioengineering-related research. ARL became a truly interdisciplinary facility, with participating faculty drawn from Aeronautics and Astronautics, Nuclear, Mechanical, and Electrical Engineering, and Physics. The research income generated by Hertzberg and his colleagues soon overtook that generated by aero/astro faculty not associated with ARL.

One of Hertzberg's interests had been the application of lasers to controlled thermonuclear fusion, i.e., the laser heating of plasmas, and he initiated a small program in this area at ARL soon after the building was completed. He and collaborators John M. Dawson of Princeton University and Ray E. Kidder of Lawrence Livermore, and their colleagues, presented a paper titled "Controlled Fusion Using Long-Wavelength Laser Heating with Magnetic Confinement," at the Esfahan Symposium on Fundamental and Applied Laser Physics in Esfahan, Iran, in late summer 1971.[34] This seminal paper established the firm foundations of the fusion program at ARL, which continues to this day as a vibrant component of the department.

Hertzberg also contributed to the development of the department's curriculum, introducing a number of graduate courses, including one on gasdynamic lasers, a seminar course on special topics in fluid physics, and courses on physical gasdynamics (i.e., aerophysics), the latter developed in collaboration with colleagues Walter Christiansen and David Russell. A decade later, Hertzberg introduced a capstone design course in space systems.

Bust and Recovery

As the 1960s came to a close, trouble was brewing in the aerospace industry. The first lunar landings had taken place but the Nixon Administration canceled the last four Apollo missions. Military spending declined with the winding down of the Vietnam War, inflation reared its head, and the economy began to weaken. Boeing's workforce started to decline from its high of 100,800 in 1967. In 1971 the Federal Government withdrew its funding of the Boeing Supersonic Transport program, and Boeing shed many more workers, ultimately reducing its payroll by more than 60,000. Because Boeing was the Seattle area's largest employer, the impact of these layoffs on the local economy was severe. It was in April 1971 that two realtors erected a billboard near SeaTac Airport, with the words "Will the last person leaving Seattle turn out the lights." The downturn in the aerospace industry, coupled with the faltering economy, was also felt state-wide, resulting in significant cuts to the University's state funding base.

Not surprisingly, enrollment in the department plummeted. In 1972, the graduating class had only 12 members, a number not seen since the very earliest days of the department more than 40 years previously. Gradually, however, enrollment began to rise, and by 1976 the department had 30 graduates Despite the rocky start to the '70s, the number of faculty in the department, including non-tenure-track faculty, remained stable and even grew to 19 in 1975. Faculty additions in the 1970s included Mahlon Ness, who joined the department in 1971 from the College's General Engineering Department upon the latter's dissolution;[*] Adam Bruckner, who joined in 1972; and Arthur T. (Tom) Mattick, who came on board in 1975. Both Bruckner and Mattick were hired by Abe Hertzberg, originally as postdocs. Bruckner would later become department chair.

John Bollard stepped down as department Chair in 1976, and was replaced by Ellis Dill, who less than a year later left to accept the position of Dean of Engineering at Rutgers University, a post he held for 25 years. David Russell assumed the helm of the department in 1977 and served in that role until 1992, when he was succeeded by Walter Christiansen. In 1975, the name of ARL was changed to Aerospace and Energetics Research Program (AERP), to better reflect the nature of the research that was being conducted there, and the name of the building was changed to Aerospace and Engineering Research Building AERB. Abe Hertzberg continued as Director until his retirement in 1993. He remained active in research, despite gradually failing health, until he passed away in March 2003.

In 1979, Bollard, together with James Mueller of the Department of Material Science, was appointed by NASA to an independent, 12-member advisory committee formed to investigate problems with the thermal protection tiles on the Space Shuttle.[35] On the flight of the Shuttle Columbia from California to Cape the Kennedy Space Center, atop its 747 carrier aircraft, more than 5000 of the tiles had fallen off. During two years of intensive research, Mueller, Bollard, and their colleagues discovered the fundamental initial cause of the tile attachment failure and the subsequent mechanics of detachment, and developed engineering solutions that were adopted by NASA. Their success resulted in special commendations from NASA, the State Legislature, the Governor, and the University.

Holding the Course

During the decades of the '80s and '90s, the Department was of relatively constant faculty size with student enrollment influenced by the roller coaster of the aerospace industry. This stable faculty population was fortunate, at least for those students who happened to enter during a lean period. By the time of their graduation, the job market was frequently strong with few applicants competing for many openings.

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[*] The department of General Engineering had been formed in 1924 for the purpose of teaching and advising students entering the College of Engineering.[4] All Engineering freshmen had a common first year. The department's faculty provided extensive counseling and taught the introductory courses in engineering problems, drawing, and surveying that had been the responsibility of the Department of Civil Engineering. When General Engineering was dissolved in 1971, the common first year was replaced by a group of College of Engineering courses developed for the freshman and sophomore year, including Statics, Dynamics, Strength of Materials, and Thermodynamics.

At the start of 1980, the Department had 20 faculty (including two supported on research) and 200 students. The aerospace industry reached a local minimum in the early 1980s, mimicking the previous decade, and then expanded rapidly. Classrooms were bursting by 1985, with strong demand for the Department's graduates. During this time undergraduate admission became highly competitive. In 1982, despite another budget crisis, the University created a new program, Applied Mathematics, which occupied the fourth floor of Guggenheim Hall. The faculty for this new entity were drawn from Arts and Sciences and Engineering. Three faculty from Aeronautics and Astronautics, Carl Pearson, Jirair Kevorkian, and Juris Vagners, were among them. About a decade later, Vagners rejoined Aeronautics and Astronautics.

Boeing's continued use of the Kirsten wind tunnel resulted in a decision to help the University modernize it. Gearing up for the 757 and 767 programs, Boeing donated $2,000,000 to upgrade the computer systems. A computer/operations room was added to the roof, using UWAL reserve funds, and two PDP 11/70 computers were purchased to process data.

The department gained a world-class authority in computational fluid dynamics when Robert McCormick from NASA Ames joined the faculty in 1981. He remained on the faculty for three years before returning to the Bay Area to accept a position at Stanford. In 1983 Hertzberg, together with colleagues Adam Bruckner (who would become department chair in 1998) and David Bogdanoff, created and developed the concept of the ram accelerator hypervelocity launcher. The initial successes of this work led to the establishment of similar laboratories throughout the world. Other notable research accomplishments came from the department's fluid dynamics and structures groups, in the areas of turbulence and vortex dynamics (Robert Breidenthal, Mitsuru Kurosaka, *et al.*), in fracture mechanics and composite materials (Kuen Lin *et al.*), and in multidisciplinary design optimization (Eli Livne).

The department's curriculum remained largely unchanged during the '80s, notable exceptions being the introduction of courses in computational fluid dynamics (CFD) by Robert McCormick and the development of the senior capstone space systems design course, which had originally been initiated by Abe Hertzberg in 1979. In late 1984 the department was invited to become a one of the nine charter members of the newly-created NASA USRA Advanced Design Program (ADP), a consortium of universities interested in working with NASA centers to improve the quality of capstone space systems design courses. In 1985 Adam Bruckner began to co-teach the course, and became the department's liaison with the NASA/USRA ADP. The first summer student conference under this program was held at the Kennedy Space Center in early July of that year. The team of A&A Seniors was awarded the first prize for its design project (a large-scale solar-thermal power satellite), beating teams from top universities such as MIT, Georgia Tech, Michigan, UT Austin, and Texas A&M. In subsequent years Bruckner expanded the design course to encompass two academic quarters, and took over full responsibility for its teaching in 1991, a role in which he continued until 1999.

Another educational advance in which the Department participated, beginning in 1983, was the College's new program in Televised Instruction in Engineering (TIE), the first foray by the College into distance learning. Keith Holsapple became the department's point person in this endeavor and served as Associate Dean of the College, managing the TIE program, from 1988 to 1997, when the new Dean of Engineering, Denice Denton, reorganized the College administrative structure and TIE was renamed EDGE, Education at a Distance for Growth and Excellence. TIE and its successor, EDGE, made it possible for engineers in industry to continue their professional education without having to come to campus for their courses. These distance-learning programs thrived and expanded, eventually making it possible for off-campus graduate students to fulfill all their Masters' degree requirements remotely. Now, even a PhD cam be partially completed in this manner. As delivery technologies advanced, EDGE kept pace, and today the courses are delivered online via streaming video.*

Following Robert McCormick's departure in 1984, the search for a CFD faculty replacement netted Scott Eberhardt in 1986. He came to the department from the NASA Ames Research Center. Eberhardt further developed the CFD graduate course offerings and research in this discipline, and later took an active role in bettering the department's undergraduate curriculum. He also led the department's highly successful ABET review in 2001.

A major event in the early 1990s was the voluntary fission of the Nuclear Engineering Department, due to a lack of students. The Dean assigned the newly homeless faculty to other departments within the College of Engineering. Thomas Jarboe, joined the Aeronautics and Astronautics Department, and was followed later by several other plasma researchers. Their work has emphasized the development of magnetic confinement fusion with an ultimate goal of commercial electricity production. Because of the large scale of the experiments, much of their research is conducted at an industrial site off campus, in Redmond, WA, across Lake Washington. This facility, known as the Redmond Plasma Physics Laboratory (RPPL), has been headed by Alan Hoffman since its inception in 1992. Plasma research oriented toward space propulsion grew out of these efforts later in the decade.

Also in the early 1990's, UWAL went through a financial crisis, when Boeing decided to move its low-speed wind tunnel testing elsewhere in order to achieve higher Reynolds numbers. This left a large income void at a time when the staff was geared toward multiple-shift support. The entire staff was transferred to other departments or chose to retire, as the tunnel's future was in doubt. During 1993-1994 there were only a handful of tests run by students and a temporary, part-time director. A "Last Wind" party was held and it was announced that the tunnel would close its doors forever. However, the Kirsten wind tunnel gained a second wind, and things began to pick up. The doors were kept open and tunnel operations were restructured to be more automated, with a leaner staff. Faculty member Scott Eberhardt led this turnaround. A decade later, UWAL was operating at over 80% customer utilization with a wide variety of users, including Boeing, and continues to attract a steady stream of industrial and academic customers to this day. The role of the wind tunnel as an educational resource cannot be overstated. Generations of students who have worked as members of the student crew have benefited immeasurably from their association with this facility. In addition, students who have taken the senior airplane capstone design sequence since the late '90s, have tested their designs in the wind tunnel, gaining valuable operational experience.

During the second half of the decade several faculty in the department (Juris Vagners, Scott Eberhardt, Eli Livne, and Uy-Loi Ly) began a research initiative in the area of unmanned autonomous vehicles (UAV), in collaboration with Insitu, a small company located in Bingen, WA, and with ARA, an Australian firm. Funding was provided by the Office of Naval Research. To demonstrate the capabilities of small UAV's, the group attempted the first crossing of the North Atlantic Ocean by a UAV in the summer of 1998. Four of the small aircraft were launched from Newfoundland in August. One of them, "Laima," named after a mythological goddess of good fortune, landed safely in Benbecula, a Scottish Island, 26 hours and 45 minutes

* The A&A Department currently accounts for more than half of the coursework offered via EDGE.

after it had taken off. This remarkable feat marked the first transatlantic crossing by a UAV of any size, and did much to expand the department's activities and visibility in the UAV area. Laima was put on permanent display at Seattle's Museum of Flight the following year.

On the education front, as part of an expanded outreach effort, the department in 1997 began to offer a new course, AA101, Introduction to Air and Space Vehicles, aimed at non-engineering freshmen. Using balsa wood gliders, computer flight simulators, and water-bottle rockets, instead of mathematical equations, it introduced students to the rudiments of flight and rocketry, and their history. The class became very popular across the University's entire undergraduate population. Other educational developments included the initiation of curricular and prerequisite changes for undergraduates and the implementation of a design-build-test-fly approach to the teaching of the senior capstone airplane design course sequence. The latter was the brainchild of Eli Livne, and has developed into one of the most sophisticated capstone design courses in the country, giving students an unparalleled hands-on design experience.

In autumn 1998, for the first time in more than 20 years, and at the initiative of newly-appointed department chair Adam Bruckner, the department established an external Visiting Committee and formulated a strategic plan. Part of this plan was to restructure the department along lines that emphasize the systems aspects of aerospace engineering, namely aeronautical systems, space systems, and energy systems. The traditional areas of aerodynamics/fluids, structures, controls, and propulsion, plus plasma science, fell under these "umbrellas." The result was a greater degree of collaboration among the faculty, both within the department and with colleagues throughout the College of Engineering and the University. In addition, the undergraduate curriculum was restructured to require more prerequisites, provide more hands-on laboratory and design experiences, encourage collaborative learning, and expose students to systems concepts.

The New Millenium

At the beginning of the 2000-2001 academic year, there were 19 faculty (including three supported on research), 92 undergraduates, and 82 graduate students. True to form, at the beginning of the decade, the aerospace industry roller coaster began heading downward again, mirroring the downturn in the economy and the aftermath of September 11, 2001. Nonetheless, student demand increased, perhaps because other engineering fields were also relatively soft. The increased enrollment has remained steady, with mild, random fluctuations from year to year. At the time of this writing the department had more than 100 undergraduates (including early admit sophomores) and 125 graduate students.

By 1999, faculty hired in the boom years of the 1960s were rapidly beginning to retire. Over a three year period, the department hired seven replacements, including the first woman, Kristi Morgansen, who was brought in with a Clare Boothe Luce endowed professorship in 2002. On average, the department faculty has not been this young since the go-go years of the space program in the 1960s. One additional young faculty was hired in 2005 and two were hired in 2008, to start in 2009 (one of the latter is a new position, thereby the number of tenure-track faculty positions has increased to 16).[§]

[§] There were also some faculty departures: Mark Campbell went to Cornell University in 2001, Todd Anderson transferred to GE in 2003, Scott Eberhardt took a position at Boeing in 2006, and Rolf Rysdyk left in 2007 for a position at Insitu.

Over the decades, the fraction of women students has slowly increased. The first one was Rose Lunn, who graduated in 1937 at the top of her class and later went on to an illustrious career at North American Aviation.[36] It was typical of the difficulties experienced by many professional women in those days that when Lunn was first hired, she was assigned secretarial duties. It took quite some effort on her part to convince her supervisors that she was capable of a lot more than typing! Until the early 2000s, even with strong recruitment efforts, the fraction of women entering the department did not exceed 15%, about the same as in other aerospace programs nationwide. In autumn 2004 the figure jumped to 25%, a very heartening development, no doubt aided by the fact that the department at last had a woman faculty member. This higher female enrollment figure has remained stable since then.

The new faculty hired in the first decade of the 2000s gradually introduced new courses which added to or replaced other courses in the department's graduate curriculum. To date these new courses have been primarily in the controls area but there have also been course changes in the fluids, structures, and plasma disciplines. Another curricular change has been the revamping of what had been the graduate energy conversion series that had been introduced by Reiner Decher in the early '70s. The first two courses are now devoted to space power systems and spacecraft dynamics and control, respectively. The third course in the series, which was always devoted to advanced space propulsion, continues but is focused entirely on electric propulsion. The undergraduate curriculum saw the reinstatement of a senior-level course on rocket propulsion and, more recently, the introduction of a senior-level course on systems engineering. Additional changes were made at the Junior level. At the time of writing, a new track in the department's MAE degree program had been initiated, namely, the Master of Aerospace Engineering in Composite Materials and Structures (MAE-CMS). Like all of the department's graduate course offerings, the new program is also available entirely via distance learning through EDGE.[*]

Guggenheim Hall Renovation

While engineering tools and technology advanced beyond the imagination of some of the earliest graduates of the department, Guggenheim Hall remained largely unchanged. By modern standards its laboratories had become outmoded and cramped; the classroom, laboratory, and general building infrastructures had become woefully inadequate to meet the demands placed upon them; the building was not accessible to the disabled; and was declared to be in the worst seismic shape of any building on campus.[§] Since the construction of the building in 1929 only a few minor updates to some parts of the building had been carried out.[**] It was thus with great excitement that the department received the news in early summer 2003 that Guggenheim Hall would be completely renovated as part of the University's "Restoring the Core," an effort by the UW to preserve historic buildings on campus. The road to the actual restoration turned out to be a long one, beset by many bureaucratic, political, and budgetary issues. Construction finally started in April 2006 and was completed in August 2007. For the duration of this project, the A&A department and the Applied Mathematics department (which occupied the 4th floor) were moved to Condon Hall, the former home of the UW Law School, located off the main campus,

[*] EDGE: Education at a Distance for Growth and Excellence (see section titled "Holding the Course.")

[§] Interestingly, during the Magnitude 6.8 Nisqually Earthquake of Feb. 28, 2001, Guggenheim Hall suffered the least damage of any building on campus – a water cooler became detached from its wall!

[**] A planned total makeover of the building in 1966 was never executed because the design was rejected by the faculty as being unresponsive to the department's needs.

near University Bridge. The moves out of and then back into Guggenheim were disruptive but everyone managed to "survive" the ordeal in good spirits. It was well worth the inconvenience. Although the Gothic exterior of the building was retained as is, except for a good cleaning and new windows, the interior was completely transformed (except for the stairwells and grand main entrance foyer). The building was brought up to code in all its aspects (including seismic resistance), an elevator was installed and a disability entrance provided, lab and office spaces were vastly improved, and the building's infrastructure was brought up to the latest technological standards.

The effort to restore the building was a public-private partnership. The State Legislature provided 85% of the cost of the remodel, so the University sought the remainder from private sources. Alumni George Jeffs (BS'45, MS '48) and Joe Sutter (BS '43) were the fundraising campaign co-chairs. The fundraising effort, coupled with financial support from the office of the Provost succeeded in restoring some of the aspects of the renovation that had had to be "value-engineered," i.e., cut, including new furnishings. The latter were installed a year after the remodel of the building was completed, necessitating another, though much briefer, relocation of the faculty, staff, and students. Guggenheim Hall is now finally ready to serve the new generations of students who will call the building their home during the 21st Century.

The Department Makes Good

Early on, Boeing made an investment in aeronautics at the University. Over time, that investment began to pay off. In 1926, all but one member of Boeing's engineering department were University of Washington graduates. Even into the 1940s, the majority of Boeing's engineers came from the University. It is no exaggeration to say that the Boeing Company was built by University of Washington graduates. Almost every Boeing airplane project has had a University of Washington Aeronautics alum at the helm. Any history of the Boeing Company includes names of alumni such as Maynard Pennell ('31), George Martin ('31), George Snyder ('31), Jack Steiner ('40), William Hamilton ('41, M.S. '48), Joseph Sutter ('43), and Lynn Olason ('43).[36]

Boeing is not the only place where Aeronautics alumni made an impact. Scott Crossfield ('49, M.S. '50) was the first man to successfully break Mach 2, and was heavily involved in the design and testing of the X-15. George Jeffs ('45) headed Rockwell's Apollo and Shuttle programs, and George Solomon ('49) became Executive Vice President of TRW. Robert Hage ('39) is best known as the co-author of the classic text, *Airplane Performance, Stability, and Control*. Dale Myers ('43) served as NASA Associate Administrator with responsibility for the Apollo, Skylab and Shuttle programs. Moustafa Chahine ('56) was Chief Scientist at Caltech's Jet Propulsion Laboratory for many years. Suzanna Darcy-Hennemann was the first woman test pilot at Boeing, and became one of the leading pilots in the 777 flight-test program; recently, she was named director of Boeing's entire flight-test program. Numerous other Distinguished Alumni of the department who had major impacts in the field of aerospace engineering are listed in Ref. 36. On the less technical side, Gregory "Pappy" Boyington ('34), leader of the famed Black Sheep Squadron during WW II, also earned an engineering degree from the Department.

Since 1978, three Aeronautics alumni, Jack Steiner, George Jeffs, and Joe Sutter, have been selected by the University of Washington as *Alumnus Summa Laude Dignatus*, the

University of Washington's highest honor bestowed on its alumni.[37] Very few departments at the University can boast of this many alumni of such distinction.

Fig. 15 Some distinguished University of Washington Aeronautics alumni. Left to right: Jack Steiner, George Jeffs, Joe Sutter, Scott Crossfield.

It is clear that the Department of Aeronautics & Astronautics has trained a host of outstanding aerospace leaders over the past eight decades. The Department will produce even more legendary engineers now that the educational and research spaces in Guggenheim Hall have been brought into the 21st Century.

Summary

In the next decade the University of Washington will celebrate 100 years of instruction in aeronautics. This paper is a step in preparation to commemorate that event. It represents a snap-shot of an on-going effort to document the history of the Department of Aeronautics and Astronuatics, through oral histories, media clippings and other historical documents.

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NOTE: All photos without credits are the property of the Department of Aeronautics & Astronautics

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