

# A History of the University of Washington Department of Aeronautics and Astronautics 1917-2003

J. Lee,<sup>\*</sup> D.S. Eberhardt,<sup>†</sup> R.E. Breidenthal,<sup>‡</sup> and A.P. Bruckner<sup>§</sup>

Department of Aeronautics & Astronautics  
University of Washington, Box 352400  
Seattle, WA 98195-2400

## 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.

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.<sup>1</sup> This location is now occupied by Boeing Field, otherwise known as King County Airport. 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.<sup>2</sup> 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



**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.

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<sup>\*</sup> Graduate Student

<sup>†</sup> Associate Professor

<sup>‡</sup> Professor

<sup>§</sup> Professor, Department Chair

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.<sup>3</sup>

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.<sup>4</sup>

Design and construction of the new wind tunnel started in 1917, supervised by Assistant Professor John W. Miller, then of the Civil Engineering department. 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.<sup>5</sup> Miller later became the first person to take an aerial photograph of the University of Washington campus.<sup>6</sup>

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 aviation-related course offered at the University.<sup>4</sup> 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.<sup>6</sup>



**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. Per Boeing's specifications, McKone organized classes in basic aviation, aircraft design, aerial propulsion, and wind tunnel testing.<sup>7</sup> He taught these classes for just one year before leaving the University.<sup>6</sup>

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 seems to have lost interest in work at Boeing. 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.<sup>4,6</sup>

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.<sup>8</sup> At the encouragement of a friend, he began studying electrical engineering at the University of Washington, graduating *magna cum laude* in 1909.<sup>4</sup> 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 cycloidal propeller, which Kirsten spent over 20 years trying to perfect 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.<sup>3</sup> 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<sup>9</sup> 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,"<sup>10</sup> 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.<sup>11</sup>

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."<sup>12</sup> 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.

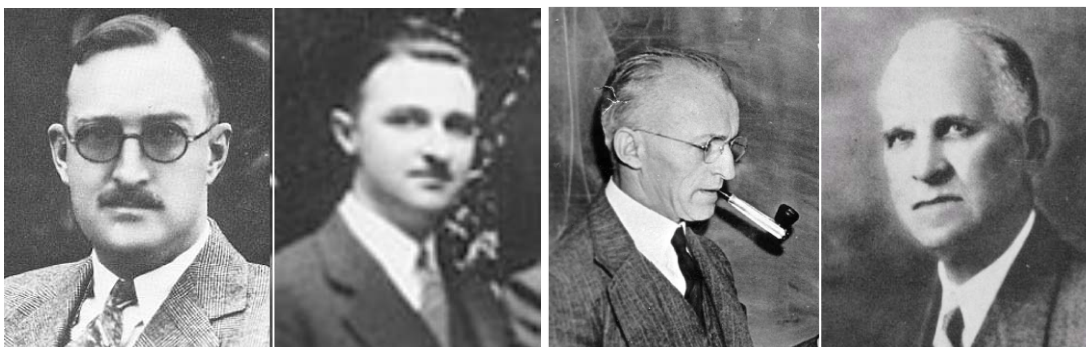
## Founding a Department

Kirsten began teaching aeronautics courses at the beginning of the 1921-1922 academic year. He undoubtedly gave the courses a face-lift, but they basically remained the same as when Miller had taught them. Over the next four years very few changes would be made.

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.<sup>13</sup> 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.<sup>4</sup>

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.<sup>13</sup> Construction began soon thereafter.<sup>14</sup>

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, who had been serving as the secretary of the Guggenheim Fund board of trustees, 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.<sup>6</sup> In July 1929, Professor Everett O. Eastwood was named the head of the department, thus marking its official beginning.<sup>15</sup> The building was completed in the spring of the following year.<sup>16</sup>



**Fig. 3 The Department's Founding Fathers. Left to Right: Bill 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 seems to have originally been one of expedience. He was a competent administrator, and a good organizer; just the kind of person to get the new department up and running, but really nothing more. Eastwood never showed any particular interest in flight, either professionally or personally.<sup>13</sup> 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.<sup>17</sup> 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.

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.”<sup>18</sup> The building included room for six small instructional wind tunnels in the basement, only one of which was ever built. It is known as the Venturi Tunnel and is still in operation. 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. 4 Guggenheim Hall in 1931.**  
(CF Todd Coll., PNW Coll. UW #14680)



**Fig. 5 Fred Eastman**

Everybody wanted a piece of the new building. In addition to being the home of Aeronautical Engineering, the Civil and Electrical Engineering departments, the College of Engineering Administration, and the Engineering Library were also housed in Guggenheim Hall.<sup>19</sup>

The early 1930’s 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 Aeronautical Engineering degrees; in 1931 there were 11 graduates and by 1933 this number had jumped to 28. However, the Depression took

\* Fred Eastman served the department until his retirement in 1970. He was Chair from 1946 to 1952. On February 10, 2003, he celebrated his 99<sup>th</sup> birthday.

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.<sup>13</sup>

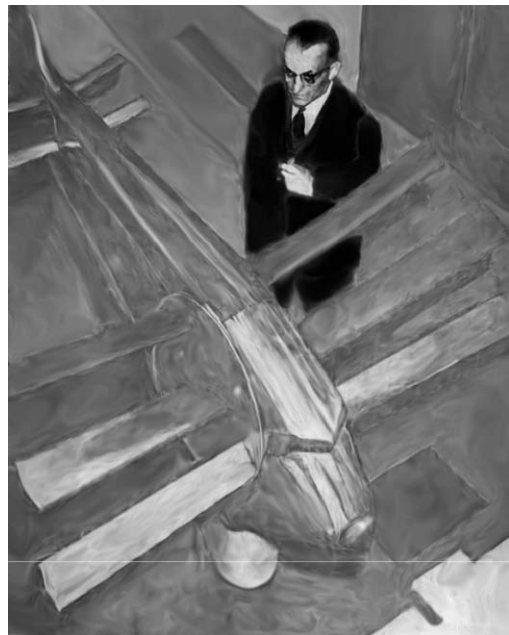
## The Wind Tunnel Years

The years from the mid-1930's 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.

During the early 1930's, 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.<sup>20</sup>

The proposal, "An Aerodynamic 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.<sup>20</sup>

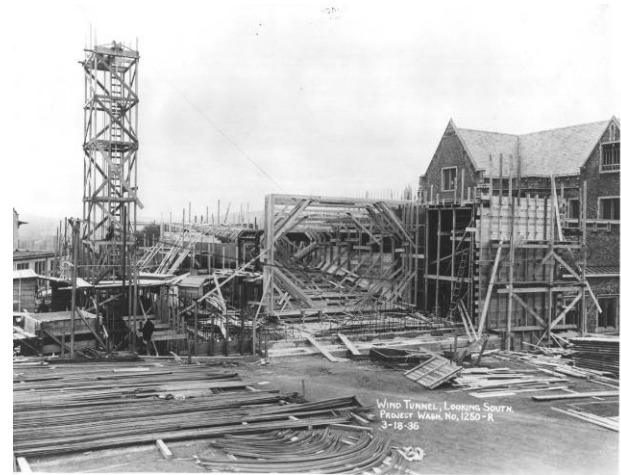
It is interesting to review some of the salient points made in the proposal. One was a barb aimed at GALCIT's high cost to other universities and its essentially holding a monopoly for testing on the west coast. Another was the training of students and staff for research. The wind tunnel would "allow 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.



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

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.<sup>10</sup>

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.<sup>21</sup> 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.<sup>21</sup>



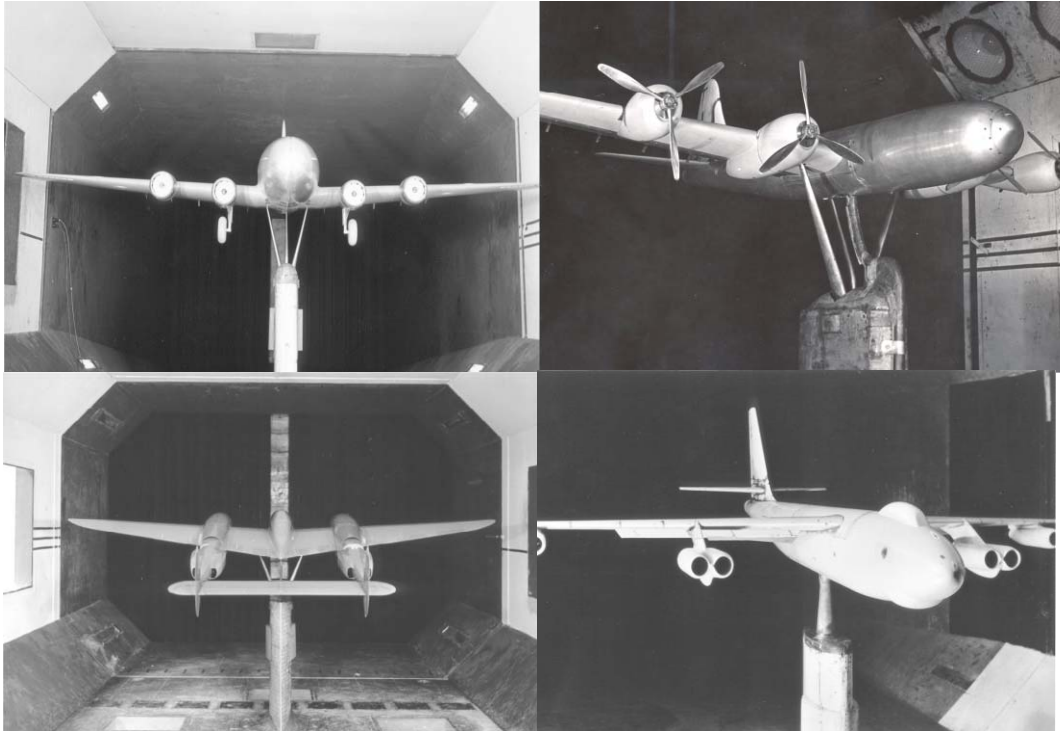
**Fig. 7 The Kirsten Wind Tunnel under construction, March 1936.**

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 tests 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.<sup>21</sup> 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.<sup>22</sup> 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 P-38.**

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.

## 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.<sup>23</sup> 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, with E.O. Eastwood in charge.

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 1950’s. The Ph.D. degree was offered for the first time during the 1959-1960 academic year. Eight students entered this new program that year.

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 1940’s 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 1940’s.<sup>24</sup>

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 2<sup>nd</sup> edition of the well-known book *Low Speed Wind Tunnel Testing*, and was a founding member of the Subsonic Aerodynamic Testing Association (SATA).<sup>25</sup>

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 1980’s. Today, the course still exists, but an airplane is leased. From 1953 to 1957 Ganzer served as department head.



Fig. 9 Robert A. Joppa Fig. 10 Victor Ganzer

## Finite Elements

During the 1950's 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-1950's two senior structural engineers at Boeing, M.J. Turner and L.J. Topp; a visiting professor from Berkeley, R.W. Clough; and Harold C. Martin, from the UW Aeronautical 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*.<sup>26</sup>

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.



Fig. 11 Harold C. Martin

## 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 33 years old.

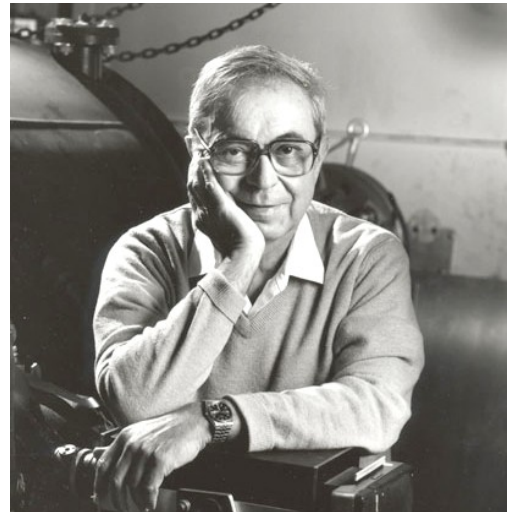


Fig. 12 John H. Bollard

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 Goldberg, of the AVCO Everett Research Laboratory (Goldberg 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 Ludwig 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.<sup>27</sup> This seminal paper established the firm foundations of the fusion program at ARL, which continues to this day.

## **Bust and Recovery**

As the 1960's 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.

John Bollard stepped down as department Chair in 1976, and was replaced by Ellis Dill, who nine months 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.<sup>28</sup> On the flight of the Shuttle Columbia from California to Cape Kennedy, 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 '80's and '90's, 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.

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 1980's, 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 department, 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).

A major event in the early 1990's 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 towards 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. A decade later, UWAL is operating at over 80% customer utilization with a wide variety of customers, including Boeing.

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 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.

In autumn 1998, for the first time in more than 20 years, 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.

By 1999, faculty hired in the boom years of the 1960’s 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. On average, the department faculty has not been this young since the go-go years of the space program in the 1960’s.



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.<sup>29</sup> It is 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! Even with strong recruitment efforts, the fraction of undergraduates in the department who are women is still only about 15%, roughly the same as in other aerospace programs nationwide.

## 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 1940's, 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).<sup>29</sup>

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. 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.<sup>30</sup> 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.

## Acknowledgements

The authors are deeply indebted to their colleague, David A. Russell, for his very helpful suggestions on the manuscript.

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