

THE FIRST FIFTY YEARS  
(A Fragmentary, Anecdotal History)  
Department of Aeronautical and Astronautical Engineering  
The University of Michigan

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Aeronautical engineering as an academic program culminating with a bachelor's degree had its start in this country at The University of Michigan. But before this start could be made, the keen interest in aviation that had found its stimulus and focus in the Wright Brothers' pioneer flight in 1903 had to be transformed from a largely avocational, amateur, sporting interest into something professional, scientific and academic. In Ann Arbor it was largely through the efforts of two men - Herbert Sadler and Felix Pawlowski - that this inevitable yet significant transformation was accomplished.

Both men were intimately involved with pioneers in the history of flight. Sadler's great granduncle, James Sadler (1751-1828) of Oxford was the first English balloonist. Hodgson's History of Aeronautics in Great Britain devotes a chapter to the Sadler Family. During Herbert Sadler's early teaching career at the University of Glasgow one of his colleagues was Percy S. Pilcher, a follower of Lilienthal and the pioneer of gliding in Britain.

Professor Sadler maintained an interest in flying when he moved to the U. S. and became chairman of The University of Michigan's Department of Naval Architecture and Marine Engineering. In 1911 after attending the first International Aviation Meeting at Boston where he watched the Wright brothers, Glenn Curtiss, Louis Bleriot, Graham White and others in races and exhibition flights, he returned to Ann Arbor and re-organized the moribund University of Michigan Aero Club. With his help the students built and operated the two pieces of equipment basic to a study of aeronautical engineering: a wind tunnel and an airplane. The tunnel, which was in one of the naval architecture lofts in the West Engineering Building, was quite small. The airplane, which was patterned after the Wrights' bi-plane, is perhaps more accurately described as a cross between a kite and a glider. It possessed rudimentary controls and the necessary strength to carry a pilot to manipulate them. Professor Sadler had sought Wilbur Wright's advice in behalf of the Aero

Club. Wright wrote him: "If you will advise them to build a glider and to fly it, do not let them build it too light."

The Club did its flying in the hills surrounding Ann Arbor. Because their knowledge of flying was largely empirical, they relied heavily on the pilot's instincts and courage. Lacking both the theoretical and empirical means of coping with lateral stability by means of pilot-operated controls, they very sensibly attached ropes to the wing tips and assigned club members to hang onto them and run along under the glider to keep it laterally stable. Occasionally they were hoisted off the ground by a gust of wind or the pilot's erratic use of the elevator control.

The student interest in aeronautics Sadler had encouraged and guided was entirely extra-curricular when Felix Pawlowski was hired as a Teaching Assistant in Mechanical Engineering in 1913. Like Sadler, Pawlowski had seen the Wright brothers fly. While doing graduate work in Mechanical Engineering at the University of Paris in 1908, Pawlowski had journeyed to LeMans to witness one of the Wrights' first flying exhibitions on the continent. The thirty-four year old Pawlowski was so stirred by the experience that he decided to become an aeronautical engineer. He planned to enroll in the world's first flying school, which the Wrights set up at the foot of the Pyrenees in the town of Pau, France. But when he learned of the great cost of the lessons - the school was designed not for graduate students but wealthy French sportsmen - Pawlowski returned to the University of Paris and in 1910 taught himself to fly in the fields outside the city. He learned in a monoplane similar to the one that Bleriot had flown across the English Channel the previous summer.

Pawlowski's plan to become an aeronautical engineer was brought nearer fulfillment when Professor Lucien Marchis offered at the University of Paris what was probably the first course in aeronautics. In 1911 Felix Pawlowski, pilot and possessor of the certificat d'etude of the University of Paris arrived in the U. S. in pursuit of his dream to be an aeronautical engineer. His efforts to obtain work at the Wrights' factory in Dayton were unsuccessful, so he decided to apply for a post as a professor of aeronautical engineering. He wrote eighteen colleges and universities most of which did not even reply to his fantastic proposal. Among the very few that did were M.I.T. and The University of Michigan. Only Michigan offered him a job. Dean Mortimer Cooley offered Pawlowski an \$800-a-year appointment as Teaching Assistant in Mechanical Engineering with the promise that he would be permitted to teach a course in aeronautical engineering. The aero course was not to be offered for a year or so and it was to be a non-credit course, but Pawlowski was tempted

enough by the offer to give up his job as a truck designer in Toledo, Ohio - a job which probably paid a good deal more than the assistantship and to move to Ann Arbor.

Although Pavvi taught no aero courses in the fall of 1913, he put to good use his knowledge of the practice and theory of flight. He took over from Sadler the role of faculty advisor to the Aero Club, helping the students construct and fly another and larger bi-plane glider, and offering them non-credit instruction in the principles of aerodynamics and aviation. Interest in aeronautical engineering was further stimulated in the fall of 1913 by a series of lectures delivered in Ann Arbor by Pavvi's professor from the University of Paris, Lucien Marchis. Although his topic was practical applications of physics, which included lectures on subjects other than aeronautics, the appearance of this world-famous authority on an American campus strengthened the increasing academic respectability of aeronautical engineering in this country.

It is no coincidence that the men who did the most to establish the idea in Ann Arbor that aeronautical engineering was a suitable field for university instruction and research - Sadler, Pawlowski and Marchis - were from Britain and the Continent. For the French, Russians, Italians, British and Germans had by 1910 long recognized the value of applying science to the problems of aeronautics and were engaged in aeronautical research at universities - as in Prandtl's laboratory at Gottingen - at military installations - as at Chalais - Meudon, the French army aero lab, at government installations - Alderhof in Germany - and at numerous private laboratories, Riabduchinski's in Koutchino, Russia, and those of such English scientists as Cayley, Wenham, and Phillips. During this same period the U. S. was dependent largely upon the efforts of a host of amateur inventors who approached the problem empirically and with limited means but great ingenuity. This situation is somewhat reflected in the number of military aircraft possessed by each of the leading powers at the outbreak of World War I in 1914 (France - 1,400; Germany - 1,000; Russia - 800; Great Britain - 400; and the U. S. - 23.) But perhaps it is more accurately reflected in the fact that the stimulus and model for university instruction and research not merely in aeronautical engineering but through the entire range of the physical and medical sciences came, to a large extent, from abroad.

In the years after 1910 the rapid rise in American interest in aeronautics happily coincided with Pavvi's increased command of English. As a result, early in 1914 Dean Cooley approved of the introduction into the curriculum of the first credit courses in aeronautical engineering. The two-hour course, Theory of Aviation, was offered in 1914-15. Taught by Pavvi, it dealt with the principles

of aerodynamics and the mechanics of flight. Seven students enrolled: D. M. Bavly, M. L. Goldstein, K. W. Heinrich, A. Horbaszewski, Yocham Hu, F. E. Loudy, and Chien Hsun Sung, four of the seven from overseas. Loudy was later to earn a special place in the history of engineering education as the holder of the first Bachelor of Science degree awarded in aeronautical engineering. But when Dean Cooley approved that first course, aeronautical engineering was far from being solidly established. As Cooley explained it in his autobiography, *Scientific Blacksmith*: "I hid this course in the Department of Marine Engineering and Naval Architecture for a time, for aeronautical engineering was not considered important enough to make it conspicuous..." However, under Sadler's care - and with Dean Cooley's cooperation - a separate department evolved. But before this was to occur, Pavvi's two-hour course needed to be supplemented ... and so did he.

The process by which one two-hour course taught by one man slowly expanded into an array of courses taught by a staff is neatly summarized by Professor Emerson W. Conlon's history of the department in *The University Encyclopedic Survey* (1954):

"The regular courses in aeronautical engineering, leading to a professional degree, were organized as a group of electives in the Department of Naval Architecture and Marine Engineering. Only junior and senior engineering students were eligible. The Curriculum was much like that for naval architecture and marine engineering students and was similar also to the course in mechanical engineering. The aeronautical subjects were added partly at the expense of the electives.

The first course, *Theory of Aviation* dealt with the principles of aerodynamics and the mechanics of flight...

In 1915-16 two new courses in aeronautics were added, *Propulsion of Aeroplanes*, which dealt with propeller design and the principal features of the various types of motors, and *Aeroplane Design*, which consisted of lectures and drawing room work. The details of the actual construction of an airplane were discussed, and a design was made to fulfill a given set of conditions. Sixteen students were enrolled in the three courses during the year.

In 1916-17 a complete four-year program of study leading to the bachelor's degree in aeronautical engineering was arranged. The department was included in the then renamed Department of Naval Architecture, Marine Engineering and Aeronautics. Pawlowski, as Assistant Professor of Mechanical Engineering,

still taught certain courses in mechanical engineering. During this year the following aeronautical courses were offered: General Aeronautics, Theory of Aviation, Theory and Design of Propellers, Aeroplane Design, Aeronautical Laboratory, Design of Aeronautical Motors, Theory of Balloons and Dirigibles, Theory and Design of Kites, Design of Aerodromes and Hangars, Advanced Stability, Aeronautics - Advanced Reading and Seminar, Aeronautics - Advanced Design, and Aeronautics - Advanced Research. General Aeronautics was added as an introductory course dealing with the fundamentals underlying the design and performance of both the lighter-and the heavier-than-air craft.

Of the fourteen courses proposed and listed, only the first six were required as a minimum qualifying the student for the degree in aeronautical engineering; the remainder was offered as electives in accordance with the needs of the senior and graduate students. During the first semester General Aeronautics was taught by Sadler, and Theory and Design of Propellers, Pawlowski offered Aeroplane Design, Advanced Reading and Seminar, and Advanced Aeroplane Design.

During the second semester the following courses were reoffered: General Aeronautics (Sadler), Theory of Aviation (Gerhardt), Aerodynamic Laboratory (Sadler), and Design of Aeronautical Motors (Fishleigh)."

In spite of the gradual expansion of the aero teaching staff, no one eclipsed Pavvi as a colorful campus figure. Of the several generations of faculty and students who encountered him in his long career with the University (1913-46), probably most of them have at least one favorite Pawlowski anecdote. Milton J. Thompson ('25e [Ae. E.]), who joined the department in 1930 and who is now with the University of Texas, recalled that Pavvi was an exotic, continental figure on the somewhat provincial Ann Arbor campus of the '30's.

"From time to time," Professor Thompson recently recalled, "Pavvi would sport a moustache and goatee in true continental style, but on numerous occasions, it would suddenly disappear for a while without explanation. But two seemingly permanent Pawlowski trademarks were his wing collars and his cane. The cane was quite a lethal weapon, consisting of a central steel bar of about one-half inch diameter. On the bar was stacked a series of leather washers, with the exterior edges smoothed and highly polished. Pavvi's most characteristic walk was with his hands clasped behind him, holding his cane as a sort of tail structure, as he moved across campus with short, quick steps suited to his rather portly figure."

Pavvi was no less memorable in his car. Milford Vanik ('20e [Ae. E.]), himself a daring and colorful balloonist, recalls seeing Pavvi on hot summer days in the mid-1930's chugging down East University in his high-off-the-ground Model T bound for a swim at Barton Dam. His precisely trimmed moustache and goatee and his long, elegant cigarette holder combined incongruously with his bright red one-piece bathing suit.

Mil also recalled that Pavvi's smoking provided the basis for his unorthodox filing system. "It was organized bedlam. His file cabinets were hopelessly filled, so his main filing was done in the open. Stacks and stacks of American and European newspapers, magazines, journals and books; bluebooks, drawings, letters from all over the world, newspaper clippings, reports, notes, bills, advertisements, pamphlets. They were piled on his desk, drafting table, windowsills, chairs, and any other supporting surface.

Pavvi smoked cigarettes in quantity. Chesterfields in the 50 pack-flat tins - about three tins a week. Whenever he finished a tin, it was placed on top of his current stack of papers; then more papers, books, letters, etc., followed in order.

What appeared to be a disorderly mare's nest, was actually a filing system - crude, but effective. When Pavvi needed a particular bluebook French aviation journal, or unpaid bill, he would recall the approximate time-lapse since he had filed it. Then, he would count down the requisite number of empty Chesterfield tins that served as chronological separators. After riffling through a few documents, he would invariably come up with the item he wanted. "

But Pavvi was more than a colorful, eccentric local character. He also enjoyed a national reputation as an aeronautical engineer. For example, in early 1917 with American entry in World War I imminent, the U. S. Army sought two aeronautical engineers. (It was at this time that Thomas Edison had suggested that a board of scientists appointed by the President to assist the war effort might include one mathematician "in case," as Edison put it, "We want to calculate something out.") To his considerable credit, Pavvi was one of those selected. He returned to the campus later that year when it was decided in Washington that the U. S. could best help the Allied war effort not by designing new aircraft but by manufacturing aircraft of European design that had already proved combat worthy. So Pavvi turned to teaching the principles of flight to undergraduates who sought in this way to get into the Air Corps as soon as they were drafted.

During the war and for several years afterward, Michigan, which had pioneered in the U. S. in offering instruction and research in aeronautics, had a faculty consisting of one full-time man: Felix Pawlowski. Finally, in 1921 Pavvi was given a full-time colleague to relieve him of part of his teaching load and free him for research. Edward A. Stalker ('19e [Ae. E.], M. S. E. '23), who at the time he was hired had two years' experience in airplane design with the Stout Engineering Laboratories, Dearborn, Michigan, was appointed Instructor in Aeronautical Engineering. In 1930 when the Aeronautical Engineering Department was established as a separate organization from Marine Engineering, Professor Stalker was named the first chairman, a post he held until he resigned during World War II to enter industry.

There is no more colorful, adventurous chapter in the history of aeronautical engineering at Michigan than the one recounting student efforts to fly - in gliders, balloons, and primitive airplanes. It begins early in the century with the construction of copies of the Wright gliders, which were succeeded by a model "B" hydroplane build by the Wrights in 1912 and donated in 1915 to the Aero Club by two wealthy Detroiters, Russell and Frederick Alger. During a trial flight from Barton Pond, shortly after the club had gotten it, the hydroplane crashed and was ruined - although the student pilot escaped unharmed. Then in the mid-twenties, student interest in ballooning became keen. Michigan aero students - and the Aero Club - acquired balloons and distinguished themselves in American and international competition.

The first free balloon flight by Michigan aeronautical students took place in 1926. The following vivid account of the preparation of the balloon - "Michigan No. 1" - and of its first flight was written by Professor Milton J. Thompson, a crew member on the maiden flight.

In 1925 it was discovered that some time previously the University had been given a balloon by a group called the Michigan Aero Society. While it was in storage in the mold loft of the West Engineering Building, scavengers made off with the high-grade manila rope that formed the lower part of the net. And with the passage of time, the oiled silk bag had become torn and deteriorated. A student group heard about the balloon and initiated a strenuous program of net repair, as well as the patching of the many tears in the oiled silk gasbag. The students involved were V. Blakeman Qua ('25e[Ae. E.]); Herbert G. Winter ('26e [Ae. E.]), and myself. George H. Hineman ('27e [Ae. E.]) also participated in the preflight activities. Work continued through the winter at a somewhat reduced pace, and advantage was taken of this breather period to take steps to finance the proposed flight.

At this time, The University of Michigan Aero Society carried on extra-curricular activities in aviation, but there was no national professional society with which a student group might affiliate. A 'Balloon Division' of the Aero Club was organized with memberships available at around \$10 or \$15 apiece. The 'bait' offered was that each student who signed up would be eligible for a later balloon flight, after the pioneering group had had their turn.

Early in May 1926, the balloon was finally ready, the weather was perfect, and sufficient funds were in hand to pay for the coal gas to be used for inflation. The inflation operation took place in a cleared area in north Detroit, adjacent to a gas line running between the River Rouge and Highland Park plants of the Ford Motor Company. The pilot for this flight was Ralph Upson, who had won the Gordon Bennett Trophy in France in 1914, while the crew consisted of Qua, Winter and Thompson.

Inflation began on a Saturday afternoon with lift-off originally scheduled for sometime after sundown, in order to minimize gas losses from expansion due to solar heating. The bag leaked quite badly, once a slight pressure was applied to its interior, apparently due to partial deterioration of the oil with which the fabric of the bag was impregnated. The situation became worse after nightfall and the entire night was spent in periodically feeding gas into the bag to compensate for the leakage losses. Thus the feeling began to develop that the flight might have to be abandoned. Sunrise brought new encouragement, however, in that the sun's heat softened the oil sufficiently to reduce the leakage to a point where Upson considered it safe to proceed.

After lift-off at about 6:30 Sunday morning, the balloon was allowed to rise to an altitude of about 2,500 feet, where prevailing winds carried it westward and directly over Ann Arbor. At a point near Grass Lake, between Ann Arbor and Jackson, additional ballast was jettisoned, permitting the ship to rise to about 6,500 feet. Here the wind carried 'Michigan No. 1' south across the state line into Ohio to the small town of Bryan, slightly west of Toledo. After being aloft six hours and traveling about 100 miles, Pilot Upson prepared to land. He selected an open field located on the leeward side of a clump of trees so the balloon would be protected from ground winds. The rate of descent was slightly greater than it should have been, so the basket started to brush through the treetops. And the crew began heaving overboard the remaining ballast and anything else available, including a fur-lined flying suit Qua had brought with him from McCook Field. When the balloon finally came to rest on the ground,



a farmer ran up to the crew and asked worriedly, 'Who fell out back there in the trees?'

Lindbergh's trans-atlantic flight in 1927 was a dramatic triumph for the airplane - but the balloonists were not particularly impressed. In spite of the stench of coal gas, the complications of rotting fabric and inadequate funds, the risk of being shot at by farmers, struck by lightning, caught in trees, drowned, frozen to death, or lost in the wilds of northern Ontario, they persisted. Their persistence is superbly illustrated by the efforts of Mil Yanik and George Hineman to enter the 1930 National Balloon Race and capture the \$1000 first prize.

“First of all,” Vanik recalls, "we needed a sponsor so we could buy a balloon. After months of effort, an angel was located. A national moving-van firm needed advertising and agreed to sponsor the entry for \$850. Hineman bought an old fabric-racing balloon - sight unseen - for \$500 and we went to Houston, Texas, and entered the race. The day before the race, as we unrolled the balloon we saw the seams split from old age. The race committee was distraught also, and helped us obtain the loan of a spare Army balloon to fly the race. On race day, the Army balloon was inflated and the sponsor's advertising banner hung from it. Two hours before takeoff time, General Frank Lahm, Chief of the Army Air Corps, appeared at the race as a spectator, saw the advertising banner on the Army balloon, and rescinded the loan of the bag. Result, no balloon, an unfulfilled contract, \$850 already spent, and no money to repay.

Capt. Honeywell, a veteran balloonist took pity on us. He offered to withdraw from the race and sell his balloon for \$800. One hour before race takeoff, a promissory note was signed, the sponsor's banner hung, and the Hineman-Yanik team took off on time.

The race was an epoch. Of the 19 entries, eleven were forced down by storms. We went to 23,000 feet (without oxygen) over Texas, were shot at by farmers at 1,000 feet over Arkansas, and landed in the mountains of Kentucky after flying two days and two nights. We traveled 685 miles and 44 hours. (Four hours short of the world endurance record.) The result of the race was in doubt for four weeks. It was finally determined that we missed second place by mile, so we were awarded third place and \$500 prize money.

The sponsors were delighted. They agreed to sponsor us again in the Gordon Bennett International Race from Cleveland as a non-contestant pilot balloon, since we had failed to win a place on the official U. S. team. In that race the Hineman-Vanik crew flew from Cleveland, Ohio to Vermont, and outdistanced all of the world's best balloonists except the winner, W. T. VanOrman.

The two-races provided us with enough income to payoff the Honeywell note, become solvent, and become possessors of a good racing balloon.

In the years following, Hineman-Vanik flew the 1934 National Race from Birmingham, Alabama, taking third place, the 1934 Gordon Bennett International from Warsaw, Poland, to Gdov, USSR, 180 miles east of Leningrad, and several regional U. S. races."

But Vanik's most memorable flight started as a routine balloon trip from Cleveland to Ann Arbor to attend the Michigan-Minnesota football game. He left Cleveland at 11 p. m. on the Friday before Thanksgiving, 1931, in the balloon he and Hineman had bought in Houston. But the 80,000 cubic foot bag got caught in a violent snow and sleet storm over Lake Erie. The rigging iced up, forcing him down toward the water; warmer air at the lower altitudes melted the ice and he rose again. This went on all night.

At daybreak all he could see was water. Chilled, hungry, and lost, Vanik drifted northeast over Lake Huron and Georgian Bay. After he had spent 18 hours driven by sleet, blizzards, and harsh November winds, Vanik sighted a shoreline. By now he had lost a great deal of gas by diffusion and had to land. Even though the shore was soon obscured by falling snow, Yanik pulled his rip panel and dropped quickly toward earth. He landed in fire-charred, desolate woods through which he walked for two days in search of a house. At the end of the third day of stumbling through the brush, he came upon a farmhouse. From the farmer he learned he was in northwest Ontario, 70 miles north of Michigan.

"As far as I know," Vanik said recently, "the balloon is still there, hanging in the trees. Incidentally, I have found there are better ways of going to football games. "\_

Although gliding was perhaps less spectacular than ballooning, it involved more University of Michigan Aeronautical students and was carried on over a longer period of time than ballooning. The first Glider Club was founded in 1904; another was organized in 1912, but neither lasted over a year. Aero students

took up gliding in earnest in 1928 with the founding of a glider section of the University of Michigan Aeronautical Society. This organization - which changed its name in 1932 to University of Michigan Glider Club - lasted until the early years of World War II. Its members crashed their first glider shortly after acquiring it in 1929, destroyed several others, and also inflicted all kinds of lesser damage on a series of gliders. They also lost one of their members in a fatal accident. But during the fifteen years of its existence, the Glider Club introduced scores of aeronautical engineering students to the indispensable experience of flying an aircraft.

Hans Weichsel ('43e [Ae. E.]), now a Bell Helicopter Vice-President, gives us this vignette of Glider Club activities in the thirties.

"We would meet under the clock in the old Engineering Building, pile into the Club's bright red Dodge truck and drive to the Ann Arbor Airport. Assembling our Franklin glider involved little more than securing the wings--wooden spars, fabric covered and strut braced - to the welded steel tubing fuselage. To start with, students one at a time would be placed in the cockpit - which was open and had no windshield--and taught how to balance the glider. With a 10-15 mile an hour wind, a student was soon able to master the controls and balance the ship fore and aft as well as laterally on the single-wheel landing gear. Next came ground tows with the rudder pedals being used to keep the glider behind the tow truck. Before long, the student was going up 50 to 100 feet, cutting loose and gliding straight ahead for a landing. Finally, 180-degree turns, and then the ultimate: tow to 200-300 feet in altitude, do a 370-degree circuit of the airport and land at the take-off spot.

Besides the useful practical experience gliding gave us, there were thrills, too. There was, for example, the excitement of the steep climb out, the wire break and the anxious moments when the student got the nose of the glider down to pick up enough air speed to make a safe landing.

Like the balloonists, the gliding enthusiasts competed in national meets at Elmira, New York, and at the Sleeping Bear dunes, near Frankfort, Michigan. And like the balloonists, many of them later distinguished themselves as pilots, for example: John Rinek became a Pratt & Whitney test pilot; John Reeder became chief test pilot for NACA - later to become NASA; and Scott Royce became a colonel in the Air Force.

But, just as the gliders superseded the balloons, small airplanes grounded the gliders with the onset of World War II. In 1939 the government initiated the

Civilian Pilot Training Program, and a 65 hp. Taylorcraft, a Luscombe, and then a Piper Coupe powered by a Franklin engine - all belonging to the University of Michigan Flying Club - lured the students away from the Franklin gliders of the Gliding Club which became inactive in 1943.

Although aero students in the 1920's and 1930's spent many memorable hours flying balloons, gliders and small, single-engine airplanes, they devoted a good many more hours to work and study in classrooms and laboratories for it was during these two decades that the department gradually acquired the necessary equipment to conduct instruction and research in aeronautical engineering. Again, Pawlowski played a prominent role. Aeronautical engineering moved from West Engineering to the East Engineering Building, which included plans for a wind tunnel. Pavvi visited Europe in 1924 to study the development of aeronautics there and to obtain information useful in the design and installation of the new wind tunnel.

While Pavvi was in Europe, W. F. Gerhardt, who received one of the first bachelor's degrees in aeronautical engineering granted by Michigan and Michigan's first master's and doctor's degrees, returned to the University from his engineering position at the McCook Field research and development center of the Air Corps at Dayton, Ohio. Fred taught design and helped initiate a number of the more advanced students in applied research. His "Venetian Blind" multi-plane aircraft, for example, did reach the state of being an experimental vehicle at McCook Field, where it managed to get off the ground before it quickly collapsed into a heap of wings, struts, and guy wires that looked like a venetian blind dropped from a five-story window.

During this period, Ed Stalker came up with the idea of installing an airfoil model and balance system on the front end of an automobile. This scheme was particularly suited to a series of thick airfoils in which Stalker was interested at this time. An old Dodge Brothers passenger car was secured and a weird arrangement of supporting struts and the model was installed. Stalker, assisted by Milton Thompson, then a graduate student, would make test runs on a fairly extensive section of highway near Ypsilanti where several miles of straight, flat road was available. Tests had to be conducted shortly after dawn before surface winds of significant magnitude developed after sunrise. The gusts associated with these winds made accurate testing impossible.

In 1930 after considerable delay the subsonic wind tunnel was completed under the direction of John D. Akerman ('25e [Ae. E.]). The concrete construction of the return ducts was poured as an integral part of the building, but the main

central duct, the fan installation and the model balance system were installed under Akerman's direction was appointed to this position. Professor Kerber wrote with Gerhardt the Manual of Flight Test Procedure and his interest in this area led to his later association with CAA.

The period from 1927 through 1930, beginning with the Lindbergh transatlantic flight, was one of intensive development in the field of what is now classified as personal aircraft. These were the small vehicles carrying two to six or eight passengers and in most cases cruising less than 200 miles per hour. Because of the great increase in the number of new designs being proposed, action was taken by the Congress to establish the Civil Aeronautics Administration, then an adjunct of the Department of Commerce. In addition to assisting in the development of commercial aviation, by developing airports and airways, the CAA was also assigned the responsibility of checking new designs, testing prototype vehicles, and finally granting licenses to the manufacturer. The so-called 'Approved Type Certificate' was granted on the basis of demonstrated structural integrity and reliability in performance.

During his leave of absence in 1929, Professor Kerber was instrumental in establishing the initial set of requirements for these procedures. He later severed his connection with the University and remained with the CAA for a period of several years. Professor Kerber may well have blazed the trail for the numerous Michigan graduates who were attracted to the government civil aviation service. They outnumbered by far those from other schools. It is probably not inaccurate to say that there have been more Michigan aeronautical graduates in the Bureau of Air Commerce and its successor organizations, than graduates from any other engineering school. When Kerber left the department, Pavvi was appointed to the Guggenheim professorship.

The mention of the numerous Michigan graduates with CAA serves to illustrate a major characteristic of the Aero Department at Michigan: from the first its major product has been a graduate. Although its research activities and facilities have always been of a high order, the primary emphasis has always been on preparing students for aeronautical careers. In the fifty years the department has existed, it has granted 2,731 degrees in aeronautical engineering (1,884 bachelors, 782 masters, 28 professional, and 37 doctoral). MIT and Cal Tech, both more deeply involved in research than Michigan, grant more Ph. D's than Michigan but considerably fewer bachelor's degrees. For example, during one recent five-year period Michigan granted more degrees - undergraduate and graduate - in aeronautical engineering than any other institution in the U. S., 437.

Besides having graduated several of the astronauts--Edward H. White (M. S. E. '62), James A. McDivitt (B. S. E. '62) and Theodore C. Freeman (M. S. E. '62) Michigan can also claim a number of Early Birds, including both Pavvi and the holder of the first bachelor's degree in aeronautical engineering, Flavius Earl Lody. But perhaps special recognition should also be given to those Michigan alumni whose flying careers extend from the early days straight through to the present. Marius Lodeesen-Grevinck ("Lody"), ('30e [Ae. E.]) represents the very highest achievement among such pilots. Mil Vanik recalls Lody as a quiet, easy-going, affable fellow whose father was a retired Dutch Army general who immigrated to Ann Arbor so his three sons could have an American university education.

“Lody,” according to Mil, "was a natural-born pilot who loved flying and was the first to solo of the group that took flying instruction on 'Suitcase Charley' Hayes' Waco 10 at Burns Field on Plymouth Road halfway to Detroit. Lody also took the Naval Aviation ground school course offered by the Navy at the University. Commander Charles Williams, who instructed the course and was also in charge of the Naval Reserve Squadron at Grosse Ile was impressed and talked Lody into applying for a Naval Aviation Cadet appointment. Even before the appointment came through Lody had picked up enough bootlegged flying time from Commander Williams so that he was soloing a Navy seaplane at Grosse Ile as a civilian.

After Michigan graduation, and acceptance as a Naval Aviation Cadet, Lody completed the two-year course at Pensacola, graduating as a rated pilot, a commissioned reserve Ensign, and no job. He returned to Ann Arbor in the midst of the depression and after many months of job-hunting finally found a last resort job as a house-to-house refrigerator salesman. The day he was to start the job, Lody received a letter from Pan American Airways offering him a job as a mechanic, so he dropped everything, rushed to Miami and started his new career as a mechanic.

After several years, Lody graduated to flight engineer on the large Martin M-130 flying boats in the Pacific, and eventually to pilot and Captain on the Boeing B-314 flying boats in the Atlantic. Subsequently he flew DC 4's into South America, became Chief Pilot of Panair to Brazil, flew Constellations on the South America-European run, and helped pioneer the around-the-world route for PAA. As a rated Master Pilot, he was stationed in England in 1959 flying the London Bangkok leg of the round-the-world route. In 1961 he was

stationed in Bermuda flying PAA Boeing 707 jets on the round-the-world route.

Lody has been offered many top desk jobs in the PAA organization, and has always chosen to stay with his only love - flying, in the role of Master Pilot. Now, after 35 years in the air and over 30,000 hours of flight time without a single accident, he will be up for retirement soon.

To the many Aeros of his era who aspired to be pilots, but instead followed a career in aviation from the ground, Lody's career symbolizes an achievement of which we were all a part in spirit if not in fact. "

With the onset of World War II, the Aero Department became geared to the war effort. Some faculty members joined the Armed Forces, others participated in the training of aircraft inspectors and pilots and others engaged in applied research devoted to improving the design or manufacture of military aircraft. Pavvi continued to devote himself to teaching but at the end of the war after thirty years on the Michigan faculty he made plans for retirement.

He returned to France in 1946 and spent the last five years of his life there. He settled in Pau, that small town at the foot of the Pyrenees where the Wright brothers set up the world's first flying school in 1909. Probably it was the closed valley with its mild, still air that attracted Pavvi - as it had the Wrights nearly half a century earlier. But one would like to think that perhaps he had been drawn to Pau not only because its warm, still air was ideal for an old man, but also because Pavvi could hear in it the sputter and clatter of those early Wright planes that had launched him on his career as an aeronautical engineer.

The immediate post-war years saw the end of the development of the airplane as conceived by Wilbur and Orville Wright. The power available in turbojet and rocket engines brought man for the first time within reach of supersonic flight. Instruction and research in aeronautical engineering were both stimulated by the problems associated with transonic flight. The field of nuclear power also opened up many possibilities. Michigan seized many of these opportunities, offering courses in guided missiles, nuclear energy for aircraft propulsion, and conducting research in its newly established Aeronautical Research Center at Willow Run. Among the projects undertaken there were Project Wizard, an engineering study of a defensive guided missile; upper atmosphere research; supersonic-wind-tunnel studies; and the guidance system for BOMARC.

The expansion of post-war research activity was greatly aided by the construction of new facilities on the North Campus. In 1955 a low turbulence wind tunnel was constructed there and seven years later a hypersonic tunnel designed on the electric arc discharge principle was operating at Mach 20. Aerodynamic research in progress at the several departmental laboratories and facilities included work on boundary-layer phenomena, such as pressure fluctuation, heat transfer, and transition on super cooled bodies; unsteady aerodynamic flow phenomena; turbulence in the air stream; dynamics of homogeneous turbulence; and transition tests in the low-turbulence supersonic wind tunnel.

Some of the most exciting work is being done in the area of upper atmosphere studies by means of rocket-sounding methods, falling spheres, and rocket-borne spectrometers for measuring the composition of the atmosphere. The upper atmosphere studies also include development of radiation sensors for Tiros and Nimbus.

Leslie Jones who joined the High Altitude Research Laboratory in its first year and now is its director has, as a consequence, worked with both the earliest and crudest devices and the latest and most sophisticated for studying the upper atmosphere. He recalls for us here some of the highlights of the work conducted by his lab.

Upper atmosphere research has been part of the Michigan scene since 1946. In July of that year Dr. Myron H, ("Nick") Nichols brought to the Department a group of engineers and physicists from Palmer Physical Laboratory at Princeton who had been working there on such R & D projects as the Lark Missile. With added recruits from Ann Arbor a group identified as "Research Techniques" was installed in a laboratory at Willow Run Airport. One area of interest was the development and use of analog computers and differential analyzers, an activity that was the genesis of the present program in Instrumentation Engineering.

The other focus of attention was the structure of the upper atmosphere particularly those phenomena having 'meterological significance.' The goal of the research continues to be the physical properties of the atmosphere, although the emphasis has changed somewhat. In the old days, the consuming mystery was the 30 to 90 km 'stratosphere' now divided at 50 km into the stratosphere and mesosphere. Recently, the word 'aeronomy' was coined to identify knowledge of the physics of the high atmosphere, and scientific interest now extends outward a few earth radii to the point at which the



terrestrial atmosphere becomes indistinguishable from the solar plasma. The traditional concern with meteorology is retained as well, but a modern Promethean view of the troposphere is provided by satellite borne instruments.

The barren, but sometimes beautiful, wastes of White Sands Proving Ground are indelibly etched in the minds of all early upper air researchers. It was here in 1946 that the components of 100 captured V - 2's were trundled in 300 freight cars to be assembled and fired for practice by the Ordnance Corps. The V -2 could carry 2000 lbs. of payload a hundred miles and it soon dawned on the Army that more useful things than concrete should be given the round trip ride. Invitations to install scientific payloads were tendered to laboratories of the three military services and to Harvard, Johns Hopkins, Michigan and Princeton (all of whom had upper air research programs). This group formed a committee, the V -2 Rocket Panel, which served until the formation of NASA as a quasi-official commission guiding upper air rocket research in the United States. Under Ernest Krause, James Van Allen and Horner Newell as successive chairmen, the Panel arranged schedules, provided telemeters, urged the development of the Aerobee and Nike-Cajun, sponsored symposia and, as its crowning achievement, set up for the Academy of Sciences the U. S. program in rocketry for the IGY. Two significant monuments to the Panel are the so-called Rocket Panel Atmosphere of 1952, the first published standard atmospheric tables based on in situ measurements by rockets and the establishment of NASA as a civilian organization, a result in which the Panel effort was a key factor

The most memorable activities were, of course, the actual preparation and launching of rocket experiments. Then, as now, the structural parameters of the atmosphere, albeit at relatively low altitudes, were the target. It was the consensus that at some altitude where isotherm or a positive thermal gradient would permit quiescence, and hence gravitational separation according to Dalton's Law, the light gases should increase with respect to the heavier. Our task was to find out where and how much. The deceptively simple approach of capturing samples in rocket-born bottles was undertaken and constituted the major effort of the Laboratory for ten years: It is doubtful that we would have lasted through so long a program had it been marked by routine success and so it is perhaps well that more things went wrong than even Murphy's Law allows. Tears were the only adequate response when, after months of construction and pumping, the first two automatic sampling bottles were both accidentally dropped and triggered within an hour of each other and a day of the launching! The second set was installed finally in infamous V -2 #25, our curtain raiser, which burned on the stand in May of 1947 and, after three more attempts final

carried our hopes upward in April of the following year. Other remembrances include trips to El Paso in DC 3's, thirty-six hour stretches on the gantry crane, the night spots of Juarez, bone-crushing jeep-borne recovery parties in the desert, and a burst of fame in the form of an article in *The New Yorker* prominently featuring the sample bottles.

The *New Yorker* article, one of a series by Daniel Lang, was later published as a book entitled *Early Tales of the Atomic Age* (Doubleday & Co., Garden City, New York. 1948). It described our first successful V-2 flight rather vividly. The narrator is the author, Daniel Lang:

'For this shoot, I was told the instruments would be safer than usual, because No. 27 had been assembled in such a way that as it descended toward the earth it would break up into three separate parts - the warhead, the body, and the tail. The impact upon striking the earth would consequently be so much less severe than usual that the rocket would not even dig a crater. Arranging the instruments was practically as important as the flight itself, and would take the rest of the afternoon and all night to complete. All the men on the platform were G. E. experts with the exception of one, a meteorologist - a curly-headed, baby-faced fellow named [Stocker] Sturgeon. He was the air-bottle man from the University of Michigan. Sturgeon smiled miserably when White told me that he had been nicknamed, inevitably, *Virgin*, because he had come to White Sands for four shoots but had yet to be successful with his air bottle. Once the missile had not gone up high enough, twice it had failed to rise, and on Sturgeon's last attempt the shoot had been canceled, because of a bad accident at the launching site. Alongside Sturgeon was his bottle, which was made of steel and was thirty-two inches long and eight inches in diameter. It was shaped like a fire extinguisher except for a long nozzle, which, I was told, would protrude from No. 27 during its flight, in order to suck in the atmospheric sample. The bottle was painted bright yellow to help Kincannon find it, and on it, in black paint were the words "RETURN TO UNIVERSITY OF MICHIGAN, WILLOW RUN, MICHIGAN. ATT: M. H. NICKEL SHIP RR. EXPRESS CHARGES GUARANTEED." '

After describing the launch of #27, Lang describes how he and Sturgeon jeeped across the desert in search of the fallen missile. The chapter ends with these words:

'Fifty yards ahead, near two yuccas; we could discern a whitish object. An L-5 was circling over the spot. When we reached it, we saw that No. 27 had successfully come apart. The warhead and body had fallen elsewhere in the

desert waste, and it was the tail, containing the air bottle and corn seeds that we had come upon. It was smashed, of course. Wires protruded from it every which way, looking like messy hair. There was a stench of alcohol. The seeds were found almost immediately, in a small metal container that had been thrown clear of the tail. We searched the missile's battered hulk for more treasure. Then Sturgeon, on his knees, yelled, "There it is!" and pulled his air bottle from the wreckage. Its yellow paint had been chipped, and it was dented in the middle, but it was intact. "Shoot him!" Kincannon ordered the photographers. Their bulbs flashed. Sturgeon, on his knees, was patting his bottle. '

Was it worth it? All in all about 70 sample bottles were sent aloft with perhaps half yielding useful air. Analyzers were built in England and in Ann Arbor and countless analyses of ground and upper air carried out. Increases in the lighter gases were indeed measured at 60 km and above and the results published and later verified by similar experiments in the Soviet Union. The onset of separation was seemingly established until, in 1956 and during the IGY, American mass spectrometry flights showed no separation below 105 km throwing the whole situation in doubt. Soon, however, difficulties in the new technique were revealed and improvements undertaken by our own laboratory. This led in 1962 to new unassailable spectrometer results, which verify the early sampling work, and define the diffusion situation quantitatively to 200 km.

Aeronomy is now firmly established in the language and is becoming established as an academic discipline. A start has been made at Michigan with a two-course series in the Department offering fundamentals and a vista of courses in the field. '

The Department's interest in upper atmosphere research stimulated the development of radio telemetering systems to transfer the measurements to the ground as they were made. Professor Nichols, who came here with the upper atmosphere research group in 1946, had directed a project from 1943 to 1946, which developed and flight-tested the first high-speed time-division telemetering system and one of the early multi-channel telemetering systems for rockets. So in addition to conducting upper atmosphere research, Professor Nichols worked up courses in the new science of instrumentation. In 1946-47 four graduate courses were reoffered dealing with the dynamical and random response of instrument wind tunnel and flight test instrumentation, automatic control, and engineering applications of the electronic differential analyzer. The latter course was probably the first of its kind taught in the U. S.

In 1949 Lawrence L. Rauch, who had worked under Professor Nichols at Princeton, was invited to join the staff as an Assistant Professor, and the following year Robert M. Howe, from M. I. T. joined the staff. By the academic year 1951-52 additional courses had been organized in the areas of nonlinear systems, missile guidance, advanced feedback control, and radio telemetry. In 1953, an independent graduate Program in Instrumentation Engineering was organized to meet the general need for dynamical systems engineering. Presently, a staff of eight members, all of professorial rank, plus several assistants is responsible for some 23 instrumentation courses in the Department of Aeronautical and Astronautical Engineering and the Instrumentation Engineering Program.

Anniversaries are occasions for gazing raptly and affectionately at the past. And surely the fiftieth anniversary of the Department of Aeronautical and Astronautical Engineering should be no exception. The men who gave the department its impetus and those who as students and faculty transmitted that impetus forward in time were truly pioneers, with all the venturesomeness and far-sightedness that term implies. They deserve our interest and our respect, and for that reason this account has focused on them.

But anniversaries are also occasions for looking into the future. However, the astonishing developments in aeronautical engineering over the past fifty years illustrate how difficult seeing into the future can be. On that day fifty years ago when young Felix Pawlowsky stood in a West Engineering Building classroom before the seven students attending the first meeting of his course in the theory of aviation, he would surely have been astounded by the train of events he was to set into motion. So perhaps it is best for this account to close not with a forecast of the future but with an expression of hope that over the next fifty years the Aero Department will attract teachers and students with the same dedication to the profession as those who wrote the record of the first fifty years.