History of the Aeronautical Engineering Department at the University of Minnesota 1929 to 1962

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The full text in PDF format (530KB)

The University of Minnesota first offered courses in aeronautical engineering to undergraduates in mechanical engineering in 1926. Professor Charles Boehnlein from the Department of Mathematics and Materials instructed all these early courses. The electives focused on aerodynamics.

The early foundations of aeronautical engineering as an option within mechanical engineering departments typified the situation at schools across the United States in the 1920's and 1930's. University faculty and administration often saw aeronautical engineering as little more than a highly specialized field of mechanical engineering. Many courses in mechanical and aeronautical engineering, such as engine design, structures, dynamics and controls, overlapped in this period. When university officials realized that aeronautical engineering stood apart, they moved aeronautical engineering out from under the wing of mechanical engineering.

In early 1928, Ora M. Leland, Dean of the College of Engineering and Architecture, proposed to the Minnesota Board of Regents that an independent department of aeronautical engineering be established. He believed that "Minnesota is favorably located to become a center for this field of engineering for the Northwest." Leland recommended that the new curriculum continue much as it had in the mechanical engineering department:

> *A large part of the course in aeronautical engineering will be the same as mechanical engineering. Thus, by a combination of our existing courses in civil, electrical, mechanical and chemical engineering, we shall be able to cover almost all of the proposed curriculum. Then, with our elective work in automotives, aviation, aerodynamics, and airplane and motor design, we shall be able to give a very creditable course and one which would fully justify itself. For advanced theoretical work, we have the advantage of a strong department of physics and another of mathematics.*

It seems that Leland envisioned a department firmly rooted in traditional, sound engineering methods, informed in aeronautical knowledge, and capable of providing young aeronautical engineers for the budding industry. Only his last comment about advanced theoretical work suggests any vision Leland may have seen for the development of the undergraduate curriculum or graduate studies.

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Leland named Professor Boehnlein and Professor Ronald Hazen, an assistant professor from Mechanical Engineering, as two of the department's proposed faculty members. He valued their experience as aviators. Leland wrote further, "I intend to obtain a third man, trained in aeronautical engineering but able to teach in one of our other departments, when a suitable vacancy occurs." The third position turned into a special lecturer appointment given to John D. Akerman. Akerman not only taught during the 1928-1929 school year, but helped design the final form of the department. In the fall of 1929, the Department of Aeronautical Engineering at the University of Minnesota officially opened its doors to students. John Akerman, then an associate professor, served as the first department head, and would hold that position for nearly three decades.

The department's curriculum reflected the interests of industry, consistent with John Akerman's background. The Latvian-born Akerman began his aeronautical studies at the Imperial Technical Institute in Moscow under Nickolai Joukowski. When World War I broke out, Akerman served as a pilot first for the Russian Imperial Air Service, then as a pilot in the French air force. He moved to the United States in 1918. Akerman's aeronautical interests led him to the University of Michigan, where he earned a bachelor's degree in aeronautical engineering in 1925. Akerman stayed at Michigan until 1927, doing coursework for a master's degree and working on the new subsonic wind tunnel endowed by the Guggenheim Fund for Promotion of Aeronautics. He designed the motors used to drive the tunnel airflow. He left Michigan for a position as chief design engineer at Hamilton Metal Plane Company in Milwaukee before finishing his master's degree.

Mohawk Aircraft Corporation, located in Minneapolis, hired Akerman as the chief engineer for their new, low-wing monoplane in 1928. When Dean Leland began searching for someone to fill the special lecturer position, he found Akerman working for Mohawk. Akerman fit Leland's expectations well. His training as an aeronautical engineer and his strong link to the local industry made Akerman a logical choice.

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Akerman's reputation for his design work served him, and consequently the department, well during its early years. The Institute of Aeronautical Sciences and the Royal Aeronautical Society in London elected him as a Fellow in 1945 and 1948 respectively. He continued his work in industry as a consultant to Mohawk, Maderas Rotor Power Plant, Porterfield Aircraft and Engineering Corporation in Kansas City, and the Minneapolis Honeywell Regulator Company. The federal government even assigned Akerman and Jean Piccard, another professor who joined the faculty in 1936, to study the aeronautical research and technical developments in France and Germany during the summer of 1945 for the army. Through his connections, Akerman obtained discarded equipment and war surplus materials for department use. So Minnesota students' exposure to the industrial methods and developments remained strong through Akerman. The course descriptions and titles from this period indicate the practical nature of the curriculum.

A five-year curriculum replaced the standard four-year course of study in 1946. As intended, the five-year curriculum provided students with the opportunity to take more social sciences. Dean Lind wrote in his biennial report to the President for 1946-1948, "The general objective of the five-year program is to weave some of the threads of liberal education into the fabric of engineering education."

The department offered eighteen courses during its first year. Akerman taught the introductory courses in aviation and aircraft engines. These courses dealt primarily with hardware and pilot knowledge: structures, instruments, electrical systems, navigation, and communications. Charles Boehnlein continued as the professor for the more theoretical courses that dealt with aerodynamics. His three-course series introduced the concepts of aerodynamic forces, stability, propeller theory, and laboratory practices. Professor Joseph Wise from the civil engineering department taught two classes on structural stresses and forces as they apply to airframes and landing gear. One instructor, Mr. Hoglund, rounded out the faculty. Hoglund took responsibility for the laboratory courses, which covered airplane design, airplane parts and their construction and airships.

The practical nature of the coursework grew out of the department's foundation in mechanical engineering and the intentions of Dean Leland. But Akerman, as head of the department, had great influence over the direction of the department. Therefore, we should look at his courses in particular as an indication of what to expect from Minnesota's program.

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In the 1930s, Akerman started teaching aeronautics courses as evening classes. Akerman saved copies of a quiz and the final exam from the basic aeronautics course. Surprisingly, Akerman gave essay exams. He asked questions such as "Define parasite resistance. How is it minimized?" and "Make a sketch of an airplane wood and wire wing construction showing drag and anti-drag wires."

Course offerings expanded during the 1930s with the addition of new faculty and new interests in industry. In the mid-30s Akerman began studying the effects of high altitudes on pilots. He believed the next advancement in aircraft technology would be stratospheric flight "where high speeds are possible and bad weather is not encountered." On October 23, 1934, Dr. Jean Piccard, a Swiss chemical engineer, and his balloon-piloting wife, Jeannette Piccard, ascended in a cloth balloon to 57,579 feet to record data on the stratosphere. The flight and the Piccards' possible contribution to his own project attracted Akerman's attention. Jean Piccard started experimenting with balloons in the early 1930s with his physicist brother, Auguste. While Auguste earned more fame for his scientific work than his brother, Jean readily commanded attention when discussing balloons and the stratosphere. With Dean Samuel Lind's approval, Akerman invited both Piccards to Minnesota, but only Jean's position-first as special lecturer, then as Professor in 1938-carried any status or pay. In addition to the first stratospheric coursework, the faculty added courses on seaplanes in 1930 and dirigibles in 1931, both taught by Professor Wise. All this coursework, particularly Wise's courses, reflected the industrial focus of the program.

The available courses in aeronautical engineering at Minnesota in the 1930s seem to indicate an industry-oriented outlook as dictated by the leadership. Further evidence supporting Akerman's strong link to industry-and less to academia and laboratory research-survives in his papers. In August 1930, Akerman wrote a letter to Nicholas Beasley, President of Nicholas Beasley Aircraft Company in Marshall, Missouri. The letter declared Akerman's preference to return to industry. He wrote, "My brother-in-law, Stanley S. Lasa, informed me that you are looking for a competent engineer. May I submit my qualifications?" Although Akerman never left the University of Minnesota for industry, he continued to consult. But his attraction to industry over other career paths in aeronautical engineers surely influenced his vision for the department. He saw Minnesota as a training ground and service department for industry. The department's curriculum at that time confirms this.

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Arguing that the department of aeronautical engineering at Minnesota focused solely on supplying young engineers and services to industry hardly justifies harsh criticism of it. In fact, Minnesota's department produced substantial numbers of engineers to the budding field, fulfilling industry's growing interest for more engineers with aeronautical knowledge. During the 1939-1940 school year, 3034 students enrolled in aeronautical engineering programs across the United States and Canada; 455 of those students studied at the University of Minnesota.

The aeronautical engineering curriculum at Minnesota showed little change towards incorporating engineering science in its first twenty years. While courses were added, they mostly fell in the category of "practice", not theory or science. In some cases, the faculty even dropped some science-based engineering courses. One example of this occurred in the 1935-1936 school year when the second quarter of thermodynamics was removed from the aeronautical engineering requirements. On the other hand, shop courses, such as Surveying and Forging, Welding, and Heat Treating, remained a part of the curriculum until 1946. Furthermore, until the fall of 1946, the curriculum required no mathematics beyond one quarter each of differential calculus and integral calculus. The Engineer's Council of Professional Development (ECPD) accredited the program offered in aeronautical engineering at Minnesota in 1936. Apparently, no longer requiring a second thermodynamics class did not effect the quality to the education available at Minnesota in the opinion of ECPD.

After ten years, the administration started showing concern over the direction of the aeronautical engineering department. It is not unusual, but expected, that the administration should evaluate their departments regularly. The department's and the school's competitiveness with other universities depends on having a state-of-the-art and progressive curriculum. Dean Lind had for some time been promoting the advancement of the curriculum. Lind's assertive attitude stems in part from his role in the newly-organized Institute of Technology (IT).

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In 1919, President Marion Burton advocated the unification of the college of engineering, the school of chemistry, and the school of mines. At that time, the Regents voted "to correlate the administration of the College of Engineering and Architecture and the School of Chemistry under one administrative head". The Regents readdressed the issue in 1935 when they believed the reasons for reorganization were more applicable. President L.D. Coffman wrote, "The interests of these three schools are similar; their work is becoming more and more inter-related; they all lie in the general field of technology; their curricula are based on mathematics and physical sciences." Further, the Regents felt that "the smaller the administrative unit, the more restricted the field of learning; the greater the isolation, the greater the intolerance and narrowness of those being trained in it". The administration believed that the reorganization of the three schools under one leader would strengthen all the programs through greater and easier interaction between faculty and students. Samuel Lind received the appointment as Dean of IT in October, 1935.

President Coffman suggested to Lind in late 1935 a number of issues that IT should investigate. These included a common freshman year, a study of alumni job placements, a comparative study into relations between industry and universities, and an investigation into how IT could promote the economic development of the region. Coffman also suggested looking at the efficacy of establishing two levels of engineering education at Minnesota-one for the rank-and-file engineers and another more intensive curriculum designed for future engineers in leadership positions.

The Regents and President Coffman saw the formation of IT as a step in the right direction to keep the University of Minnesota on the forefront of engineering education. Consequently, Dean Lind felt obligated to evaluate his departments critically. He favored upgrading the curriculum, but by 1942, he bowed to the war-time crisis to provide the largest number of scientists and engineers, and the best research possible. He postponed the upheaval of IT that restructuring of the curriculum would entail until the threat had passed. Lind wrote in his biennial report to the President in 1942 that because of the emergency created by World War II, "further raising scholastic requirements have been temporarily suspended."

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By 1946, the aeronautical engineering department received a lot of attention from Dean Lind and the new University President James L. Morrill. That year the university began negotiations with the U.S. government to acquire the idle Gopher Ordnance Works and the accompanying 8,000 acres of land. The university finally purchased the installation in March, 1948 for $1. The Rosemount Aeronautical Laboratory (RAL) now served as the aeronautical engineering department's primary research facility. Faculty members (Kenneth Anderson and Rudolf Hermann in particular) designed and installed a number of wind tunnels at Rosemount, including a hypersonic wind tunnel capable of producing speeds between Mach 7 and 11 and air temperatures of 3000 degrees Fahrenheit. While the RAL would be the site of significant research for both industry and the military, the Rosemount era proved to be a time of considerable concern about the strength and direction of aeronautical engineering at Minnesota.

In the fall of 1946, John Akerman suffered a heart attack. Since he was the head of the department, Akerman's health became a significant worry to the administration. President Morrill wrote to Dean Lind, "This leads me to raise with you the question as to whether we ought not, in conference with Professor Akerman, to proceed toward the strengthening of the Department of Aeronautical Engineering by the addition of a second well-trained and experienced man, competent in both teaching and research." Malcolm Willey, Vice President of Academic Administration, addressed a further issue in a letter to President Morrill. He wrote, "The Rosemount situation is also involved since the main projects on which we are relying to carry forward the Rosemount development are in the field of aeronautical engineering. The contracts cover researches that Professor Akerman is responsible for."

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In the midst of these troubles brewing in the aeronautical engineering department, Dean Lind retired in July 1947. After a year-long search, the Board of Regents approved Athelstan Spilhaus, a professor of meteorology and the director of research at New York University, as the new Dean of the Institute of Technology in September, 1948. He officially took office in January, 1949. Spilhaus brought with him a vision of developing the scientific foundation of Minnesota's engineering programs. He advocated the focus on the fundamentals and leadership in theoretical research. He believed that a science-based curriculum and research would be the components to make a strong engineering program. Athelstan Spilhaus earned his bachelor's degree in mechanical engineering, then pursued a master's degree in aeronautical engineering at the Massachusetts Institute of Technology (MIT). He studied engineering, but moved into fields more often classified as science--oceanography and meteorology. Arguably, the time Spilhaus spent at NYU influenced his perspective of engineering education. The mission statement from the 1924 NYU bulletin for the College of Engineering suggests an early conceptual understanding of engineering science's possible contributions in aeronautical engineering. It reads, "The spirit of the course at New York University is to train aeronautical engineers rather than aerodynamicists, men who can take part in the practical work of designing and constructing airplanes and dirigibles and their engines on a scientific basis." In knowing Spilhaus's educational background, his professional activities, and his intellectual environment, we can understand the reasons behind his vision of science-based engineering at Minnesota.

Dean Spilhaus took over from much the same point at which Dean Lind had left. From the rising concern expressed by Dean Lind and the university administration, we can surmise that Lind was again actively evaluating the conditions of the departments in IT with retrenchment in mind. Dean Spilhaus naturally wanted to establish a sense of where the university stood in educational approaches, research, and technology. In 1950, Spilhaus reported that "development of graduate instruction and research is emphasized. At the same time, however, continual effort toward improving the regular undergraduate instruction has been intensified, this improvement too being stimulated by the increased research and graduate studies." He saw the country "in a state of approaching total mobilization" for the coming years. Spilhaus wrote further, "This places the heaviest demands on technology in all its phases. Clear recognition and acceptance of this situation should guide future planning." These ideas spanned across the disciplines; he referred to all of IT in these remarks.

But Spilhaus paid particular attention to the aeronautical engineering department. Undoubtedly, President Morrill would have shared with the incoming dean the concerns both he and Dean Lind felt about the department. Further, in those first two years after Dean Spilhaus arrived, only one course-Airplane Design Laboratory for seniors-was added to the curriculum. Many might say that this is merely a coincidence, that this should hardly draw Spilhaus's attention. But as we shall see, Akerman and Spilhaus never saw eye-to-eye. Akerman showed no real effort to comply with Spilhaus's vision in those first two years, and would show forceful resistance to it later.

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In his first biennial report to the President in 1950, Spilhaus summarized his evaluation of the state of the aeronautical engineering department and his challenges for growth. He wrote,

> *In aeronautical engineering increased emphasis has been placed on graduate work and a number of students are assigned to the department by the Naval Postgraduate School at Annapolis. … Three supersonic wind tunnels are in operation at Rosemount where a considerable volume of contract research work is being carried out. Because of the distance between Rosemount and the University, it is difficult to integrate the sponsored research work as fully as is desirable with the academic work of the institute. This physical separation has a tendency to inhibit the free interchange across departmental lines, which is one of the most valuable factors in the prosecution of research in a university.*

While Dean Lind understood that the aeronautical engineering department would benefit from retrenchment, Dean Spilhaus had the drive, the determination, and the advantage of timing to improve IT and all the engineering programs at Minnesota. From his doggedness to redirect the aeronautical engineering department, in particular, Spilhaus obviously worked from an agenda for change.

As I will show, the turbulent relationship between John Akerman and Dean Spilhaus hindered the development of engineering science in the aeronautical engineering department. Some may argue that the Spilhaus-Akerman relationship represents conflict between supporters of engineering science integration and those content with practical design methods. Invariably, other school's faculty dealt with the same issue and met with similar resistance to change. More often, though, other schools adopted engineering science methods with greater ease than at Minnesota. The events at Minnesota highlight a clash of personalities, and probably do not represent a larger trend. However, the effect was a slowdown in the fuller integration of engineering science at the University of Minnesota's aeronautical engineering department.

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The spring of 1951 brought with it Dean Spilhaus's first major attempt to personally redesign the aeronautical engineering department. As a result of the common misconception that a surplus of engineers existed coupled with the military need for soldiers to fight the war in Korea, enrollment reached its lowest point in the fall of 1951. The budget mirrored the drop in enrollment. Spilhaus pushed departments to streamline their costs as much as possible without risking their students' educations. Following his own advice, Spilhaus proposed making Aeronautical Engineering a division of Mechanical Engineering as it had been through 1929. He explained to President Morrill,

> *On a cost-per-student-hour basis, Aeronautical is our most expensive department in the Institute, and from an educational point of view I think we should get away from departments which deal with an end product. In this case, the airplane is a combination of fluid mechanics, structural mechanics, thermodynamics, and heat engines-all of which are taken up better in other departments of the Institution.*

Fiscally the arguments may have been sound, but history negates the efficacy of the move. Many aeronautical engineering programs from this era started as options within a mechanical engineering department as happened at Minnesota. However, by 1951, the administrations at those universities - Iowa State and Purdue are two such cases - had normally formed independent departments of aeronautical engineering. Mechanical engineering coursework no longer served as the technological and theoretical interests of aeronautics effectively. This stems largely from the nature of aircraft and its working environment. Except for submarine crafts, aircraft (airships and balloons included) are the only vehicles that travel in a third plane of motion. The complexity of motion alone increases the complexity of an aircraft over any vehicle travelling on land or the surface of water. Further complexity arises when we consider the sensitive nature of the air to disturbance. The smoothness of an airplane's skin can dramatically change its performance. A very thin layer of ice on a wing, for example, can effect the shape of the airfoil -the cross-sectional section of a wing-and the skin smoothness. Anyone who has ever slid on a patch of black ice while driving knows how dangerous an imperceptibly thin layer of ice can be. On an airplane wing, that same amount of ice may cause a substantial loss of lift, leading to a crash. As historian James R. Hansen states, "aeronautical engineering became a field of engineering where 'almost' was not good enough." A mechanical engineering department was no longer "good enough" for aeronautical engineering education.

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On the surface, Spilhaus's move on the aeronautical engineering department can be seen as an assault on the importance of discipline. Truthfully, that may have been part of it. But several facts suggest otherwise. First, Spilhaus earned his master's degree in aeronautical engineering from MIT. Spilhaus would have at least respected the field after completing a degree in that discipline. Secondly, he declared his motives openly both in the proposal to President Morrill and his report for the Board of Regents. He wrote in the 1952-1954 biennial report, "An effort was made, also, to eliminate highly specialized curricula with very limited enrollment, not solely because such curricula are expensive to maintain but also in the belief that such a degree of specialization in undergraduate work is not warranted in engineering today."

Thirdly, Spilhaus never demanded that aeronautical engineering alone change. Spilhaus's interest in improving curricula spanned across all of IT. By the fall of 1952, IT had completely integrated a five-year program for all the engineering departments. For the first two years, all engineering students followed a standard curriculum that emphasized the "basics", particularly mathematics and physics.

Lastly, the success of Spilhaus's proposal meant a restriction in Akerman's capacity to direct the department. Akerman and Spilhaus worked against each other at almost every turn. Akerman saw the department as his child. Spilhaus, flexing his administrative muscles, gave Akerman reason to believe that his autonomy was threatened. In a report on the university's Aeronautical Research Facilities, Akerman expressed his perspective on American aeronautics and how the University of Minnesota could provide for the field.

> *The recent recognition by the public, industry and government of the necessity of extensive research in technological fields, in order to maintain American leadership in the modern world, is of chief importance.*
>
> *… These facilities [at Rosemount] supplement the new facilities now available on the main campus and are valuable both as instruments for student instruction and as necessary tools for research. An opportunity to secure the services of specialists in research and teaching fields, who want to combine their research activities with academic work, was also provided.*

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Unfortunately, the strained relationship between Akerman and his Dean ultimately only created 'drag' on the advancement of aeronautical engineering education at Minnesota. The proposition to move aeronautical engineering back into the mechanical engineering department failed. However, the hostile feelings between Akerman and Spilhaus only grew more intense.

Spilhaus refused to give up his quest to see Minnesota's engineering curriculum develop its strength in basic science, engineering science, and its 'underlying principles', meaning mathematics. Again, in his 1956 biennial report to President Morrill, this aim is evident. He wrote,

> *Curriculum revision is also directed toward a commonness of interest in basic subjects with emphasis on engineering sciences and its underlying principles throughout.*
>
> *In speculating how to best use limited resources for education, the rapidly expanding fields of physical science and technology, the conclusion may be reached that there are two priority areas: first, as has been emphasized, priority support for the basic sciences and, secondly, priority support for the development of the newest applications, potential outgrowths and results of cross-fertilization of the established sciences.*

Despite his efforts through 1955, the Engineering Council of Professional Development (ECPD) had the following criticism after its evaluation of IT: "the tendency in certain areas towards 'practice' courses in the fifth year with relatively little use of fundamentals and theory, and the desirability of the greater use of mathematics and engineering sciences in these courses." Spilhaus knew early on in his time at Minnesota that the curriculum in the aeronautical engineering department was especially practice-oriented and an overhaul of the aeronautical course requirements should be a priority.

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Spilhaus's second attempt to gain control of the tailspin he saw in the aeronautical engineering department came in May 1957. He proposed a radical modification to the department, a merger with the Department of Mechanics and Materials and the subsequent removal of John Akerman as its head. Mechanics and Materials was a service department; it granted only graduate-level degrees, but taught undergraduate courses. In this way, other departments need not develop expertise in an additional area. Aeronautical engineering was a professional department; one that granted undergraduate degrees.

Spilhaus intended the merger to combine the strengths of both departments, and hopefully improve upon the weaknesses he saw in the aeronautical engineering program. In his proposal he wrote, *Those weak departments which are to be retained are permitted to strengthen themselves in the best possible way by acquiring staff competent in an engineering science area. Such a course of action avoids perpetuation of a current engineering practice orientation which becomes obsolete in the practicing life of the future engineer and encourages a sound reorientation on lasting engineering science fundamentals.*

Spilhaus easily could have directed this comment directly at the aeronautical engineering department. In not doing so, Spilhaus clearly expressed that his aim applied to all of IT. To Spilhaus, strengthening IT meant more than just adding basic science courses, but engineering science. But despite the broad, sweeping changes that he had made to IT, Spilhaus believed that those changes did little to solve the problems in aeronautical engineering.

Spilhaus believed the general incompetency of the staff and leadership were the deep-rooted problems holding back the aeronautical engineering department. He argued,

Staff competent in engineering science are essential to provide the internal guidance necessary for strengthening its undergraduate curriculum and its graduate and research programs.

… Furthermore, the presence of staff in a department competent in two or more engineering science areas should aid greatly in (a) redirecting a curriculum along broad and basic lines, and (b) replacing descriptive courses which emphasize the "how" of current practice by analytical courses directed towards understanding the "whys" so essential to creative engineering of the future.

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Spilhaus suggested that the new department formed by merging Aeronautical Engineering with Materials and Mechanics would be stronger in more engineering science areas, thereby making the department stronger and more competitive.

Spilhaus identified Dr. Chieh-Chien Chang and Dr. Rudolf Hermann, both professors of aerodynamics and fluid mechanics, as the only two professors on staff competent in an engineering science area. Spilhaus emphasized, "Obviously Aeronautical Engineering must be strengthened by the addition of engineering science competence." But he directed his most honest criticism of the department pointedly at John Akerman.

Even though Aeronautical can draw on the rest of the University for course work and consultation, a reasonable number of competent staff must be located administratively within the Aeronautics Department, otherwise such important matters as educational policy and curricular development are left to second-rate people. Merely having competent staff is not sufficient; they must be located where they can be most effective in policy and curricular matters.

Unquestionably, Spilhaus believed that Akerman was holding the department back and ultimately weighing it down because of its inability to attract new, competent faculty.

Naturally, Akerman took offense at Spilhaus's implications and the overall proposal. In fact, no records survived to suggest that Spilhaus and Akerman even communicated directly with each other about the proposal during the year in which the merger was on the table. President Morrill acted as the mediator between the Dean and the Department Head.

At Morrill's request, Akerman wrote a one hundred and eleven page report countering the criticisms made by Spilhaus. Akerman argued that from 1949 to 1956, Spilhaus restrained the department. He wrote, "the restraint was definite in the form of instructions from the Dean not to expand, but to concentrate in one line." Some of Akerman's highlights of how Spilhaus 'restrained' the aeronautical engineering department are as follows: "meteorology was reduced to one course…and the professor was removed from the Aeronautical Engineering staff and attached to the Mechanical Engineering Department," "flight activities and facilities…were thrown out of the Department by the Dean," and "controls and servo mechanisms were classified as Mechanical and Electrical fields." Akerman further wrote that schools like Princeton, Purdue and Illinois had extended their own flight activities, and MIT and Michigan had recently included controls and servo mechanisms in their fields of study. By drawing attention to the other schools' activities, Akerman hoped to show how detrimental Spilhaus's vision was to the aeronautical engineering department.

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Akerman tried to further bolster the reputation of his department in the section, "Efforts to Present the Status of Aeronautical Engineering in a Very Poor Light." Spilhaus created a chart comparing the two departments in question and mechanical and civil engineering with respect to the strength of a number of engineering science areas. Spilhaus examined each department for research activities and faculty competent in a given engineering science area, such as fluid mechanics. In this way, Spilhaus attempted to illustrate the significant weakness of the aeronautical engineering department. Akerman added a "corrected column" to Spilhaus's chart. He complained that Spilhaus manufactured the engineering science areas that were "more suitable" to Mechanics and Materials, and gave Aeronautical Engineering an appearance that lacked competence. Akerman's additional column included his own evaluation of the department's research activities and the staff and faculty.

Akerman reacted particularly strongly to Spilhaus's treatment of the staff other than Drs. Chang and Hermann. He wrote, "No mention is given to other fields or other staff members, although under other department of the Institute his chart lists persons and activities of lesser stature as 'Fields of Strength'." Spilhaus' concern lay in the lack of *permanent* faculty. He wrote, "Beyond [Chang, Hermann, and Stolarik] the department depends primarily on temporary assistance in the form of Rosemount lecturers. **The number of competent staff in the Aeronautical Department is thus well below critical size and this is one reason why it has been unable to attract new competent staff**."

Akerman made a solid attempt to counter every claim Spilhaus made about the state of the aeronautical engineering department. But he showed even less tact and control over his feelings than Spilhaus did. He wrote,

Such action can only be explained one of two ways: (1) deliberate purposeful degradation of the work done in the Department of Aeronautical Engineering, or (2) complete ignorance and misunderstanding of the Aeronautical Sciences. Both of these explanations have been encountered in the history of aeronautical education when outsiders have dealt with aeronautical fields.

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It seems likely that Akerman knew Spilhaus earned his master's degree in aeronautical engineering. Clearly then, Akerman viewed Spilhaus's proposal as a 'deliberate' attack, not a 'misunderstanding'. Akerman aimed further shots at Spilhaus when he wrote, "Is this the beginning of a 'planned allocation' of our young men to various fields of technological study by 'super authorities' wielding hidden power through excessive influence over the subordinated group of aeronautical students? Why not do it by arbitrary assignments as exercised in Russia?" Further, he viewed as one of the consequences of accepting the merger proposal "the apparent acceptance of questionable ethics in the promotion of personal projects to the detriment of loyal and capable personnel with long service and achievement records."

Akerman wished to be free of Spilhaus as well. His report to Morrill included a counter-proposal for the separation of the aeronautical engineering department from IT and the establishment of an independent School of Aeronautical Sciences. He wrote,

> *This plan would have the main advantage of free selection of humanistic, basic scientific and specialized aeronautical courses as determined by the faculty of the Aeronautical School to meet the needs of a proper aeronautical education without the adjustments, generalities, compromises, influences and dominations of the other departments to suit their interpretations as to what is proper in aeronautical science and industry.*

Clearly, Akerman never appreciated Spilhaus's vision for Minnesota.

When President Morrill read Akerman's report, he noted that Akerman seemed to argue more effectively for the organization and strength of the aeronautical engineering department than Spilhaus did of its weaknesses. But he also recognized that the "problem is essentially one of personality conflict [and] distrust of Akerman's scientific competence." He questioned privately whether Spilhaus would have ever proposed the merger if Akerman was not the department head. Had Spilhaus been the only person to voice his concern about Akerman's ability to lead, Morrill may have been more inclined to search for other solutions to the conflict than the two proposals already on the table.

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On April 11, 1958, after almost a year of debates, meetings and letters (none between Spilhaus and Akerman), the Board of Regents accepted the recommendation to merge the Department of Aeronautical Engineering with Mechanics and Materials. Akerman retained his status as Professor, but would only serve as head of the Rosemount Aeronautical Laboratory, which became an independent agency within IT, no longer a subsidiary of the aeronautical engineering department. Dr. Benjamin Lazan, Associate Dean of IT and head of Mechanics and Materials, took over as head of the combined departments.

Spilhaus believed as did C.C. Chang, that the department's curriculum was out of date and its objectives were obsolete. But both Spilhaus and Akerman saw the university's limited resources in research as a hindrance to the department. Rosemount Aeronautical Laboratory filled the void in Minnesota's research capabilities. With that improvement, Minnesota's aeronautical engineering department could attract the kind of faculty members that would advance the department as a research school.

Rosemount Aeronautical Laboratory served as the department's primary wind tunnel facility. RAL housed a continuous-flow transonic tunnel, continuous-flow and blow-down supersonic tunnels, and a high-temperature hypersonic wind tunnel. Limited space in the Aeronautical Engineering building on campus and the destruction by fire of the Engineering Experiment Station in February 1953 meant that the majority of the departmental research had to take place away from campus.

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The University of Minnesota officially acquired the buildings and equipment on over 8,000 acres of land of Gopher Ordnance Works, an idle powder manufacturing site, from the War Assets Administration (W.A.A.) for $1 in 1948. The stipulations of the agreement required the university to use the facility for 25 years on projects of public interest. The W.A.A. also reserved the right to take back the facility should a war emergency arise. This exchange stood as the largest transfer to an educational institution by the W.A.A. Rosemount housed such a number of different facilities. But university negotiators, including Akerman, expected the aeronautical laboratory to be one of the most significant players at Rosemount. He wrote in his proposal to the War Assets Administration regarding the Gopher Ordnance Works that RAL "would provide not only a new research center but also a training place for new scientists studying supersonic velocities in aerodynamics." President Morrill confirmed this perspective in his statement recorded by W.A.A. in its news release. Morrill's quotation reads, "Present research being undertaken at the former war plant include basic and developmental research in the aeronautical and ordnance fields of jet propulsion, electronics, guided missiles, subsonics, transonics, supersonics, air velocities, polio, cancer and agriculture."

In the original proposal, Akerman relied on the 1946 Meade War Investigating Committee Report to Congress in aircraft research, development and production as evidence of the pressing need in the United States to establish a facility like RAL. Akerman wrote, "[The report] said the United States now finds itself inadequately equipped with research facilities for new radical, high-speed aircraft and the NACA and armed forces are 'primarily responsible' … The committee said the Army and the Air Forces and NACA now plan 'unprecedented expansion of basic and applied research'. It said these plans should be expedited and needed facilities constructed post haste." For these reasons, Akerman argued that the establishment of Rosemount Aeronautical Laboratory "would be a great educational asset to the State and the Nation." As an educational tool, Rosemount offered Minnesota students the opportunity to get involved with real engineering projects as part of a class assignment or as a student employee. For the aeronautical engineering department at Minnesota, RAL meant not only access to vast research opportunities, but it also attracted some of the top research engineers to the faculty.

The significance of a laboratory like RAL to the strength of engineering science in an aeronautical engineering department cannot be overemphasized. In a university laboratory environment, professors and students can work together investigating real engineering problems. Even Spilhaus admitted that the department already had two invaluable faculty members in Chang and Rudolf Hermann. With capable engineers like Chang and Hermann serving in both the classroom and the lab, the aeronautical engineering department at Minnesota could teach its students valuable engineering science methods.

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To understand how engineering science could find its way into the curriculum at Minnesota before Akerman's removal as department head, we must examine the teaching and research practices of the faculty. Rudolf Hermann serves as an excellent example of how this could be done. But before we examine Hermann's contributions to Minnesota's history, let us consider his own background to understand how it shaped his own ideas about engineering science.

Rudolf Hermann came to the University of Minnesota in December of 1950. By this time, Hermann had already established himself as a highly competent scientist and engineer both in Germany and the United States. He earned his Ph.D. in Physics from the University of Leipzig in 1929. He then moved to the Technische Hochschule at Aachen to study aerodynamics. In 1935, he completed his *Doktor habilitation*, the second doctorate required of all Professorial candidates in Germany.

Hermann's first engineering position was as an assistant in the Department of Applied Mechanics and Thermodynamics at the University of Leipzig from 1929 to 1933. The German lab environment gave even the lowest level assistants hands-on experience not only performing experiments, but also with evaluating and interpreting the data obtained. More importantly to the advancement of engineering science than simply experience in the lab were the science-based, theory-oriented questions being asked by the German scientists and engineers. It seems the experience of working in the university lab, not to mention his educational background, served him well, for in 1934, Hermann took over as head of the supersonic wind tunnel division at Aachen, a position he kept until 1937.

Adolf Hitler became Chancellor of the German republic in 1933. By early 1935, the German leadership unveiled the Luftwaffe, publicly acknowledging its defiance of the Versailles Treaty. Because of the conditions of the Versailles Treaty, development of the German military aviation had fallen behind that of the Allied powers from World War I. Therefore, Hermann Göring, the air force's commander-in-chief, advocated increased development in aeronautics. The famous German rocket development center, Peenemünde, rose out of Göring's push for advancement.

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In 1935, the Luftwaffe Technical Office introduced Wernher von Braun, the German rocket pioneer, to Rudolf Hermann who was still working at Aachen as an assistant professor in addition to holding his position in the wind tunnel center. The Peenemünde group was troubled by the aerodynamic design of the fins and turned to Hermann and his facilities at Aachen to provide preliminary study of the drag component.

Because of the significant role supersonic aerodynamics plays in rocket development and the distance of the Aachen lab from Peenemünde, von Braun felt that the rocket facility needed its own supersonic wind tunnel and specialist. Hermann joined the Peenemünde group in 1937 as the Director of the Supersonic Wind Tunnel Laboratory of the Army Rocket Experimental Station. The construction of two supersonic tunnels was Hermann's priority. The first tunnel was a 20 second, blow-down tunnel with a 40 centimeter wide test section and a maximum running speed of Mach 4.4, the second was an 18x18 centimeter, continuous flow tunnel with a maximum speed of Mach 3.1. The theoretical design of the nozzles used to accelerate the tunnel flows to supersonic velocities proved to be an extraordinarily complex task. Nevertheless, Hermann and his team continued to perfect the designs for the testing facilities while providing novel methods, such as drop tests from an altitude of 7,000 feet, to gather supersonic flight data on the aerodynamic design of the A-5, the redesigned A-3 rocket used to test guidance systems. The lessons learned from the study and testing of the A-5 were later incorporated into the design of the V-2 rocket. This experience gave Hermann the status of chief aerodynamicist for the V-2 rocket.

On August 18, 1943, the British air forces bombed the Peenemünde facility. Army Ordnance decided to move the supersonics group to an underground site at Kochel in the Bavarian Alps. Preparation of the new facility was slow. Hermann's team did not report to Kochel until 1944. Until his arrival in the Alps, Hermann lectured on supersonic aerodynamics and ballistics at Aachen and in Berlin, a tribute to his expertise in the field. In fact, Hermann's position as a lecturer for Aachen and Berlin began in 1935 and did not end until 1945.

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With the end of World War II, the Allied Powers sent representatives to occupied Germany with the intentions of claiming the top scientists in a variety of fields for the benefit of science at home. The operation came to be known as Project Paperclip. By the end of 1952, 544 German specialists were living in the United States because of Project Paperclip. Five hundred and sixteen of these specialists and 1063 of their dependents had obtained U.S. citizenship, Rudolf Hermann included.

As these scientists and engineers arrived in America, they were usually housed and put to work on military installations under guard. In 1945, Hermann found himself employed as a consultant with Air Engineering Development Division at Wright Patterson Air Force Base in Dayton, Ohio. The American public was not told of the presence of German scientists and engineers working in the United States until early December, 1946. Newsweek magazine described the work of the scientists from Kochel, "As the war ended, [Dr. Rudolf Hermann] was building a 7,000-mile-an-hour wind tunnel in the Bavarian Alps. With six associates brought from Germany, Hermann is working on supersonic wind tunnels for the United States Army."

Even before World War II had ended, questions were being asked about how the situation with the German scientists should be handled. Some people in the U.S. military and government, such as Under Secretary of War, Robert Patterson, felt that only the Germans "whose work required their presence" should be imported and "that [the War Department] keep them under strict surveillance; and that it return them to Germany as soon as possible." General Gladeon Barnes, Chief of Ordnance, hoped that all the scientists imported, some, particularly rocket scientists, would be permitted to "come work with 'long-term' intentions." By 1948, however, some of the incoming Germans were being approved for work in American industry, and with that approval came essentially full freedom of choice. Scientists already in the United States were also being released for industry work. In 1950, Hermann left his 'Paperclip' position at Wright Air Force Base, and joined the faculty in the Department of Aeronautical Engineering at Minnesota.

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The environment at Minnesota in 1950 was not conducive to much change when Hermann arrived. But he did not bring to the university just a new way of doing old work. He brought knowledge and expertise of supersonic and hypersonic flight, subjects that were new to the curriculum. In addition to the newness of the field, Hermann taught mostly graduate level courses, which was a weak area in the aeronautical engineering department.

During the twelve years Hermann was a member of the faculty at Minnesota, he taught a three quarter series on supersonic aerodynamics. In the fall, he taught Aerodynamics of Supersonic Inlet Diffusers; during the winter quarter, Aerodynamics and Flight Performance of Supersonic Missiles; and in the spring, the continuation of the winter quarter course. The only given description, that for the fall course, read,

> *Diffuser types and pressure recovery. The one-dimensional normal shock diffuser. Various definitions of diffuser efficiency. Compression by one, two, or more oblique shocks. Two-dimensional diffuser for ramjets. Spike diffusers and pulsations.*

At first glance, the description looks highly suggestive of an introductory course to the equipment in the field of supersonic research, surprisingly like the previous graduate courses offered at Minnesota. But when we compare the details of this description to that of Akerman's graduate level course, Advanced Aircraft Engines, we see significant differences. Akerman clearly focuses on the hardware: what equipment exists, what state-of-the-art design is on the horizon, and how well does the device work. In Hermann's course description, the devices are named, but also mentioned are the characteristics of sonic and supersonic environments: "pressure recovery", "compression by oblique shocks", "definitions of diffuser efficiency", and "pulsations". Researching supersonic aerodynamics requires an understanding of the equipment and instrumentation, which Hermann's course invariably introduced. But it also appears that Hermann wanted to teach the science of supersonics, that is, the conditions which exist in supersonic environments and how to understand, predict, and work within them. Without course syllabi or lecture notes, it is difficult to fully grasp the actual content of the course. However, we can highlight real distinctions between pedagogical methods through a careful study and comparison of their wording of course descriptions.

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Hermann served the University of Minnesota both as a teaching professor and a researcher, much as he did in Germany. He and his family lived in one of the 25 staff houses on the grounds of RAL, where he was the Technical Director of the Hypersonic Facilities. At RAL, Hermann conducted theoretical research on supersonic and hypersonic flow characteristics, rocket sleds, and ramjets, with much support and funding from the U.S. Air Force and Navy.

Hermann was quite productive during his years at RAL. By February 1958, when the University Archives compiled the Hermann biographical file, he had published over 45 papers on supersonic aerodynamics and diffusers. Between July 1959 and July 1961, he wrote or co-authored an additional thirty reports.

Hermann was one of the top, if not the top researcher in supersonic and hypersonic aerodynamics in the United States in the 1950s and 1960s. His reports ranged in topics from the basic questions and issues that arise in the development and construction of wind tunnels to the advanced theory of high-speed flows. Hermann wrote papers such as "Starting and Operation of the 12 Inch by 12 Inch Supersonics Blow Down Wind Tunnel", "The decay of weak oblique shock waves in two-dimensional supersonic flow", and "Theory of ground interference on rocket sleds". Many of Hermann's articles were published as RAL research reports, but others were published in the *Journal of Aeronautical Sciences* or presented at conferences on wind tunnels, supersonics and space technology.

Between his teaching, research, and paper commitments, Hermann found time to write a text, *Supersonic Inlet Diffusers and Introduction to Internal Aerodynamics*. Hermann wrote in his preface, "With the growing emphasis on obtaining higher and higher Mach numbers in supersonic flight of turbojet and ramjet powered aircraft, the necessity of maximizing the inlet diffuser pressure recovery of the propulsion system has become increasingly evident." He intended that his book would provide "a systematic and comprehensive treatment of flow characteristics of diffusers in general and inlet diffusers in particular." Hermann envisioned his audience to be scientists and engineers in government, industry, and academic research laboratories as well as graduate students.

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As we have seen, his course descriptions indicate Hermann's focus on engineering science and theory. Dick DeLeo spoke about Hermann's course, Supersonic Inlet Diffusers, which Hermann kindly offered in the afternoons to the staff of RAL in addition to his students on campus. He said, "His lectures … were very complete. He really didn't need the text at all. They were exceptionally good. And that [subject] was all new at that time. That was probably the best course at that time in the country." To the great benefit of the students, DeLeo recalled, "He used that [course] in the design of wind tunnel diffusers. We got a program with [Arnold Engineering Development Center] to develop supersonic diffusers for their big wind tunnels down in Tullahoma [in Tennessee] and used a lot of his theory there to help out. It was a very good course."

In the classroom and in the lab, Hermann brought theoretical knowledge and his understanding of engineering science to the students and put it in their hands. It seems the students benefited from Hermann's teaching methods and his personal style. DeLeo commented, "[Hermann] was more personable [than Akerman]. He would try to guide you." When working with Hermann, students faced real engineering problems like the design of the Tullahoma diffusers. Also, they studied with a world-class theoretician and, interacted professionally with experienced co-workers and supervisors. With Hermann at RAL, Minnesota students had one of their best opportunities to develop skills in engineering science.

After June 1958, Akerman was no longer the head of the department of Aeronautical Engineering. The resistance to change that he put up to Dean Spilhaus disappeared. The new department head, Benjamin Lazan, immediately took the stick and set a course for the coming decade. The Report of the Curriculum Committee presented to the College of Engineering in December 1958, included four typed pages of renamed, redesigned and reorganized-for-continuity, and new courses that were intended to better prepare students for the state of industry, a perspective of which Spilhaus believed Akerman had long ago lost sight. The changed even included abandoning the old three-quarter sequence of courses, Aerodynamics (Aero 100-101-102), a series whose description had been only slightly modified twice since 1931, and replacing it with the three-quarter series, Theoretical Aerodynamics.

It is difficult to know how much of a contribution Rudolf Hermann made to these changes towards a more theoretically-minded program. But these are some curriculum recommendations that reflect the high regard by the faculty and the administration for Hermann's work and teaching style. In a memorandum by the secretary of the Board of Regents, L.R. Lunden wrote,

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> *The President [of the University, O. Meredith Wilson,] discussed with the Board the need for an organizational change in the Rosemount Aeronautical Laboratories to provide more emphasis in the area of hypersonic research and a more direct relationship of the Laboratory to the Institute of Technology and the Graduate program.*

In the Biennial Report: 1960-1962, Acting Dean Frank Verbrugge of IT wrote, "A consolidation of the program of Rosemount Aeronautical Laboratories and a closer integration of that activity with the related graduate programs in I.T. was effected during 1961-1962," fulfilling the recommendation of President Wilson.

In June 1962, Rudolf Hermann left the University of Minnesota to accept the position of Director of the newly founded aeronautical research laboratory at the University of Alabama at Huntsville, a neighboring facility to Marshall Space Flight Center where Hermann's former collaborator from Peenemünde, Wernher von Braun, was working. But during his time at Minnesota, he contributed to the Aeronautical Engineering program his knowledge and understanding of supersonic and hypersonic theory and an approach to engineering science at a time when the Institute of Technology was ready for change.

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