R. T. Jones

1910–1999, Honorary Fellow AIAA

ROBERT Thomas Jones, Aeronautical Engineer, first went to work for NACA 65 years ago. During his long Civil Service career, he became one of the world's leading aerodynamicists, made discoveries that changed the history of aeronautics, and received many important honors. What sort of man was this, whose career has been so long and whose contributions have been so many and so important?

First, consider how he got into aeronautics. A fascination with aviation in the 1920s was commonplace among those of us who were schoolboys then. In Macon, Missouri, where he lived, young Bob read *Aero Digest*, treasured its cover pictures of the airplanes of the day, and poured over its technical articles on performance estimation, stability and control, and stress analysis. He began the design and construction of a small, motorcycle-engined airplane upstairs in his house. An unusual high school mathematics teacher helped him to understand stress and strain. High school graduation intervened, the airplane remained unfinished, and Bob went off to the University of Missouri in 1927. But the aviation bug had bitten him badly. He discovered Walter Diehl's famous *Engineering Aerodynamics* and found it more exciting than his required courses. He left the university to enter the aviation industry by working for Charles Fowler's flying circus, where he carried gasoline and patched biplane wings in exchange for flying lessons.

A great demand for a "family flyer of the air" was expected. In Marshall, Missouri, the Nicholas-Beazley Company began the manufacture of a sporty, three-place, low-wing, cantilever monoplane. Bob, with his highly practical (if brief) background in the flying circus and a good recommendation from Charles Fowler, landed a job there. The young Jones made it clear that the engineering office was where he wanted to be, and when a vacancy suddenly occurred there he was soon applying Diehl's aerodynamics, carrying out stress analyses, and performing static tests to failure. But Nicholas-Beazley, along with many other companies, was wiped out in 1930 by the depression.

When Nicholas-Beazley folded, Bob returned home to study Glauert's *Aerofoil and Airscrew Theory* and Munk's *Fundamentals of Fluid Dynamics for Aircraft Designers.* His father, chairman of the local Democratic committee, helped Bob get a job operating the elevator in the House Office Building, which was across the street from the Library of Congress. Bob paid visits to Dr. Albert F. Zahm, the library's director and once a member of NACA. They must have talked about mathematics, for Bob decided to study that field. He began with Hamilton's quaternions! Retired Congressman David J. Lewis went to Dr. Zahm to request instruction in mathematics and physics; the Congressman was 65 years old and had finished with law and government. Dr. Zahm sent him to the bright elevator boy across the street. Bob taught Lewis algebra and calculus.

At about this time Bob made another friend whose influence on his career was tremendous: Dr. Max M. Munk, who had left NACA, set up an office in Washington as consultant and patent attorney and was giving evening courses at Catholic University. When he discovered that the elevator boy had studied his book, he suggested to Bob that he take his evening course, a graduate course. When Bob said that he might not be prepared for it, Dr. Munk gave him a little oral exam and enrolled him. Bob took Munk's evening courses for about three years—vector analysis, airfoil theory, and relativity theory—and drew upon this early education throughout his career. The election of Franklin Roosevelt (1932) brought the Public Works Administration and emergency jobs to Langley Memorial Aeronautical Laboratory. Dr. Zahm and Congressman Lewis recommended Robert Jones for one of these jobs. It required a sequence of unlikely events and remarkable people, but Robert T. Jones was embarked on a career in research in NACA. But his appointment was for nine months only.

Bob's bosses, Fred Weick and Henry Reid, Director of the Langley Laboratory, tried to arrange for him to take a Civil Service exam so they could hire him permanently, but the Civil Service rules specified a bachelor's degree. Weick and Reid then thought to issue a special Civil Service exam that would require everything that Bob knew. In due course an examination was issued with questions on Hamilton's quaternions, operational calculus, aircraft stability and control, wing theory, and a few other subjects. To the surprise of those at Langley, another fellow showed up who could pass this exotic combination and had a bachelor's degree as well. Both were offered positions and Weick assigned the other applicant to Bob Jones, who put him to work. Bob finally got a permanent appointment at a subprofessional grade. Some years later, when he approached the first professional grade, P-1, he again encountered the requirement for the bachelor's degree. This time NACA was more ingenious: the stated requirements for grade P-2 did not mention any degree, so NACA promoted him directly to that grade! By the time World War II began, Bob had published important papers, including a most clever way to find the transient lift on finite-span wings. He had become deservedly well-known in aeronautical circles, especially as an expert in stability and control. Northrop Aircraft, where I was in charge of aerodynamics, was struggling with the problems of the all-wing airplanes, such as the YB 49, and every trip to Langley Field for wind-tunnel tests or other business included a visit to Bob to discuss stability and control, especially the properties of swept-back wings. When he worked out his famous theory of low-aspect-ratio wings in 1944 he became embarrassed when it was referred to by his name, because he thought it was an obvious extension of Dr. Munk's classical and well-known work.

At about the same time he remembered from an old NACA Technical Note of Munk's (1924) that you can calculate the effects of sweepback and dihedral angle in a wing by a simple "independence principle": the two-dimensional flow around the wing due to the stream component perpendicular to the wing axis is independent of the flow due to the stream component along this axis. Bob realized that this independence principle did not depend upon incompressibility, and thus he discovered the "theory of sweepback" which is certainly one of the most important discoveries in the history of aerodynamics.

At first he made the mistake of putting the low-aspect-ratio and sweep theories in the same paper, but the NACA editorial committee, which had to approve the paper, believed the former and not the latter. It seemed to some impossible to render a supersonic flow essentially subsonic by such a simple device as sweepback. Bob said in retrospect, "It has to be remembered that at that time there was thought to be a very great difference between subsonic and supersonic flow." While the argument with the editorial committee was still in progress, Bob's colleague Robert Hess read Adolph Busemann's 1935 paper concerning supersonic flow, and Hess and others realized that Busemann's argument would lead to the same result as Jones' if the wing were swept behind the Mach cone. But Busemann had not discussed this case in his paper, so the editorial committee remained unconvinced. Bob divided the troublesome paper in two parts, and the low-aspect-ratio part was published. NACA began experiments in an effort to confirm the startling conclusions of the simple-sweep theory. Before the experiments were completed, V-E Day occurred, Allied engineers went into Germany, and the news came back that the Germans, thanks to Albert Betz and Busemann, knew about this effect of sweep and were using it on all of their new designs. Shortly thereafter Bob pointed out this also applied to (unseparated) viscous flows. For his discovery of the sweep effect and other contributions, Bob was given the Sylvanus Albert

Reed Award by the Institute of the Aeronautical Sciences in 1946. It was also in 1946 that he left the Langley Laboratory and moved to Ames. Both Munk and Jones recognized the power of reverse-flow theorems for supersonic flow, which led Jones to discover that in supersonic flow a swept oblique wing with an elliptic load distribution has the lowest drag for a given lift. L. B. H. Smith then pointed out that if the thickness distribution were parabolic, this wing would have the lowest drag for a given volume, [the so-called Sears-Haack area distribution]. In 1958 this led Geoffrey Lee of Handley Page to propose an oblique-wing supersonic transport for what later became the Concorde.

Here again was an example of Bob's intuition: The aeroelastic properties of the oblique wing have frightened a number of engineers, for the upstream panel seems likely to deflect aeroelastically upward and the downstream panel downward. To Bob it seemed obvious that these effects simply do not occur in flight. A study of the equilibrium of rolling moments will confirm that he was right; the details are left to the reader. It must be said that the conclusion is not quite obvious to most aeronautical engineers.

From 1962 to 1970, Bob worked for Arthur Kantrowitz at the Avco-Everett Laboratories. At Avco he played an important role in the development of the intra-aortic balloon pump that assisted the heart muscle to pump blood, and also helped to nourish the heart muscle itself because of its timing. This assist device was used on more than one million patients.

Bob returned to Ames in 1970, and in 1971 was awarded the degree of Doctor of Science, honoris causa, by the University Colorado "in acknowledgment of his scientific eminence and his services to society." In 1973 he was elected to the National Academy of Engineering.

During this period, and with NASA Ames Director Hans Mark's full support, Bob undertook studies of pivoting-wing aircraft. This led to the AD-1 piloted aircraft that made fifty flights with seventeen different pilots, demonstrating landings at 45° sweep and acceptable flying qualities for wing sweeps up to 60°. Upon his retirement in 1976, NASA issued his collected works in more than one thousand pages; this article derives largely from my introduction to that volume.

Prior to his retirement from NASA Ames in 1981, he provided elegant analyses of flapping flight and winglets, which included consideration of the structures they require, and showed how his oblique-wing result could also be derived from M. N. Kogan's 1957 recognition that the intersection of a wing's rear and fore Mach cones forms a surface analogous to the Trefftz plane of subsonic theory. In 1990, he published his lovely book on wing theory, which every aerodynamicist should try to master.

In the late 1980s and early 1990s, doctoral students of Ilan Kroo at Stanford rekindled Bob's interest in the oblique-wing supersonic transport, resulting in remarkable PhD dissertations by Alexander Van der Velden and Stephen Morris on the subjects of oblique-wing supersonic transports and oblique-winged aircraft. Morris built and flew a 20-foot-span, twin-engined, and remotely controlled oblique wing that flew at sweeps up to 50°. This stimulated Dick Seebass' and his colleagues' interest in an oblique-wing supersonic transport as reported herein. The aeronautical world still seems hesitant to accept configurations without symmetry. Nevertheless, I, for one, fully expect to see future transport airplanes with "Jones' oblique wings."

Among Bob's many awards, a few of which are mentioned above, are the Prandtl Ring, the Congressional Excalibur Award, and the Smithsonian's Langley Award.

Aeronautical engineer, applied mathematician, astronomer, designer of telescopes, bio-mechanicist, violin maker, inventor, author, discoverer of profound principles, civil servant, devoted father—our highly honored friend Bob was all of these. He was also a man of exemplary character and a most delightful companion on any occasion, whose intelligence and intellectual honesty shone brightly from clear, big, blue eyes.

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