1965 ELMER A. SPERRY AWARD

PRESENTATION OF THE

1965 ELMER A. SPERRY AWARD

to

Maynard L. Pennell

Richard L. Rouzie

John E. Steiner

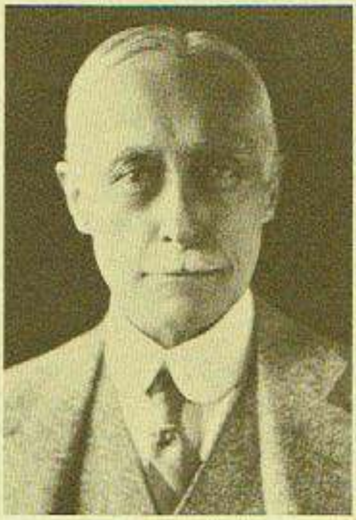
William H. Cook

Richards L. Loesch Jr.

With Citation to the men and women
of the Commercial Airplane Division,
The Boeing Company

By the Board of Award under the sponsorship of
The American Society of Mechanical Engineers
Institute of Electrical and Electronic Engineers
Society of Automotive Engineers
The Society of Naval Architects and Marine Engineers
American Institute of Aeronautics and Astronautics

AT THE ASME WINTER ANNUAL MEETING BANQUET
NOVEMBER 9, 1965 • SHERMAN HOUSE • CHICAGO, ILL.



ELMER AMBROSE SPERRY
1860-1930

FOUNDING OF THE AWARD

The Sperry Award commemorates the life and achievements of Dr. Elmer A. Sperry (1860-1930) by seeking to encourage progress in the engineering of transportation. Much of the great scope of the inventiveness of Dr. Sperry contributed either directly or indirectly to the advancement of the art of transportation. His contributions have been factors in improvement of movement of men and goods by land, sea and by air.

The award was established in 1955 by Dr. Sperry's daughter, Mrs. Robert Brooke Lea and his son Elmer A. Sperry Jr., and is presented annually.

PURPOSE OF THE AWARD

The Elmer A. Sperry Award shall be given in recognition of—

"A distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation whether by land, sea or air."

1965 BOARD OF AWARD

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MAYNARD L. PENNELL

RICHARD L. ROUZIE

JOHN E. STEINER

WILLIAM H. COOK

RICHARDS L. LOESCH JR.

AWARD CITATIONS

MAYNARD L. PENNELL for leading the study, design and research team which engineered and produced America's first jet transport and guided the evolution of the Boeing family of jet airliners.

RICHARD L. ROUZIE for bringing engineering production experience to the jet airliner family first as chief project engineer, later as chief engineer and then as director of engineering.

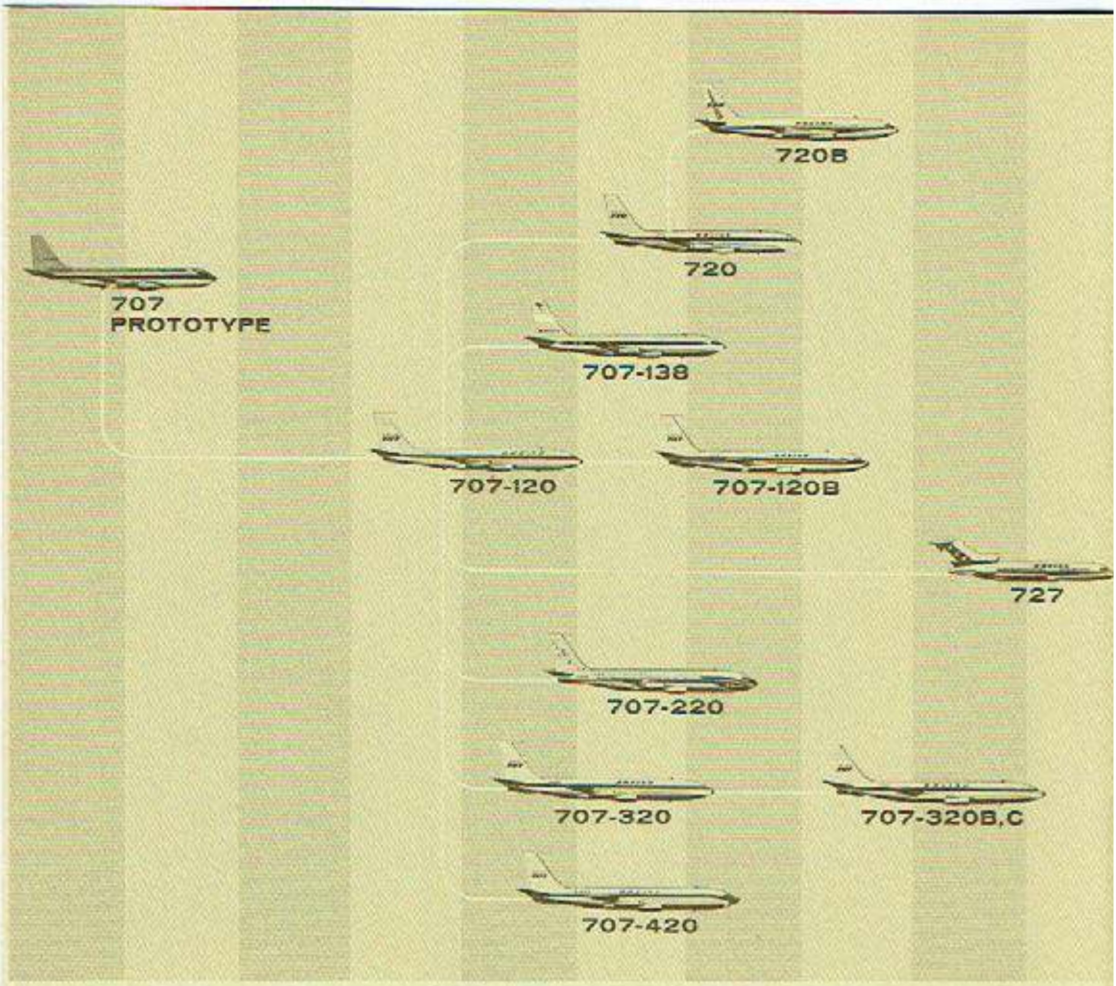
JOHN E. STEINER for applying knowledge of airline requirements and aircraft operations to the design of the jet family and leading development of the 727 as chief project engineer.

WILLIAM H. COOK for directing the applied research effort which served as the basis for the engineering excellence of the jet transport family.

RICHARDS L. LOESCH JR. for providing continuous leadership for the flight test programs of the 707-720-727 series which established the practical operation of the jetliner family.

CERTIFICATE OF CITATION

To the men and women of the Commercial Airplane Division, The Boeing Company, for their dedicated effort and essential contribution to the concept, design, development, production and practical application of the family of jet transports exemplified by the 707, 720 and 727.



THE JET TRANSPORT FAMILY

BY THE END OF 1945, under the impetus of a world at war, the technologies of air transportation had moved to a new threshold. Cabin pressurization had been refined; radar had become a navigational reality; piston engines had been improved in power, reliability and economy; payload had grown. Many of the advances were incorporated in the first large post-war transports—the Constellation, the Stratocruiser and the DC-6. But there was another war-born factor: The jet engine had come into its lusty, squalling infancy.

Design engineers knew that the new jet engine must in time become a part of commercial air transport. They knew, too, that such an application would demand the greatest engineering advance in the history of commercial aviation. Theretofore no new airliner had surpassed its predecessors in speed by more than 100 miles an hour nor materially in cruise altitude. The jet engine promised speeds into the transonic zone but demanded high altitude for economic operation. The engineering challenge implicit in the new factors of speed and altitude alone was of the first magnitude.

When, in 1946, The Boeing Company assigned a design engineering group to explore and evaluate potentials in the future of transport aircraft, the company had begun the release of engineering drawings for the construction of the world's first swept-wing jet-powered bomber — the XB-47. By 1952, when the definitive design for America's first jet transport had been presented to Boeing management for decision, the B-47 was in production and the B-52 was poised for its first test flight. Behind these two pioneering jet bombers lay more than 12,000 hours of wind tunnel research and unnumbered man-hours of engineering design and structural development.

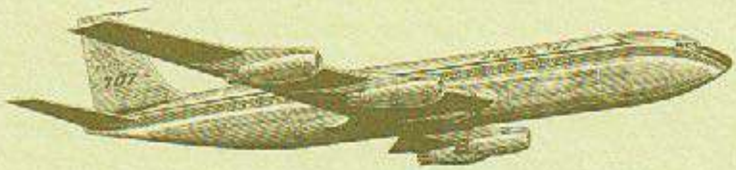
In England, in the same year, the DeHavilland Comet, a jet airliner of more conventional design, was being readied to go into service on Britain's national overseas airline. This pioneering effort, given appropriate recognition with the Elmer A. Sperry award in 1959, had represented, as Sir Aubrey Burke said, the British aircraft industry's bid for a share of the post-war airliner market.

With the counsel and support of his top technical and administrative management, William M. Allen, Boeing president, asked his Board of Directors to authorize a company-funded jet transport prototype program which was to cost sixteen million dollars. Incorporated in this decision was a philosophy of wholehearted responsiveness to airline needs and requirements. Perhaps the greatest contribution to the refinement of the subsonic jet airliner concept was the insistence that the jet transport should not only add long range and high speed but should provide those attributes on an economic basis and with flight characteristics in all regimes from takeoff to landing which were entirely suitable for and compatible with airline operations. In addition to the safety and comfort of its passengers, which were basic, the jet airliner was to have the potential for growth which would provide for the further orderly development of this new advance in transportation.

From the beginning the design, development and production of the Boeing family of jet airliners was a team effort. The revolutionary nature of the concept called for new structures, new wings and airfoils, new systems, new doors, new windows, new manufacturing processes — a wholly new airplane.

As the project grew it drew upon the skills and experience of thousands of individuals whose activities were integrated into an organization dedicated to the achievement of a fixed goal. No one man, nor five, nor ten could do the whole design and engineering job, but one man must lead and motivate and inspire, and he must have lieutenants whose management skills, knowledge and capacities set them apart in their areas of specialization.

From 1946 until the jetliner family was an established reality, Maynard L. Pennell was the active engineering management head of the project. First as chief of preliminary design, later as senior project engineer, chief project engineer - aircraft, chief engineer of the Transport Division and director of engineering for the division, he led his team through the maze of engineering problems which the creation of a wholly new air-



plane presents. It was his accurate appraisal, in the late 1940s, of jet transport possibilities that led most directly to the decision to build the 707 prototype. His conviction that everyone connected with a project has a contribution to make inspired active creative effort on the part of every person on his team, and so brought the uninhibited, advanced concepts of young engineers and scientists into the same development pool with the experience-based designs of their seniors.

In the field of engineering production, the leadership and experience of Richard L. Rouzie made outstanding contributions to the project. The varied requirements of airlines called for changes from one airplane to another as they rolled from final assembly. Rouzie's ability to visualize the extent of repercussion in structure, aerodynamics, weight and strength from a given change and his capacity to transmit the nature of the challenge to his engineers saved the 707 project from costly delays and made every change work to the benefit of the entire aircraft.

Rouzie drew upon his experience with such commercial planes as the Model 307 Stratoliner of 1939 — the first transport with cabin pressurization — and the Model 377 Stratocruiser — the commodious post-war civil airliner with its unique lower deck lounge — to develop the new and complex engineering release and control systems required. In a major change from past practices, he made greatly increased use of electronic computers in these systems, assuring each airline customer an economic vehicle tailored to its particular requirements without jeopardizing either the airplane's integrity or its delivery date.

John E. Steiner's contribution to the jet airliner program began when he assumed responsibility for all aerodynamics research and analysis in 1947 from his previous work as a flight engineer and flight test aerodynamicist. His assignment shifted to preliminary design as the 707 prototype construction began, and when orders for the first production airliners were received, he assumed direction of all 707 engineering coordination with customer airlines. In this capacity his understanding of aircraft operational problems provided the basis for liaison which implemented even further the policy of responsiveness to airline requirements.

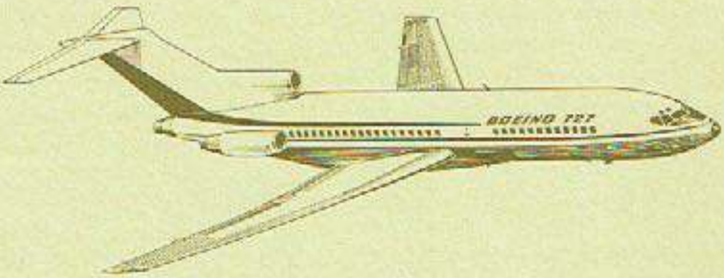
The "family" concept of jet airliners had emerged early in the studies of Maynard Pennell's original group: a recognition that too great a variety of requirements imposed upon a single and therefore limiting design would result in more compromises than complete satisfactions of those requirements. As Steiner's airline liaison information was coordinated, the specific needs for a jetliner family became even more clear. The first commercial 707 was the 707-120, a four-engine transcontinental model with minimum transatlantic capability. A need for a similar aircraft with greater power for use from high altitude fields under high temperature conditions called for the 707-220, essentially the same airframe with larger, more powerful engines.

The first airframe change was made to meet airline requirements for greater range and more passenger and cargo space for the long routes. It was at this point that the salient airline-economics feature of the Boeing jetliner series was adopted: Each member of the family would incorporate as much of the dimensions, parts, structures and systems of the others as specific design limitations would allow. Thus when the longer 707-320 Intercontinental model with its increased wing area was announced, its cabin width was identical with that of its shorter predecessor. Throughout the -320, commonality of parts and systems with the -120 was maintained so that airlines employing both models would require smaller stocks of spare parts and would have to train maintenance and flight crews only once for the basics of their tasks, briefly for the essential differences.

Airlines with intermediate-range routes or with en route stops on transcontinental runs presented requirements which called for a new model. This jet transport would have range shorter than the -120 but equivalent passenger accommodation for that range and lower seat-mile costs. With its reduced fuel capacity requirement, the plane would be essentially lighter. Thus the Model 720 came into being. Again, its cabin width, essential structure and systems paralleled the previous models.

When market analysis forecasts indicated a growing air cargo requirement, design engineers provided for added flight deck strength, cargo doors, quick-handling equipment for palletized cargo and ultimately for quickly convertible passenger-cargo jetliners. In airline service, the cargo and convertible cargo (C) models of the 707-320 are providing volume and payload capacity which has helped to stimulate the movement of goods by air within the United States by 21 per cent and on United States international carriers by 65 per cent in the first five months of 1965 over the same period in 1964.

When the public's favorable reaction to jet flight indicated a growing demand for jet service on short-to-medium-range routes, Boeing market and traffic trend research indicated that the need was for an aircraft somewhere between the Caravelle size and the Model 720. It would require exceptional low-speed flight characteristics for operation into the small fields on shorter haul routes, and would call for unprecedented takeoff capability from runways only 5,000 feet in length. The requirements



called for a new model, one which would be a more radical departure from the original 707 design than the Intercontinental or the 720. Design groups established a three-engine configuration as most suitable.

The management decision to proceed with production of the new tri-jet 727 was made late in 1960. The essential question was: Would the new design live up to the promise it showed in market forecasts, on the drawing board and in the wind tunnel when it entered service?

From the start of the 707 prototype project, Pennell and his engineers had benefited from the counsel and direct assistance of two corporate executives, both distinguished engineers, whose achievements have won them international recognition. Edward C. Wells, a company director and vice president who heads the Boeing Airplane Group, was the 1942 winner of the Lawrence Sperry award of the Institute of the Aeronautical Sciences for his design contributions on four-engine aircraft. George S. Schairer, vice president for research and development, in 1949 received the Sylvanus Albert Reed award of the IAS for his work in development of large swept-winged, high-speed aircraft. While not directly attached to the jet airliner program, each contributed to a major degree in the design and development of the family of airliners, and both believed in the 727 design.

John O. Yeasting, vice president - finance at the time of the first 727 consideration, was especially aware of the impact which the introduction of a new model would impose upon the company's financial position. His confidence in the ultimate success of the proposed extension of the

jetliner family tree was reflected when he accepted the assignment as general manager of the Commercial Airplane Division at the start of the year in which the 727 decision was made.

From J. B. Connelly, vice president and assistant general manager for sales and contract administration in the Commercial Airplane Division came further support. Connelly had guided the sales program for the jet airliners from the beginning. As much as any other man in the company he knew the sales potentials and the probable reactions of the airline executives who would be instrumental in making purchase decisions. He was confident that the new model 727 would make a place for itself.

William M. Allen's decision to recommend the proposal to his Board of Directors was based upon the counsel of these men and others in his Management Council and also upon his own conviction that the team which had developed the new concept was the most competent which could have been assembled in the industry. The financial risk in this decision was greater than that which had launched the 707 prototype design and construction.

With the decision made, John Steiner was named senior project engineer for the 727 program. From its earliest flight tests, the new plane showed the results of the progressive refinement of a new product in its control systems, flight characteristics, comfort and economics. On certification flights the 727 became the first jet transport to land and take off at the La Paz, Bolivia airport at an altitude of 13,358 feet, and demonstrated its short-field and high-temperature capabilities at scores of airports in Europe, Asia and Australia. In its first year of airline service, the 727 proved to have bettered economic and performance guarantees by as much as 12 per cent to the benefit of both airlines and passengers.

Throughout the jetliner program, no innovation was permitted to be applied to production airplanes until it had undergone extensive research, development and test. To direct this activity, as preparations for the production 707-120 moved ahead, William H. Cook brought his years of technical aerodynamic experience gained in work on the B-29, B-47 and B-52 bombers and the supersonic Bomarc pilotless aircraft. Under his leadership philosophy which regards problems as natural functions of the job, the technical staff studied each requirement, conducting the research which served as the basis for the technical excellence of the designs throughout the development of the family of jet airliners.

Although the company had pioneered the design and construction of large swept-wing jet aircraft for the military, the application of these principles and the development of techniques required for commercial aircraft called for solutions and decisions which were new.

The relatively thin swept wing and the jet engine, both basic to the design, presented a curious paradox: both were aerodynamically "clean", greatly reducing the drag of previous aircraft and the aircraft thus had excellent cruise weight-carrying capability. Conversely, the low drag presented an approach problem of float over the runway, and the jet engine, less efficient at sea level than at altitude, could lift off a disproportionately lower weight. To resolve the paradox, a means of controlled drag augmentation and a sophisticated flap system for high lift on takeoff were required. Added sea level thrust for the early engines was achieved with the development of water injection systems and refinement of the engine intake configuration.

Improved flap systems, ultimately including leading-edge flaps and slats, were developed. The spoiler system of the earlier military jets was revised and improved to provide not only drag augmentation for approach but to act as air brakes for swift descent from altitude in emergency and to accomplish extra-positive lateral control throughout the flight regime. During landing roll, the system also spoiled the wings' lift, allowing for greater wheel brake effectiveness.

Engine positioning was based essentially upon flap segment pattern. The Boeing-developed pod mounting system was retained, but for ease of airline maintenance and to prevent possible involvement of a second engine through failure of any one, the twin-pod mounting of the B-52 engines was abandoned in favor of single-engine pods. To prevent or reduce aerodynamic drag interference with the wing, the engines were suspended below and largely forward of the wing leading edge.

The wings themselves, designed to take advantage of the distribution of engine weight, retained much of the elasticity of the earlier swept-wing bombers to spill gusts and reduce the effect of high altitude turbulence. Outboard ailerons provided low-speed lateral control for takeoff and approach, but locked out in favor of small inboard ailerons near the top of flap retraction to eliminate twisting action at high speed. At high speed, the combination of spoilers and inboard ailerons provided complete lateral control.

As chief of technical staff, Cook was responsible for the research which led to the 727 wing which, with its triple-slotted flaps and leading edge flaps and slats provides 50 per cent more lift effectiveness on the 727 over the original 707 without sacrificing speed, and also provides the low-speed control to make short field operations possible.

Contributions by the technical staff were not, however, limited to pure aerodynamics. There was need for a reliable thrust reverser which, like the reversible pitch propellor, would use engine power to slow the aircraft after touch-down. Early studies elsewhere had been inconclusive. Research into this development led to the thrust reverser which in tests stopped a 707 within 7,000 feet of touch-down without the use of brakes and, finally, moved the airplane backward.

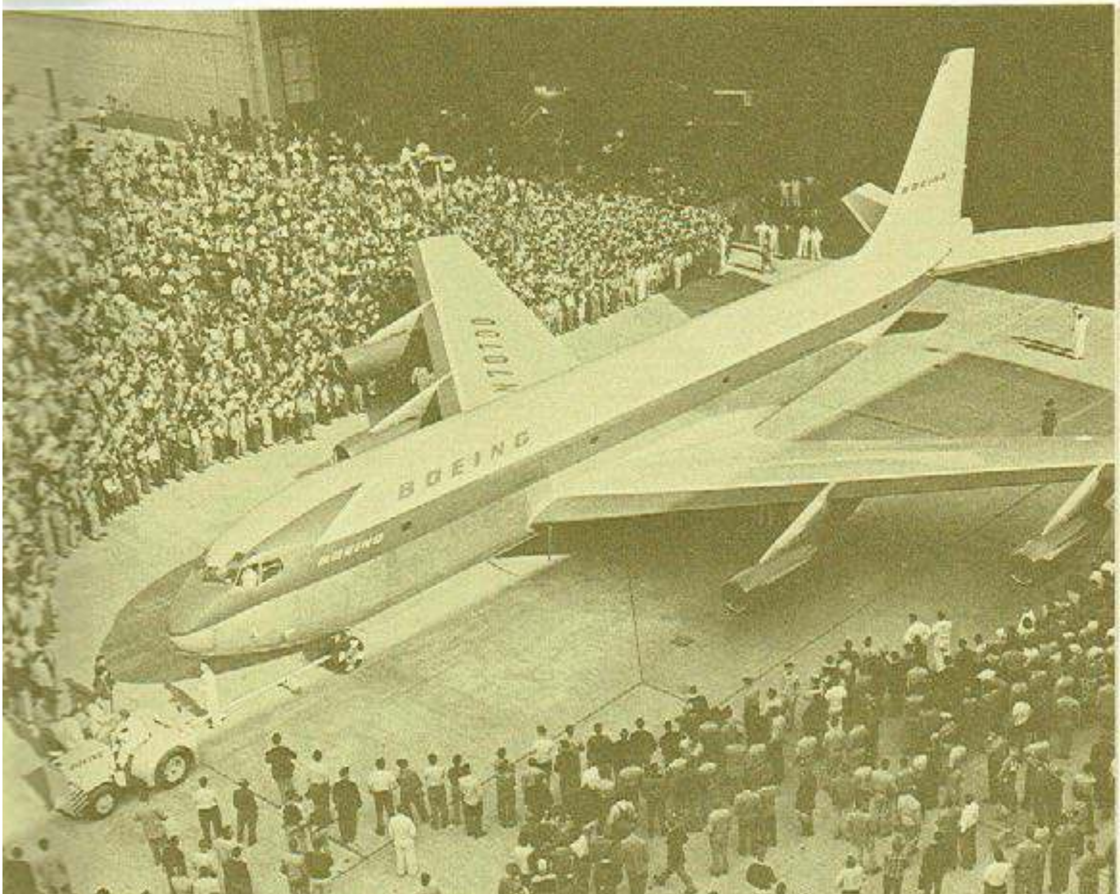
The sound of jet engines presented another early problem. Attempts to hush the turbo-jet without seriously affecting its thrust had been made, but the problem still presented a challenge which the research engineers met with a multiple-port device which was installed on all 707s. Later, when the more powerful and quieter by-pass or "fan" engine which powers the B and C models had been developed by the engine manufacturers, the sound suppressor no longer was needed for the jet exhaust, but public acceptance of the jet airliners probably would not, without it, have been so successfully achieved.

As the Boeing swept-wing and pod-mounted engines had contributed to the speed and weight factors of jet transport design, so did a new approach in structure emerge to cope with the problems which very high altitude imposed. The engineering team, aware of the metal fatigue potential of a fully pressurized cabin flexed through innumerable takeoff-to-very-high-altitude-to-landing cycles, sought a structure based upon a fail-safe principle rather than upon exaggerated and therefore very heavy structural strength levels. By incorporating redundant load paths so that if one member failed, its burden would be picked up by at least two other members, they made in a single stride more progress in limiting airframe damage propagation than had been made during preceding decades. Tests in which a guillotine blade was dropped to sever a major structural member in an over-pressurized cabin section proved that the design was fail-safe.

Testing went on from the first day of prototype construction. Technical staff supervised tests of every component and, ultimately, of the whole structure, each test adapted to the operating conditions under which the part would be used. One fuselage went into a static test rack in which loads up to one million pounds could be exerted in any pattern found in the flight regime. Another went into a water tank where, wholly submerged, the structure was subject to alternate pressurization and depressurization while the frame was subject to the twists and jolts of takeoff, in-flight turbulence and landing. In quick repetition, these cyclic tests within nine months had given the effect of 50,000 flights in airline service.

The ultimate test is in the air. On the day — July 15, 1954 — when the 707 prototype took off on its maiden flight with then Chief of Flight Test A. M. "Tex" Johnston as pilot, Richards L. Loesch Jr., as co-pilot, began his major contribution to the jetliner program. First as experimental flight test pilot assigned to the project, later as chief experimental flight test pilot and presently as chief of all flight test, Loesch has provided continuous leadership to the project. An aeronautical engineering graduate of the Massachusetts Institute of Technology, he was a Navy fighter pilot in the South Pacific. He came to Boeing as an aerodynamicist before joining the experimental flight test section.

With scientific deliberation, Loesch checked every system in detail under operating conditions. In many areas the results surpassed the designers' predictions; in others, test reports called for design changes which con-



America's first jet transport, the prototype 707, rolled from the factory May 14, 1954. The airplane has been in test and development flight ever since, assessing each advance in jet airliner refinement. After more than 1500 test flights, the prototype has just completed a Boeing-NASA-sponsored series of supersonic transport control system flight tests.

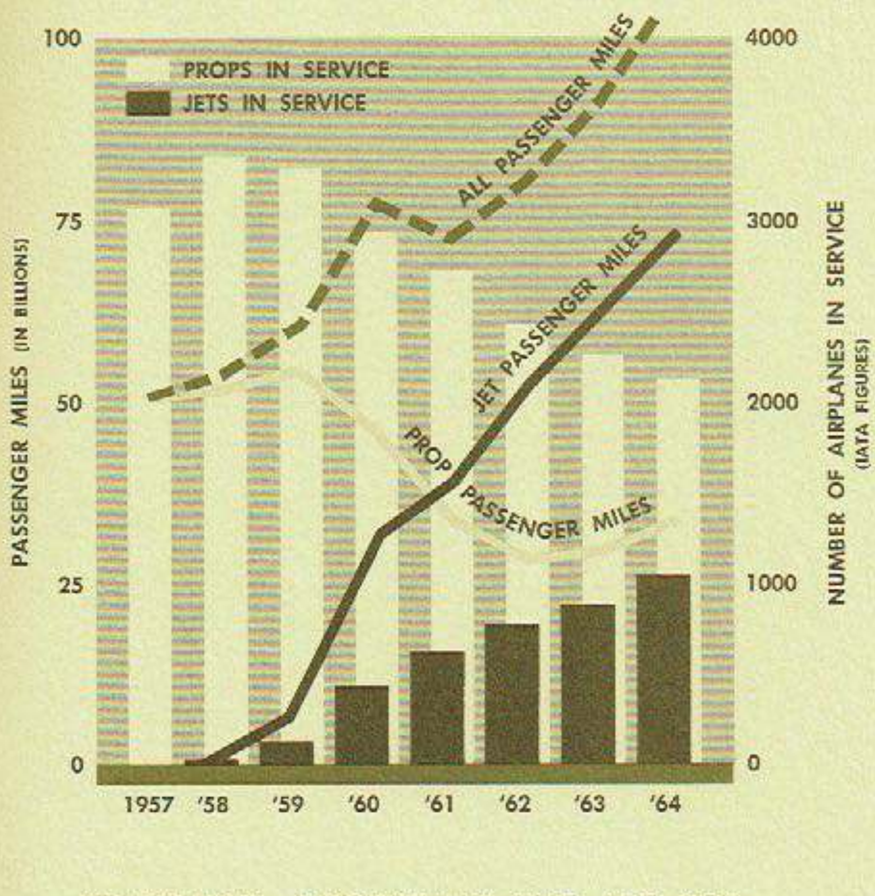
tributed materially to the production aircraft's performance and reliability. Throughout the 707-720-727 program the prototype airliner has been used to test every advance in jetliner development.

Loesch and his team of flight test engineer-pilots and analysts also have assessed the performance and characteristics of each new member of the jetliner family. Their development of an advanced system of telemetering and data processing made it possible to have processed data available by the time the flight which had produced the data had landed. The contribution to the end product of this effort alone included both technical excellence and condensation of the flight test time schedule.

As the Boeing family of jet transports continues its growth through the skills of its team of more than 20,000 members, advancements in its safety, capabilities and economics continue to be made. Proof of the advance in air transportation which it has provided is reflected in airline and passenger acceptance.

In 1957, the last full year before pure jet airliners came into regular service, the world-wide revenue passenger mile total was 50.5 billion. In 1964, the world total was 107 billion revenue passenger miles of which more than 85.5 billion — 80 per cent — were flown on jet aircraft. The productivity of the jet airliners is especially reflected in the 1964 figures when it noted that the 80 per cent were flown on 1,040 jet aircraft, while approximately 2,125 propellor-driven planes accounted for the remaining 20 per cent.

The men honored with the Elmer A. Sperry Award for 1965 and the fellow-members of their team have led the way in bringing a new dimension to air transportation. They have ushered in an era in which world distances have been shrunk by half in time and in which our travel patterns have been irrevocably changed. Their contribution to the art of transportation is the more significant because, as a result of the technological advances they have developed, the intercommunication between peoples which contributes to world understanding, stability and progress has been stimulated on an unprecedented scale.



AIR TRAVEL GROWTH IN THE JET AGE

THE ELMER A. SPERRY AWARD MEDAL

In the words of Edmondo Quattrocchi, the sculptor of the medal . . .

"This Sperry medal symbolizes the struggles of man's mind against the forces of nature. The horse represents the primitive state of uncontrolled power. This, as suggested by the clouds and celestial fragments, is essentially the same in all the elements. The Gyroscope, superimposed on these, represents the bringing of this power under control of man's purposes."