The Elmer A. Sperry Award 2013

FOR ADVANCING THE ART OF TRANSPORTATION

The Elmer A. Sperry Award

The Elmer A. Sperry Award is given in recognition of the distinguished engineering contribution, which through application, has proved itself in actual service, and has advanced the art of transportation whether by land, sea, air, or space.

In the words of Edmondo Quattrocchi, sculptor of the Elmer A. Sperry Medal:

"This Sperry Medal symbolizes the struggle 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 for man's purposes."

Presentation of

The Elmer A. Sperry Award for 2013

to

C. DON BATEMAN

in recognition for

the development of the ground proximity warning system for aircraft

by

The Elmer A. Sperry Board of Award

under the sponsorship of the:

American Society of Mechanical Engineers
Institute of Electrical and Electronics Engineers
SAE International
Society of Naval Architects and Marine Engineers
American Institute of Aeronautics and Astronautics
American Society of Civil Engineers

at the

IEEE AEROSPACE CONFERENCE
Big Sky, Montana
March 1-8, 2014
http://www.aeroconf.org/

C. Don Bateman

Don Bateman is a corporate fellow and chief engineer for Flight Safety Technologies in Advanced Technology Engineering for Honeywell.

Don was born in 1932 in Saskatoon, Saskatchewan, Canada. He graduated with a BSEE degree from the University of Saskatchewan. Don's interest began when he was five when his father took him to a "Barn Stormer" air show in the summer of 1937. Later as a youngster in 1940, he would pedal his bicycle to the airport to watch young Canadian Air Force recruits trying to obtain their flying wings in de Havilland Tiger Moths. Hundreds did so and most went to World War II to fly fighters and bombers. Sadly, many never returned. Don lost two uncles –one in training and the other on a night bombing run over Holland.

His first flight was a ride in a war-time de Havilland "Mosquito" and he forever became an addict to flying. Later in life he would get his own "wings" from the FAA, and followed through with an Instrument rating and accumulated 2,100 flight hours of experience. He went to work for Boeing on the B-707 as a young avionic system designer and then moved to a small "start up" company that eventually became Honeywell. Don is still employed today with 53 years of service with the same company.

Don became interested in flight safety accidents starting in 1956 and became a pioneer in developing many flight instruments and systems still in use today.

Don is primarily recognized for his invention, evolution and improvement to what is known as Ground Proximity Warning Systems.

Ground Proximity Warning Systems have helped make flying much safer for the flight crew and passengers but left room for improvement.

C. Don Bateman

THE GPWS STORY

Since the advent of commercial aviation in the late 1920s, over 20,000 passengers and flight crews have lost their lives in terrain related accidents. In each of these accidents the aircraft were airworthy, fully controllable and being flown by a healthy flight crew that unfortunately was not aware that their flight path was headed into terrain or was short of the landing runway. These accidents became known as Controlled Flight Into Terrain accidents (CFIT) and added to much of the public's fear of flying.

After two such disastrous CFIT accidents in 1967, Scandinavian Airlines gave wide attention to the danger of CFIT and publicized the need for a simple low cost cockpit warning in every aircraft cockpit. In response to this need, Don Bateman thought about the development of a cost effective CFIT warning system using signals from existing cockpit instruments. He began an ongoing study of the flight paths into terrain using official accident reports and data collected from flight data recorders. Over the course of the 1970s, this evolving system became known as the Ground Proximity Warning System (GPWS) or commonly called "GIP wiz" by line pilots. GPWS was continuously improved over time based on experience and knowledge. As the original GPWS evolved and improved, airlines updated and replaced their initial GPWS in an effort to keep pace with the resulting safety improvements. Eventually the present day system known as the Enhanced Ground Proximity Warning System was developed and is installed on virtually every commercial aircraft in operation today.

The Radio Altimeter, invented earlier by Howard Hughes, was the key sensor used by Don Bateman in his earliest version of GPWS in 1967. The Radio Altimeter monitored the height of the aircraft flying above ground or water and was widely installed on commercial aircraft. Other existing cockpit instrumentation used by the earliest version of GPWS included the air data computer, the glidescope receiver, as well as signals from the landing gear and landing flaps. Don Bateman collected data from over 300 CFIT accidents and sought to provide warnings for unusual flight situations, such as flying with the landing gear still up while less than 500 feet above the ground.

Simple warnings were given for an aircraft descending shortly after take-off, flying in close proximity to terrain, descending at unusually excessive descent rates while close to the ground, flying below the normal glidescope signal on approach, and the aircraft not yet in landing configuration while on approach. Later, an alert was developed for descent below a minimum descent value on approach to land. The warning for an excessive terrain closure rate for flight into precipitous terrain was among the more challenging warnings developed for GPWS.

Speed information from the air data computer was also later added to help maintain the warning time before impact and individual voices were used to help the pilot identify the cause of the warning.

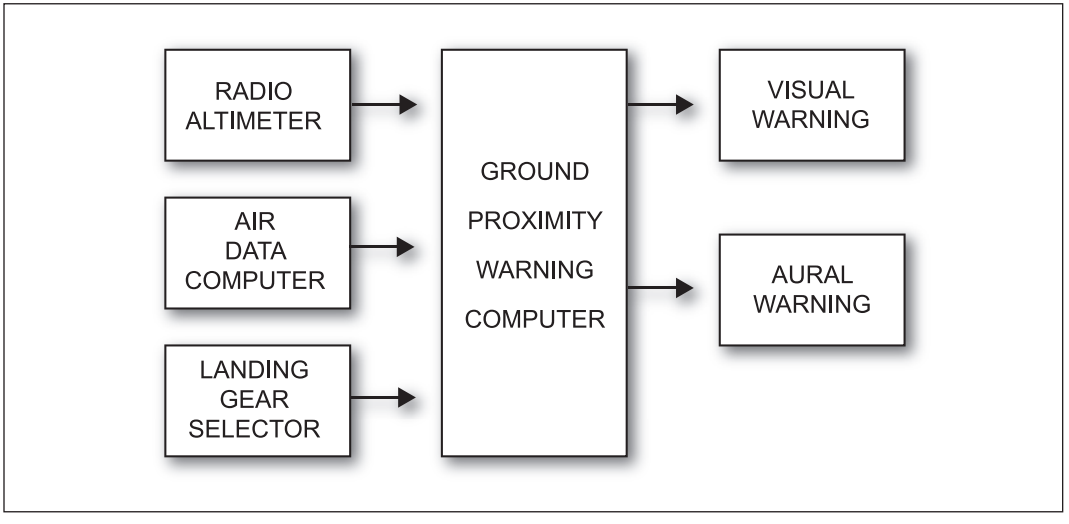

Figure 1 -- 1967 GPWS Computer System Block Diagram.

The original GPWS computer containing the signal interface and audio/visual outputs was about the size of a chocolate box and weighed less than ten pounds. To help minimize false warnings in the real world environment and to further the development of GPWS, many historical CFIT accident flight paths were flown and tested in varying test flight aircraft.

While the National Transportation Safety Board (NTSB) quickly recommended the adoption of GPWS by the commercial aircraft industry, the official Federal Aviation Administration (FAA) position regarding CFIT accidents was that they were caused by a pilot's failure to properly monitor cockpit instrumentation and follow proper flight procedures. As a result the commercial aircraft industry's initial adoption of GPWS was slow, however as CFIT accidents continued to take place, the industry began to take note. In the early seventies Pan American Airlines installed GPWS in their entire fleet of aircraft. Other airlines followed suit. Boeing decided to fit GPWS as standard safety equipment on every new delivered aircraft. In late 1974, after a tragic CFIT accident occurred with an aircraft on approach to Dulles International Airport, the FAA mandated all commercial transport aviation be equipped with GPWS. The International Civil Aviation Organization (ICAO) subsequently recommended adoption of GPWS and countries such as the United Kingdom began to require GPWS installation on commercial transport aircraft as a result. CFIT accident occurrence began to dramatically decline.

In the 1980s, Boeing and the Flight Safety Foundation began serious efforts to make the industry more aware of the CFIT accident risk and began pilot training with flight procedures for GPWS warnings. However, GPWS had limitations and was not a panacea for eliminating CFIT risk. The warning times in precipitous terrain were limited by the downward radio altimeter, which could not "see ahead" into terrain. The aircraft could also be flown into the ground or water on approach to land with no warnings in a stable approach path while at an airport without a glideslope landing aid. Terrain awareness for the pilot did not exist with early model GPWS. With additional technology, a new GPWS known as the Enhanced Ground Proximity Warning System (EGPWS) was developed which lowered CFIT risk even more dramatically and was a huge step forward for commercial flight safety.

A major improvement found in EGPWS was the addition of a worldwide terrain database which provided a color picture of the terrain both around and ahead of the aircraft as well as much earlier warning times for the flight path of the aircraft flying into terrain. Knowing the position of the aircraft in relationship to the runway provided warnings not possible with the original GPWS. This worldwide terrain database was made possible with the end of the Cold War and the resulting terrain data that became available with the fall of the Iron Curtain. The United States followed by mapping the world's terrain from plus and minus 70 degrees latitude using their Space Shuttle and side looking radar. Later the US and Japan augmented the terrain database for Polar Regions with an Advanced Spaceborne Thermal Emission and Reflection (ASTER) System using infrared cameras mounted on satellites.

With this previously classified terrain data, Don Bateman's team was able to create terrain flash memory databases that were later used to produce a terrain picture on existing color weather radar displays installed on most commercial transport aircraft. This terrain data was used to provide earlier awareness and warning times for pilots. EGPWS warning times more than doubled and provided alerts for premature descent approach to runways. This situational awareness provided by the terrain display was welcomed by pilots.

The accurate and inexpensive global position data from the U.S. Satellite Global Positioning Navigation System, the advent of inexpensive digital technology, and the terrain data made available by the end of the Cold War all made possible significant GPWS improvements resulting in further improved flight safety.

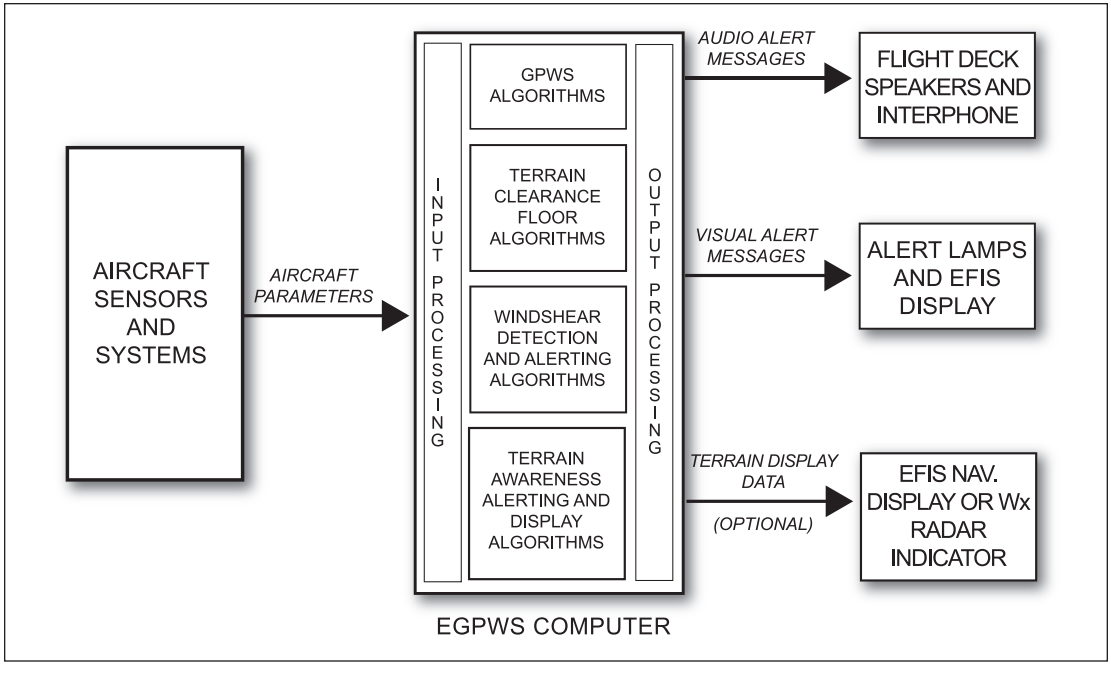

Figure 2-- Enhanced GPWS (EGPWS) BLOCK DIAGRAM.

As the result of a major CFIT accident, the FAA mandated that EGPWS be installed on all passenger aircraft with six passenger seats or more. The ICAO and the rest of the world followed quickly with similar mandates. After over 15 years of EGPWS operation, the risk of a CFIT accident has fallen even more dramatically.

Today, passengers can fly with the knowledge that a CFIT accident is a rare event thanks to GPWS and the EGPWS.

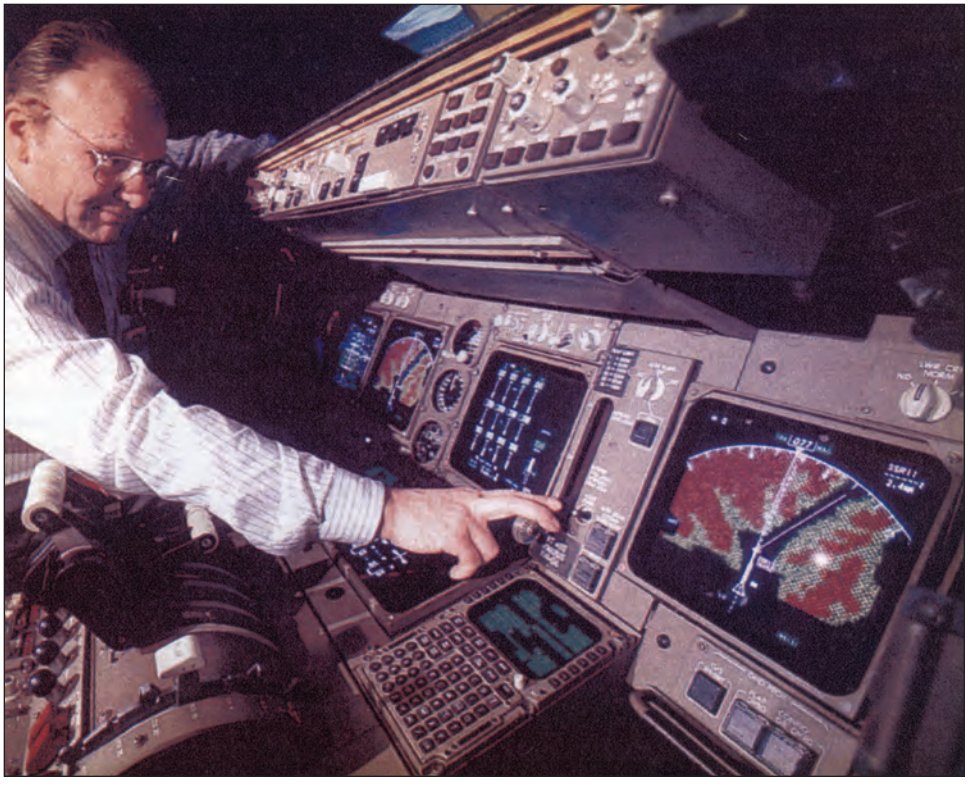

Figure 3-- A cockpit with EGPWS/terrain-weather radar display.

Elmer A. Sperry, 1860-1930

After graduating from the Cortland, N.Y. Normal School in 1880, Sperry had an association with Professor Anthony at Cornell, where he helped wire its first generator. From that experience he conceived his initial invention, an improved electrical generator and arc light. He then opened an electric company in Chicago and continued on to invent major improvements in electric mining equipment, locomotives, streetcars and an electric automobile. He developed gyroscopic stabilizers for ships and aircraft, a successful marine gyro-compass and gyro-controlled steering and fire control systems used on Allied warships during World War I. Sperry also developed an aircraft searchlight and the world's first guided missile. His gyroscopic work resulted in the automatic pilot in 1930. The Elmer A. Sperry Award was established in 1955 to encourage progress in transportation engineering.

The Elmer A. Sperry Award

To commemorate the life and achievements of Elmer Ambrose Sperry, whose genius and perseverance contributed so much to so many types of transportation, the Elmer A. Sperry Award was established by his daughter, Helen (Mrs. Robert Brooke Lea), and his son, Elmer A. Sperry, Jr., in January 1955, the year marking the 25th anniversary of their father's death. Additional gifts from interested individuals and corporations also contribute to the work of the board.

Elmer Sperry's inventions and his activities in many fields of engineering have benefited tremendously all forms of transportation. Land transportation has profited by his pioneer work with the storage battery, his development of one of the first electric automobiles (on which he introduced 4-wheel brakes and self-centering steering), his electric trolley car of improved design (features of its drive and electric braking system are still in use), and his rail flaw detector (which has added an important factor of safety to modern railroading). Sea transportation has been measurably advanced by his gyrocompass (which has freed man from the uncertainties of the magnetic compass) and by such navigational aids as the course recorder and automatic steering for ships. Air transportation is indebted to him for the airplane gyro-pilot and the other air navigational instruments he and his son, Lawrence, developed together.

The donors of the Elmer A. Sperry Award have stated that its purpose is to encourage progress in the engineering of transportation. Initially, the donors specified that the award recipient should be chosen by a Board of Award representing the four engineering societies in which Elmer A. Sperry was most active:

American Society of Mechanical Engineers
(of which he was the 48th president)

American Institute of Electrical Engineers
(of which he was a founder member)

Society of Automotive Engineers

Society of Naval Architects and Marine Engineers

In 1960, the participating societies were augmented by the addition of the Institute of Aerospace Sciences. In 1962, upon merging with the Institute of Radio Engineers, the American Institute of Electrical Engineers became known as the Institute of Electrical and Electronics Engineers; and in 1963, the Institute of Aerospace Sciences, upon merger with the American Rocket Society, became the American Institute of Aeronautics and Astronautics. In 1990, the American Society of Civil Engineers became the sixth society to become a member of the Elmer A. Sperry Board of Award. In 2006, the Society of Automotive Engineers changed its name to SAE International.

Important discoveries and engineering advances are often the work of a group, and the donors have further specified that the Elmer A. Sperry Award honor the distinguished contributions of groups as well as individuals.

Since they are confident that future contributions will pave the way for changes in the art of transportation equal at least to those already achieved, the donors have requested that the board from time to time review past awards. This will enable the board in the future to be cognizant of new areas of achievement and to invite participation, if it seems desirable, of additional engineering groups representative of new aspects or modes of transportation.

The Sperry Secretariat

The donors have placed the Elmer A. Sperry Award fund in the custody of the American Society of Mechanical Engineers. This organization is empowered to administer the fund, which has been placed in an interest bearing account whose earnings are used to cover the expenses of the board. A secretariat is administered by the ASME, which has generously donated the time of its staff to assist the Sperry Board in its work.

The Elmer A. Sperry Board of Award welcomes suggestions from the transportation industry and the engineering profession for candidates for consideration for this award.

PREVIOUS ELMER A. SPERRY AWARDS

1955 To *William Francis Gibbs* and his Associates for design of the S.S. United States.

1956 To *Donald W. Douglas* and his Associates for the DC series of air transport planes.

1957 To *Harold L. Hamilton, Richard M. Dilworth* and *Eugene W. Kettering* and Citation to their Associates for developing the diesel-electric locomotive.

1958 To *Ferdinand Porsche* (in memoriam) and *Heinz Nordhoff* and Citation to their Associates for development of the Volkswagen automobile.

1959 To *Sir Geoffrey de Havilland, Major Frank B. Halford* (in memoriam) and *Charles C. Walker* and Citation to their Associates for the first jet-powered passenger aircraft and engines.

1960 To *Frederick Darcy Braddon* and Citation to the Engineering Department of the Marine Division of the *Sperry Gyroscope Company*, for the three-axis gyroscopic navigational reference.

1961 To *Robert Gilmore LeTourneau* and Citation to the Research and Development Division, *Firestone Tire and Rubber Company*, for high speed, large capacity, earth moving equipment and giant size tires.

1962 To *Lloyd J. Hibbard* for applying the ignitron rectifier to railroad motive power.

1963 To *Earl A. Thompson* and Citations to *Ralph F. Beck, William L. Carnegie, Walter B. Herndon, Oliver K. Kelley and Maurice S. Rosenberger* for design and development of the first notably successful automatic automobile transmission.

1964 To *Igor Sikorsky* and *Michael E. Gluhareff* and Citation to the Engineering Department of the Sikorsky Aircraft Division, *United Aircraft Corporation*, for the invention and development of the high-lift helicopter leading to the Skycrane.

1965 To *Maynard L. Pennell, Richard L. Rouzie, John E. Steiner, William H. Cook* and *Richard L. Loesch, Jr.* and Citation to the Commercial Airplane Division, *The Boeing Company,* for the concept, design, development, production and practical application of the family of jet transports exemplified by the 707, 720 and 727.

1966 To *Hideo Shima, Matsutaro Fuji* and *Shigenari Oishi* and Citation to the *Japanese National Railways* for the design, development and construction of the New Tokaido Line with its many important advances in railroad transportation.

1967 To *Edward R. Dye* (in memoriam), *Hugh DeHaven*, and *Robert A. Wolf* for their contribution to automotive occupant safety and Citation to the research engineers of *Cornell Aeronautical Laboratory* and the staff of the Crash Injury Research projects of the *Cornell University Medical College*.

1968 To *Christopher S. Cockerell* and *Richard Stanton-Jones* and Citation to the men and women of the *British Hovercraft Corporation* for the design, construction and application of a family of commercially useful Hovercraft.

1969 To *Douglas C. MacMillan, M. Nielsen* and *Edward L. Teale, Jr.* and Citations to *Wilbert C. Gumprich* and the organizations of *George G. Sharp, Inc.*, *Babcock and Wilcox Company*, and the *New York Shipbuilding Corporation* for the design and construction of the N.S. Savannah, the first nuclear ship with reactor, to be operated for commercial purposes.

1970 To *Charles Stark Draper* and Citations to the personnel of the *MIT Instrumentation Laboratories,* Delco Electronics Division, *General Motors Corporation*, and Aero Products Division, *Litton Systems*, for the successful application of inertial guidance systems to commercial air navigation.

1971 To *Sedgwick N. Wight* (in memoriam) and *George W. Baughman* and Citations to *William D. Hailes, Lloyd V. Lewis, Clarence S. Snavely, Herbert A. Wallace*, and the employees of *General Railway Signal Company*, and the Signal & Communications Division, *Westinghouse Air Brake Company*, for development of Centralized Traffic Control on railways.

1972 To *Leonard S. Hobbs* and *Perry W. Pratt* and the dedicated engineers of the Pratt & Whitney Aircraft Division of *United Aircraft Corporation* for the design and development of the JT-3 turbo jet engine.

1975 To *Jerome L. Goldman, Frank A. Nemec* and *James J. Henry* and Citations to the naval architects and marine engineers of *Friede and Goldman, Inc.* and *Alfred W. Schwendtner* for revolutionizing marine cargo transport through the design and development of barge carrying cargo vessels.

1977 To *Clifford L. Eastburg* and *Harley J. Urbach* and Citations to the Railroad Engineering Department of *The Timken Company* for the development, subsequent improvement, manufacture and application of tapered roller bearings for railroad and industrial uses.

1978 To *Robert Puiseux* and Citations to the employees of the *Manufacture Française des Pneumatiques Michelin* for the development of the radial tire.

1979 To *Leslie J. Clark* for his contributions to the conceptualization and initial development of the sea transport of liquefied natural gas.

1980 To *William M. Allen, Malcolm T. Stamper, Joseph F. Sutter* and *Everette L. Webb* and Citations to the employees of *Boeing Commercial Airplane Company* for their leadership in the development, successful introduction & acceptance of wide-body jet aircraft for commercial service.

1981 To *Edward J. Wasp* for his contributions toward the development and application of long distance pipeline slurry transport of coal and other finely divided solid materials.

1982 To *Jörg Brenneisen, Ehrhard Futterlieb, Joachim Körber, Edmund Müller, G. Reiner Nill, Manfred Schulz, Herbert Stemmler* and *Werner Teich* for their contributions to the development and application of solid state adjustable frequency induction motor transmission to diesel and electric motor locomotives in heavy freight and passenger service.

1983 To *Sir George Edwards*, *OM, CBE, FRS; General Henri Ziegler, CBE, CVO, LM, CG; Sir Stanley Hooker, CBE, FRS* (in memoriam); *Sir Archibald Russell, CBE, FRS;* and *M. André Turcat, L d'H, CG*; commemorating their outstanding international contributions to the successful introduction and subsequent safe service of commercial supersonic aircraft exemplified by the Concorde.

1984 To *Frederick Aronowitz, Joseph E. Killpatrick, Warren M. Macek* and *Theodore J. Podgorski* for the conception of the principles and development of a ring laser gyroscopic system incorporated in a new series of commercial jet liners and other vehicles.

1985 To *Richard K. Quinn, Carlton E. Tripp*, and *George H. Plude* for the inclusion of numerous innovative design concepts and an unusual method of construction of the first 1,000-foot self-unloading Great Lakes vessel, the M/V Stewart J. Cort.

1986 To *George W. Jeffs, Dr. William R. Lucas, Dr. George E. Mueller, George F. Page, Robert F. Thompson* and *John F. Yardley* for significant personal and technical contributions to the concept and achievement of a reusable Space Transportation System.

1987 To *Harry R. Wetenkamp* for his contributions toward the development and application of curved plate railroad wheel designs.

1988 To *J. A. Pierce* for his pioneering work & technical achievements that led to the establishment of the OMEGA Navigation System, the world's first ground-based global navigation system.

1989 To *Harold E. Froehlich, Charles B. Momsen, Jr.*, and *Allyn C. Vine* for the invention, development and deployment of the deep-diving submarine, Alvin.

1990 To *Claud M. Davis, Richard B. Hanrahan, John F. Keeley*, and *James H. Mollenauer* for the conception, design, development and delivery of the Federal Aviation Administration enroute air traffic control system.

1991 To *Malcom Purcell McLean* for his pioneering work in revolutionizing cargo transportation through the introduction of intermodal containerization.

1992 To *Daniel K. Ludwig* (in memoriam) for the design, development and construction of the modern supertanker.

1993 To *Heinz Leiber, Wolf-Dieter Jonner* and *Hans Jürgen Gerstenmeier* and Citations to their colleagues in *Robert Bosch GmbH* for their conception, design and development of the Anti-lock Braking System for application in motor vehicles.

1994 To *Russell G. Altherr* for the conception, design and development of a slackfree connector for articulated railroad freight cars.

1996 To *Thomas G. Butler* (in memoriam) and *Richard H. MacNeal* for the development and mechanization of NASA Structural Analysis (NASTRAN) for widespread utilization as a working tool for finite element computation.

1998 To *Bradford W. Parkinson* for leading the concept development and early implementation of the Global Positioning System (GPS) as a breakthrough technology for the precise navigation and position determination of transportation vehicles.

2000 To those individuals who, working at the French National Railroad (SNCF) and ALSTOM between 1965 and 1981, played leading roles in conceiving and creating the initial TGV High Speed Rail System, which opened a new era in passenger rail transportation in France and beyond.

2002 To *Raymond Pearlson* for the invention, development and worldwide implementation of a new system for lifting ships out of the water for repair and for launching new ship construction. The simplicity of this concept has allowed both large and small nations to benefit by increasing the efficiency and reducing the cost of shipyard operations.

2004 To *Josef Becker* for the invention, development, and worldwide implementation of the Rudderpropeller, a combined propulsion and steering system, which converts engine power into optimum thrust. As the underwater components can be steered through 360 degrees, the full propulsive power can also be used for maneuvering and dynamic positioning of the ship.

2005 To *Victor Wouk* for his visionary approach to developing gasoline engine-electric motor hybrid-drive systems for automobiles and his distinguished engineering achievements in the related technologies of small, lightweight, and highly efficient electric power supplies and batteries.

2006 To *Antony Jameson* in recognition of his seminal and continuing contributions to the modern design of aircraft through his numerous algorithmic innovations and through the development of the FLO, SYN, and AIRPLANE series of computational fluid dynamics codes.

2007 To *Robert Cook, Pam Phillips, James White,* and *Peter Mahal* for their seminal work and continuing contributions to aviation through the development of the Engineered Material Arresting System (EMAS) and its installation at many airports.

2008 To *Thomas P. Stafford, Glynn S. Lunney, Aleksei A. Leonov,* and *Konstantin D. Bushuyev* as leaders of the Apollo-Soyuz mission and as representatives of the Apollo-Soyuz docking interface design team: in recognition of seminal work on spacecraft docking technology and international docking interface methodology.

2009 To *Boris Popov* for the development of the ballistic parachute system allowing the safe descent of disabled aircraft.

2010 To *Takuma Yamaguchi* for his invention of the ARTICOUPLE, a versatile scheme to connect tugs and barges to form an articulated tug and barge, AT/B, waterborne transportation system operational in rough seas. His initial design has led to the development of many different types of couplers that have resulted in the worldwide use of connected tug and barges for inland waterways, coastal waters and open ocean operation.

2011 To *Zigmund Bluvband* and *Herbert Hecht* for development and implementation of novel methods and tools for the advancement of dependability and safety in transportation.

2012 To *John W. Duckett* for the development of the Quickchange Movable Barrier.

The 2013 Elmer A. Sperry Board of Award

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