



The Elmer A. Sperry Award 2010

FOR ADVANCING THE ART OF TRANSPORTATION



The Elmer A. Sperry 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, 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 2010

to

TAKUMA YAMAGUCHI

for his invention of the ARTICOUPLER, a versatile scheme to connect tugboats and barges to form an articulated tug and barge (AT/B) waterborne transportation system operational with variable draft barges 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.

Presented at the

Society of Naval Architects and Marine Engineers

Annual Meeting Banquet
November 4, 2010
Bellevue, Washington

MR. TAKUMA YAMAGUCHI -- NAVAL ARCHITECT



Mr. Takuma Yamaguchi received a Bachelor of Engineering in naval architecture from the University of Tokyo. He began his career at a ship design company working as a staff member in the basic design division for the ships of the newly reorganized navy, and after dissolution of this organization, he established, together with friends, a ship-design company and served as the chief designer. Here, he accumulated experience through the design of hundreds of ships of nearly all types from 40 ft to 800 ft.

Around 1970, he developed an interest in tug-barge coupling applicable in the rough seas around Japan and worked out the first tug-barge coupler ARTICOUPLE-F of the friction-engagement type in 1972 for marine constructors' use. Then, in compliance with a major shipping company's request, he developed a coupler of the multi-step tooth-engagement

type, ARTICOUPLE-H, in 1975 for oceangoing tug-barge trains with satisfactory results. This type was afterwards reformed into the ARTICOUPLE-K type. Further, in 1984, combining the features of friction- and tooth-engagement types, he developed a new coupler, the ARTICOUPLE-FR. These last three types found many clients because they could meet most of the demand. Five years later, in 1989, the first three-pin supported rigid-connection coupler, the TRIOFIX-TRF type, was developed, unifying friction- and tooth-engagements, and, after this type of complicated construction, three-pin couplers of simpler construction, the TRIOFIX-TR and TK were developed with satisfactory results.

As of spring 2010, 245 tug-barge coupler units have been delivered, and Mr. Yamaguchi still serves as the president and one of the technical leaders of his company. He has been fortunate and pleased to have had two outstanding mechanical engineers, Mr. Y. Hiwatari and Mr. K. Mogami, as colleagues since the development of the first coupler. The serial development of tug-barge couplers would not have been possible without the skilled support of these two colleagues.

THE ACHIEVEMENT


The method of running a barge or barges by pushing from astern is said to have commenced on large rivers in the U.S. about 150 years ago as an improvement over alongside towing. The name of the captain or operator who hit upon this excellent idea and realized it in practice is not known. Possibly because its application was so easy and so well suited for rivers and its economical effect was so high, it spread rapidly among river barge operators. This revolutionary method of operating barges in the form of a pushed barge convoy (Figure 1) is a technique purely invented and developed in the United States, and even after its introduction into Europe and Russia in smaller scales after the World War II, additional new techniques were not added except for the introduction of mechanical connectors in Russia in the 1950s.



Figure 1: Conventional Stern Pushed River Barge Convoys



This highly economical method of operating barges was introduced into Japan in 1964 for the purpose of operating bottom-door dump-barges for building an artificial island in Kobe Harbor. This type was a pure copy of an American rope-connected river service tug-barge train, and after that, several similar tug-barge trains were built for use in various reclamation projects in Japan. In Japan, where there are no navigable inland waterways, the insufficient navigability in waves soon became a vital problem and various attempts were made to improve seaworthiness. But, in spite of many efforts, the limit was such that even the best train could not go out of Tokyo Bay, or the western inland sea and other sheltered waters. This was the impetus for the development of new mechanical couplers to solve the problem of seaworthiness. It was planned to develop two types; one applicable to bottom-door dump-barges for reclamation and another for ocean going tug-barge trains for ordinary cargo transport. In the U.S. there were similar attempts to couple tug-barge trains for sea service including the Ingram, Artubar, Bludworth, and Catug systems.



The Ingram and the Catug were Integrated Tug and Barge Systems (ITB). They both had rigid connectors that required the tug and the barge to have single purpose designs, limiting their usefulness. The Blutworth System was for an articulated tug and barge (AT/B) system wherein the coupler attached externally to the bow of the tug. The system had limitations with respect to the variation of the drafts of the two units as well as the range of pitch between units. The Artubar System, conceived in the early 70s by Naval Architect Edwin Fletcher, was the first true AT/B system with a single degree of freedom between the two units. The tug bow fit into a matching notch in the stern of the barge. The Artubar System utilized port and starboard large diameter pins, which extended hydraulically from the bow of the tug hull. The pins were fixed in rotation, and they engaged a pair of holes in the barge notch walls, port and starboard. There were three sets of holes located vertically on the barge to match the loaded, light and ballast draft conditions. The barge and tug pitched around the pins. However, in the original Artubar design, there was a slack space between the pins and the holes that permitted relative sideways movement between the units, resulting in cyclic impacts and unwanted noise. The design could not accommodate the continuous variations in draft required for dumping operations and other applications. Unfortunately, Edwin Fletcher did not live to debug and refine his invention.

Paralleling Fletcher's pioneering work was the beginning work on AT/B by Yamaguchi. His plan for AT/B systems specifically aimed to overcome the shortcomings of the Artubar System as well as to incorporate the development of multiple couplers to suit the building and operational requirements of AT/Bs for different services. The plan included the following primary characteristics:

- The coupler should assure excellent seaworthiness sufficient for the service intended.
- The coupler should connect the pusher to the barge at any point within the whole range of change of draft relationship without adjustment of draft.
- The coupler should absorb all adverse influences of dimensional errors and misalignments in construction and elastic deformation of hulls in order to maintain reliable and firm connection.
- The coupler should be remotely controllable to avoid the requirement of manual effort during connection and disconnection.
- Connection and disconnection should be accomplished in a short time, even in an event of an accident that calls for disconnection.

The development of the first couplers for reclamation work was the ARTICOUPLER F, friction-engagement type, introduced in 1972. Though the friction force was considered unreliable, research has shown that it would maintain the connection safely up to maximum wave heights of 12 – 14 feet, covering the maximum sea state range permitting reclamation work. When dumping a load from the barge, the connection is slightly loosened to permit slipping of the coupler so that

the barge hull will jump up leaving the tug at the same draft without separation from the barge. The first ARTICOUPLÉ-tug was the Akashi-maru of 3,200 HP operating a 5,200 DWT bottom-door dump-barge (Figure 2).

The ARTICOUPLÉ F-Series was welcomed by marine constructors, and by the end of 1973 eight similar trains were in operation. These couplers found many users, not only for marine construction work, but also for ordinary cargo transport in comparatively calm routes, partly because the tug could be kept connected during barge cargo operations with the coupler set at “automatic draft adjustment.”

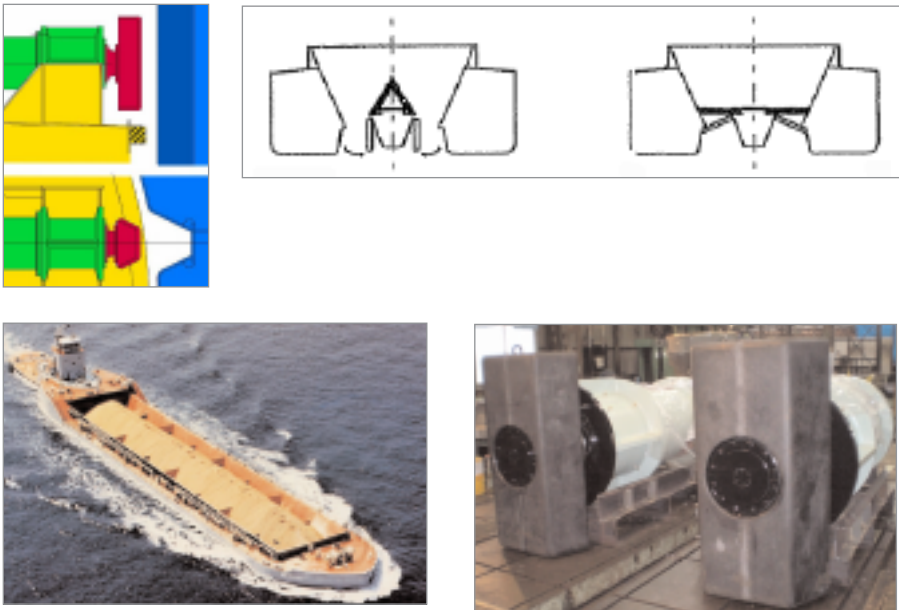


Figure 2: Articouple F, Tug Akashi-maru Pushing Bottom-door Dump-barge

Next an inquiry came from a large shipping company for a project of oceangoing tug-barge trains, for which a new coupler, ARTICOUPLÉ H-Series of multi step double row tooth-engagement type, was developed in 1975.

The tug Hachiko-maru of 4,600 HP and a cargo-barge with cargo-derricks of 8,950 DWT were built, and this combination was the first to be commissioned into regular ocean service between Japan and Indonesia (Figure 3).



Subsequently, in 1976-77 the Russian Far Eastern Shipping Co. commenced a project to build four tugs of 6,000 HP and eight deck-loading barges of 9,000 DWT for transport of logs from the Littoral Province of Siberia to Japan over the Sea of Japan. The fourth tug, “Bilibino,” of this fleet, renamed “Everlast”, is now operated in Canada (Figure 4).

Figure 4: 6,000 HP Articouple H Tug Pushing 9,000 DWT Deck-Barge

Then the design of the ARTICOUPLÉ H-Series was modified into the single row tooth-engagement type ARTICOUPLÉ K-Series to improve the functional stability during the connection process. This new type became the standard design for ocean-going tug ARTICOUPLÉ couplers. In 1980, ARTICOUPLÉ K-couplers were exported to Norway and Denmark (Figure 5) and, since then, many couplers of this type have been used in various routes around the world.



Figure 5: Articouple K Design and Valkyrien & Coal Barge in North Sea

In 1984 a new coupler, the ARTICOUPLÉ FR-series, a combined friction- and multi-step tooth-engagement type (Figure 6), was developed to combine good seaworthiness and the ability for automatic draft adjustment into one unit. Since then this new type has been widely accepted by owners because of its high navigability and convenience of use.

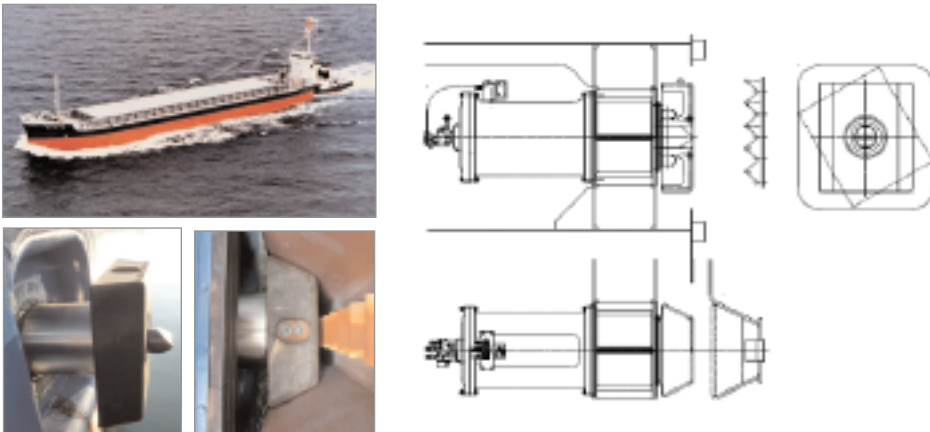


Figure 6: Articulope FR Design and Shintomei-maru & Limestone Barge (1986)

An entirely new type of three-pin supported (port, starboard and bow), rigid connection coupler was developed in 1989 for application with a 10,000 DWT salt carrier barge, and this new model of combined friction- and multi-step tooth-engagement coupler was named TRIOFIX TRF-Series (Figure 7). This new series was preferred by many owners and a number of applications were quickly adopted.

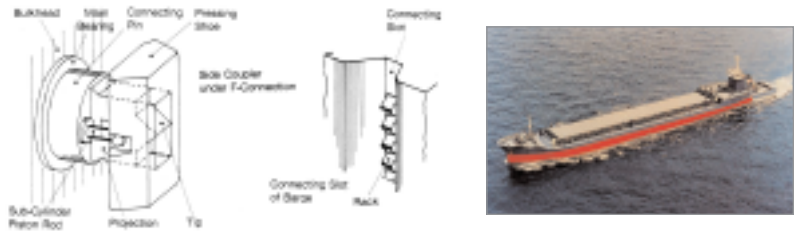


Figure 7: TRIOFIX TRF Series Design

But as the construction of this TRF-Series was fairly complicated and the cost was high, a simplified series, the TRIOFIX-TR, of multi-step tooth-engagement type was developed for application to smaller units. In 1998 Italian steel maker, ILVA, constructed a two-tug/four-barge fleet of 30,000 DWT for the transport of steel coils from Taranto to Genoa. This was a cyclical service operating at 14 knots, using TRIOFIX TK-Series couplers and ARTICOUPE K-type as side couplers. Subsequently ILVA introduced another two-tug/four-barge fleet of 16,000 DWT for service in the Adriatic Sea, and the expensive TRIOFIX TK was afterwards converted into TB (Figure 8), and then to TM (Figure 9), in order to lower the cost.

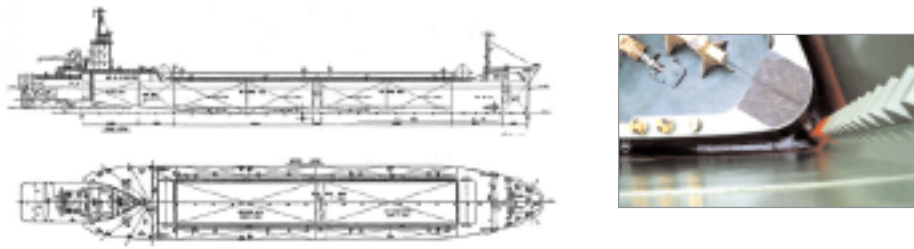


Figure 8: Triofix TB – Design with Bow, Port and Starboard Couplings

Currently, the ARTICOUPLER and TRIOFIX series cover the most popular tug-barge combinations. To date 245 coupler units had been delivered by the spring 2010. Generally speaking, the technique of maintaining satisfactory navigability in rough seas had been achieved by 1975. However, another important problem remains even now: that of propulsive performance, because the speed of tug-barge trains with the two-pin supported articulate connection, so-called ATB, is, without exception, lower than that of ordinary ships of the same loading and engine power because of heavy eddy resistance. One of the purposes of the three-pin supported rigid connection coupler, TRIOFIX, was to improve the propulsive performance of tug-barge trains significantly, and since the first TRIOFIX TRF unit, efforts along this line have continued. But extensive research was required. Around 2000 a novel idea for hull form design was performance of tug-barge trains significantly, and since the first TRIOFIX TRF unit, efforts along this line have continued. But extensive research was required. Around 2000 a novel idea for hull form design was developed and tank tests were carried out. The results were satisfactory and a speed practically the same as that of an ordinary ship of same loading and same engine power was achieved.



Figure 9: LVA Triofix TM Fleet

Nowadays, water transportation by sea and river accounts for more than 90% of the world's transportation demands, and its emission is only about 3.5% of the world's total emissions. This fact proves how economical and environmentally friendly water transport has become. Among various methods of water transport, the pushed multi-barge convoy is undoubtedly one of the most cost-effective and most environment friendly systems. However, in rough seas, it is difficult to operate with multiple barges by pushing and or by the combination of one tug and one barge. The speed of this operable combination with its articulate connection, so-called ATB, is low, and their economical superiority can only be maintained subject to the proviso that the lower speed can be compensated by other factors, such as lower personnel expense, lower building cost, etc. The introduction of the rigid connection using a TRIOFIX- coupler increased the possibility to raise the speed and the fuel economy of tug-barge trains substantially up to the level of ordinary ships without invalidating various merits peculiar to tug-barge systems. In some cases, such as forming a constant flow of cargoes between two ports by cyclical operation of a tug-barge fleet, a high overall operational economy uncompetitive to conventional ships or articulated tug-barges was realized. In other words, the rigid-connection coupler TRIOFIX, when combined with proper hull form design, can be both ecological and economical simultaneously, or environment friendly as well as purse friendly.



*Figure 10: Articouple and TrioFix Design Team:
Yoshio Hiwatari, Takuma Yamaguchi, Kiyoshi Mogami*

The initial intent to develop the seagoing tug-barge technique was derived from naval architectural principles, but the final design in a form of an independent machine could not be attained without the support of mechanical engineers. The original inventor, naval architect Takuma Yamaguchi, was pleased to have the assistance of two mechanical engineers, Mr. Yoshio Hiwatari and Mr. Kiyoshi Mogami, as colleagues and collaborators in charge of implementing the ideas and designs to create a final product (Figure 10). Without these two colleagues' skilled support and assistance for about 40 years, the development of the seagoing tug-barge technique represented by the coupler series ARTICOUPLER and TRIOFIX would never have been possible.



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.

The Sperry Board of Award would like to recognize additional support from organizations and individuals that have facilitated the continuation of 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. Nemeč* 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 Puisseux* 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.

The 2009 Elmer A. Sperry Board of Award

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