The Elmer A. Sperry Award 2012

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 2012

to

JOHN WARD DUCKETT

in recognition for

the Development of the Quick-Change Movable Barrier

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

SAE WORLD CONGRESS
http://www.sae.org/congress/techprogram/cfp.htm
Detroit, Michigan
April 16-18, 2013

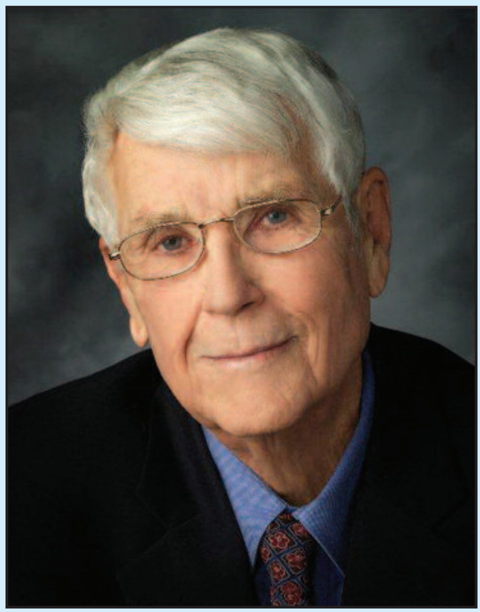
John Ward Duckett

John Duckett was born in Hollywood, California on March 2, 1929, where he lived until he was 15. He attended a Catholic grammar school and Bancroft Junior High before his family moved to San Marino, California, where he attended Flintridge Prep High School. He then attended the University of California at Berkeley where he received his BS in Industrial Engineering in 1956. His time at Berkeley was interrupted by a four year enlistment in the Air Force during the Korean War.

Shortly after graduation he married his long time sweetheart, Jean Burt, who has put up with him until this day, 56 years later! They built a home in Tiburon, California where they raised their two sons, John Jr. and Edwin Burt, and lived for 38 years before moving to Carson City, Nevada.

When Mr. Duckett was very young his parents suspected that he was a born engineer, as he was always "inventing" and building things. At fourteen he applied for his first patent on a unique design for a screw head. That one didn't work but others throughout his career did. His goal was always to have his own company and design and sell products, which he did after working three years for Coen Company, a small burner manufacturer in San Francisco. After establishing Ward Manufacturing Company, he started working with plastics and designed a line of marine products for yachts known as Docker Marine. This expanded into a much larger manufacturing operation and the formation of a new company, American Molded Products, which specialized in dip, slush and rotational molding of vinyl and polyethylene products and filament winding and pultrusion of fiberglass products.

Mr. Duckett helped one of his largest customers, John Rich, develop energy absorbing bumpers for automobiles and a water filled end treatment for highway medians. Unfortunately, this effort was unsuccessful for Mr. Rich, but it was the first such device on the National Highway System and the concept was further developed by other companies, which led to a major change in highway design throughout the US and the world. Toward the end of this effort, Duckett met John Quittner and the birth of the Quickchange Moveable Barrier took place along with the formation of Barrier Systems, Inc. After 30 successful years, the company was sold to Lindsay Manufacturing and John retired to be in, on or looking at salt water and to pursue his love of life and be with his wonderful wife, Jean and family. He is very honored, humbled and grateful to receive the prestigious Sperry Award.



John Ward Duckett

The Achievement

QUICKCHANGE® MOVEABLE BARRIER SYSTEM

THE BEGINNING

When John Quittner, an Australian inventor, attended a convention of the American Traffic Safety Services Association (ATSSA) in 1982, he was looking for a partner to develop an idea. For many years he had observed traffic congestion on the Sydney Harbor Bridge, and he thought that a practical solution to the problem would be to reverse one or more lanes of traffic to accommodate the peak direction. With this in mind, he developed an idea for a moveable curb and patented the concept.

Quittner brought a model of his concept to the ATSSA meeting and showed it to many of the exhibitors, but there was little interest. One person suggested that he should go to California and show the idea to John Duckett, who was described as "willing to try anything." It turned out to be a good suggestion, because when Mr. Duckett saw the idea, he immediately visualized a full scale concrete moveable barrier, much as it is today, and he signed an agreement with Mr. Quittner. He realized that this could revolutionize the highway industry, but first the small curb would need to be redesigned to a full size concrete barrier capable of separating traffic and smoothly redirecting a 2000 kg vehicle impacting the barrier at an impact angle of 25 degrees and a speed of 100 km/h.

THE MOVEABLE BARRIER CONCEPT

The concept was to develop a fully crashworthy system which could quickly and easily reposition a chain of barrier to allow one or more highway lanes to be closed to provide a safe working environment for construction crews. Another and more important application was to use the system to add one or more lanes in the peak traffic direction by reversing lane directions to increase the efficiency of the highway system during peak hours.

The system is comprised of two elements…the barrier chain and the transfer machines.

THE BARRIER CHAIN

The concept was to develop a barrier chain which could be lifted off of the roadway by engaging conveyor wheels under a T-shaped head and moving it up an inclined plane conveyor system, through a crossover section, and placing it on the highway in its new position six to 24 feet laterally disposed from its original position.

BARRIER SHAPE

The California Department of Transportation and the DOT's of several other states had designed what was considered to be the best profile for a highway safety barrier. This basic shape, with the addition of a T-shaped head, was chosen as the best profile for the barrier. To allow a chain of barriers to pass continually and smoothly through a conveyor system, the individual barriers would need to be substantially shorter than the 20 foot length of a traditional highway barrier. A length of one meter was chosen.

MATERIAL

Concrete had been used for years for highway safety barriers, and it was deemed appropriate for the moveable barrier. A minimum compressive strength of 3600 psi was specified.

REINFORCING

The T-shaped head is reinforced with welded wire mesh formed to fit under the head. Four 7/8 diameter C1018 cold rolled thru-rods extend through the barrier. They are threaded on each end with the hinges attached. A minimum longitudinal load for the overall arrangement is 100,000 pounds.

HINGING SYSTEM

This presented a challenge because the length of the barrier chain must expand and contract as it moves plus or minus 12 feet from a nominal 1200 foot radius. To accommodate this differential, two of each of the four hinges is slotted. The mating hinge has a close fitting hole through which a 1 1/8 4140 high strength pin is fitted.

PUSHER PLATES

On the slotted hinge a "pusher plate" is inserted through which the pin fits. This is a steel plate with one inch of rubber vulcanized to each side. As the barrier is moved from one radius to another, the rubber is compressed and exerts a self-aligning force on the pin.

THE FEET

Rubber feet are mounted to the four corners of the barrier to increase the coefficient of friction between the barrier and the road surface. Although this does not make a significant difference in limiting the lateral deflection at the point of impact, it makes a major difference in how the barriers move longitudinally during an impact. This in turn reduces the length of the catenary which, in turn, reduces the lateral movement. The current foot design uses a foot that extends slightly past the concrete, allowing a rubber to rubber contact during a crash which protects the concrete corners.

VARIABLE LENGTH BARRIERS

A variable length barrier (VLB) was developed which is capable of expanding or contracting while the chain is being moved. In the event of an impact by a vehicle, however, the barrier will lock. The system utilizes a velocity fuse in line with a hydraulic cylinder which allows free flow during normal transfer operations but will shut down if the velocity of the hydraulic fluid exceeds a preset limit.

REACTIVE TENSION SYSTEM

By utilizing a number of carefully positioned VLBs in line with specially hinged (zero gap) barriers, it is possible to minimize the deflection of the chain in response to an impact. Because the stretch of the chain is limited to the tight tolerance of the hinging system and a minimum degree of yield of the steel components in the event on a major incident, the catenary is limited and thus the lateral displacement is minimized. This system is now utilized on many permanent moveable barrier installations where minimal deflection is critical.

TESTING

In order to be used on the federal highways the system would be required to pass tests defined by NCHRP testing specifications. Mr. Duckett was able to hire, as a consultant, a former head engineer of the Caltrans Material Testing Lab, Mr. Eric Nordlen, P.E. Together they located an abandoned quarry in Clements, CA., with a long, straight road suitable for a test track. They set up a tracking system, a speed trap, and a number of VHS cameras. The test vehicle was pulled into a chain of barrier set across the roadway at a given angle. When the vehicle reached the end of the guide wire, the pulling cable would disconnect and the vehicle would freely travel the remaining distance into the barrier. After running twenty to thirty tests, Mr. Nordlen had enough data to submit the results to the Federal Highway Administration and the system was accepted for use on the Federal Highway System.

BARRIER TRANSFER MACHINES: CONSTRUCTION AND PERMANENT

The first construction machine was designed around the basic elements of a grape harvesting machine. Mr. Duckett partnered with AIM Manufacturing, a manufacturer of the harvesting machines in Lodi, CA. He set up a small office at their facility and together they designed and manufactured the first machine, which was then tested at the Clements test track by moving barriers day after day for several weeks. With very few modifications to the original design, the company was now ready to build several additional machines and a mile of barrier. AIM declined an offer to build the additional machines, so Mr. Duckett asked a former fraternity brother from Berkeley if his company would like the work, and thus Blackwelder Manufacturing in Rio Vista, CA built the next group of machines. Unfortunately, Blackwelder was in financial trouble and decided to liquidate. Mr. Duckett then met with Bill Dutra, the owner of a large construction company in Rio Vista, and discussed purchasing Blackwelder together and dividing the property, half to each company. Their bid was successful, and Barrier Systems had a new home where the company still operates today with most of the same shop personnel who worked for Blackwelder before the sale… a wonderful group of talented and dedicated individuals.

PERMANENT TRANSFER MACHINES

It was now time to develop a more sophisticated machine, and a team of engineers headed by Jack Mazer, and including Steve Peek, P.E., Darryl Bettencourt, Jim Seiferling, Kevin Schmidt and Rick Stabler was put to work. The first of these machines was built for the Coronado Bridge in San Diego, CA. It included many advanced features including automatic steering on both ends of the machine (by tracking a wire buried in the pavement), a fully enclosed cab, and a capstan drive system which was capable of exerting a force on the barrier to either push it in the direction of travel or pull it back. In later machines, the system was automated by reading RFID tags along its path and automatically adjusting the capstan to predetermined levels.

MANUFACTURING

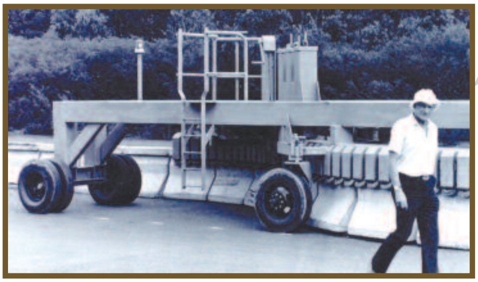
All of the construction and permanent machines have been designed and built in the Rio Vista facility. The barriers have been manufactured at many locations throughout the United States and in many other countries. The construction manager is Larry Tittle, a tremendously talented man who has been with the company since the first barriers were cast in Dallas, Texas. Because of insurance and bonding issues on that first job, Barrier Systems had to subcontract the work to another company. After the job was finished, Larry asked if he could come to work for Barrier (he was in love with the concept) and he is still with the company today.

THE BUSINESS AND SALES TEAM

It was now time to hire a business manager and Chris Sanders, one of the original bankers, came on board and still plays a major role in the company today, as he did throughout its entire growth.

The first sales manager was Jon Frank, a talented man who had worked in this industry for many years. He was followed by Ed Wood, P.E., a retired federal highway executive who had many friends throughout the industry. The final sales team was built around these two and consisted of both salaried employees and commissioned sales representatives.

THE MOVEABLE BARRIER TIMELINE



1983: John Duckett, Warner Odenthal, and Tom O'Connell license Quickchange Moveable Barrier (QMB) technology from John Quittner in Australia. Original technology was designed as a 'moveable curb' for the Sydney Harbour Bridge in Australia.

1984: Barrier Systems, Inc (BSI) is incorporated

1986: Lindsay Corporation becomes a manufacturing vendor for BSI

1987: 1st Construction Projects: Texas, North Carolina and Pennsylvania, USA

1988: 1st Construction Bridge Project: I-95 Mianus River Bridge, Greenwich, Connecticut, USA

1990: 1st International Construction Project: Montreal, Canada
1st International Permanent Project: Auckland Harbour Bridge, Auckland, New Zealand

1991: 1st US Permanent Project: Dallas, Texas, USA
BSI acquires Rio Vista manufacturing facility and begins machine production.

1994: QMB used for full width construction: Van Wyck Expressway, New York, USA

1995: 1st construction job converted to permanent installation: Roosevelt Bridge Washington DC, USA

1996: BSI acquires worldwide rights to all moveable barrier patents

1998: 1st 7.3 meter (24 feet) two-lane transfer machine introduced: Honolulu, Hawaii, USA

1999: New generation construction machine introduced: New York, USA

1999: BSI introduces Reactive Tension Barrier technology

1999: BSI introduces Road Safety Products

2000: First Steel Reactive Tension System (RTS) barrier used: Seattle, Washington; QMB added to Ben Franklin, Walt Whitman and Commodore Barry Bridges for Delaware River Port Authority, USA

2002: 1st concrete RTS barrier for construction: Chesapeake Bay Bridge, Maryland, USA

2004: 1st concrete RTS barrier for permanent installation: Honolulu

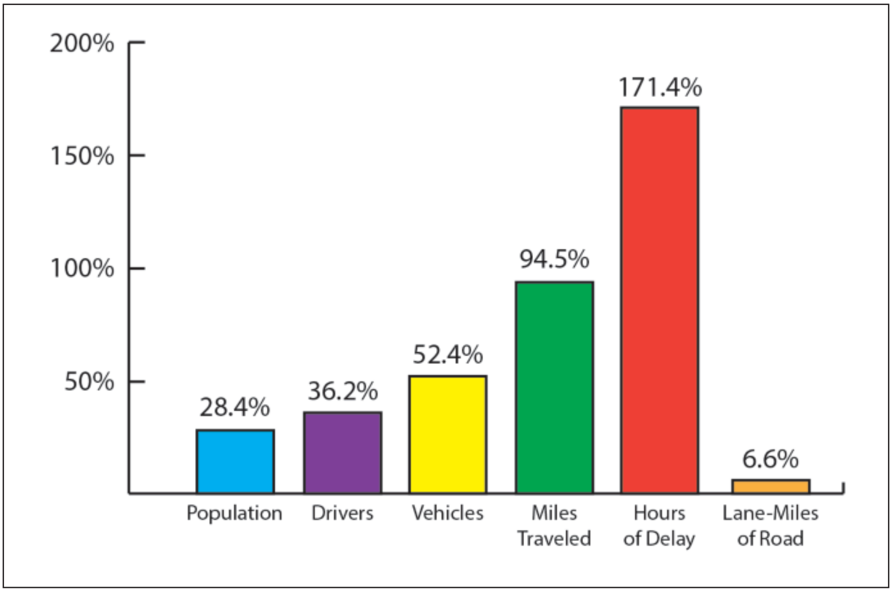
2006: 1st International RTS Project: England

2008: Auckland Harbour Bridge updates to RTS barrier and new machines: Auckland, New Zealand

2009: Longest installation of QMB project: Mexico City, Mexico

THE MOVEABLE BARRIER SYSTEM

Traffic congestion has become a serious problem for many cities around the world. In the United States alone, almost five billion hours are lost to congestion each year at an annual cost of US$101 billion. While population, drivers, vehicles, miles traveled, and hours of delay have all seen double- and triple-digit growth, the total number of lane-miles of roadway increased only 6.6% between 1982 and 2006. The challenge for 21st century highway engineers is to utilize cost-effective methods and technologies in order to meet increasing roadway demand.



New road construction has stalled compared to the increase in demand.

Current congestion mitigation approaches can generally be divided into two categories. The first is the addition of capacity with major construction by adding new roadways or by increasing the size of existing roadways either outward with widening, upward in elevated structures, or downward in tunnels. These approaches require the dedication of substantial time and resources.

The second category is focused on utilizing the existing roadway capacity more efficiently, with little or no additional construction. This includes improving construction work zone traffic management, increasing Bus Rapid Transit use, implementing ITS strategies, encouraging ride sharing and tele-commuting, and implementing managed lanes. These concepts are growing in popularity as many countries search for alternatives to expensive new construction.

Moveable barrier technology is used for managed lanes and construction applications to create "Safe, Dynamic Highways" that offer real-time roadway reconfiguration while maintaining positive barrier protection between lanes. For managed lane facilities, moveable barrier is used in areas where there is a tidal traffic flow to redistribute unused capacity from the off-peak traffic direction to give more lanes to peak traffic. For construction applications, moveable barrier is used to expand the work zone to accelerate construction through the elimination of stages or entire construction seasons, while reducing congestion and increasing safety for workers and motorists.

Moveable barrier installations around the world report increases in both safety and capacity. Additional benefits include reduction of air pollutants, improved travel times, improved fuel efficiency, and faster system implementation compared to new construction.

MANAGED LANES: IDENTIFYING UNDERUTILIZED CAPACITY

Peak traffic flows can be divided into two general classifications: "Temporal Peak" flows and "Directional Peak" flows. In the case of Temporal Peak flows, the traffic on both sides of the road is a mirror image, both in and out of the city. Both sides of the highway reach peak traffic capacity in the mornings and evenings, with some reduced flows in midday and then further reduced flows later in the evening and in the early morning hours. With Directional Peak flows, the traffic in one direction, usually inbound to the city, will peak during the AM commute, while the opposite (outbound) direction will have relatively little traffic. For the PM commute, the case would be reversed.

An example of directional traffic in the UK.

In these cases, Managed Lanes can redistribute the traffic to match the resources available. Managed Lanes can utilize many strategies, including HOV, HOT, Reversible Lanes, Contraflow Lanes, real-time road information, and congestion pricing to name a few, or any combination of these. Depending on the design phase, a Managed Lane facility can work safely with either moveable or fixed barriers. When a Managed Lane facility is designed from scratch, a fixed barrier can be used to separate lanes. In many cases where the Managed Lane concept is implemented on an existing highway to mitigate congestion, a moveable barrier system is the best approach.

THE CASE FOR POSITIVE PROTECTION

In some cases, a contraflow or reversible lane is put in place using delineator devices only (cones, pylons, overhead lights, etc.), but this has always had serious safety implications and usually results in head-on collisions and casualties. On the Auckland Harbour Bridge in New Zealand, an adjustable lane configuration that relied on plastic delineation to separate traffic suffered five casualties from head-on, crossover accidents in a 10-year span before implementing positive protection between traffic directions. With the positive protection of moveable concrete barrier, there have been no crossover accidents in 22 years, and the facility still maintains the ability to reconfigure the roadway for peak traffic several times per day. Statistics show that the safe implementation of either Reversible Lanes or Contraflow Lanes requires a crashworthy positive separation barrier. Moveable barrier is often the best solution to add positive protection between lanes of oncoming traffic while allowing the road to be reconfigured in real time based on the needs of peak traffic.

Lights, paint, and plastic delineation for lane separation lead to head-on, crossover accidents.

THE MOVEABLE BARRIER SYSTEM FOR MANAGED LANES

Moveable barrier is a two-part system. The first part consists of one-meter sections of highly reinforced concrete that are pinned together at each end to form a continuous barrier wall. The barriers have a T-top, which acts as a lifting surface for the transfer machine. The second part of the system is a Barrier Transfer Machine (BTM), which lifts the barrier and passes it through a conveyor system, transferring the barrier from eight to 24 feet (2.4 m to 7.3 m) in one pass. When necessary, the ends of the barrier are protected with the ABSORB 350, a water-filled crash cushion that can articulate through the transfer machine for seamless operation of the entire system.

The BTM lifts the barriers using a conveyor wheel system.

The barriers are passed through the conveyor underneath the BTM.

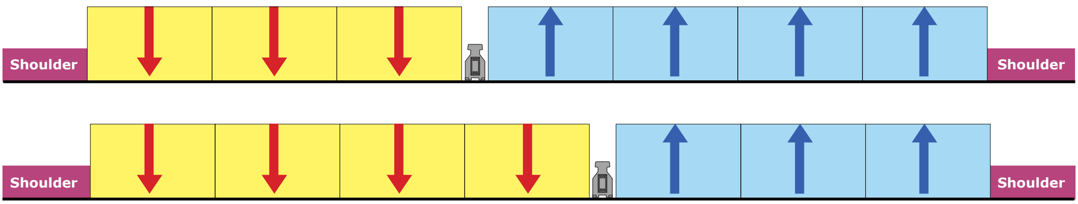
Barriers are lifted and placed, not dragged.

CREATING MANAGED LANES WITH MOVEABLE BARRIER

There are two main types of Managed Lane facilities that can be created with moveable barrier: moveable medians and contraflow lanes.

Moveable Medians

The moveable median is most commonly applied to bridges and in other highway applications with few center structures. Viaducts or elevated structures also fit this model.



The median barrier can be adjusted multiple times per day to meet peak demand.

A moveable median on the Auckland Harbour Bridge, NZ

The moveable median is perhaps the most simple way of optimizing highway capacity. In this case, there is no fixed barrier on the highway, and the moveable barrier is the only barrier on the highway. The barrier is moved back and forth multiple times per day to reconfigure the roadway based on the needs of peak traffic.

Contraflow Lanes

There are cases where a single moveable median barrier is not practical. This may be because the two directions of the highway are on different elevations or structures, because there is a substantial existing median barrier, or because there are many center structures such as bridge piers and significant signposts, any of which would inhibit the movement of a moveable median system. In these cases, two moveable walls are used, one on each side of the roadway, in order to take or borrow a lane from the off-peak side of the road and allow traffic from the peak side of the road to utilize that lane, thus gaining additional capacity. This system provides the same optimization and efficiency as a moveable median but requires two separate walls to achieve the same results because of the geometric challenges.

One noteworthy managed lanes facility is the I-15 freeway in San Diego, CA. This system will be almost 50 km long when completed. In this case there are four reversible lanes in the center of a 12-lane highway. The four-lane section is isolated from the main roadways by fixed barriers. In the center of that four-lane section is a moveable barrier. The typical alignments are 4+1/3+4, 4+2/2+4, and 4+3/1+4, thus providing five to seven lanes in each direction at different times of the day. The center four lanes will be utilized as Public Transit (Bus Rapid Transit-BRT) Lanes, HOV Lanes and Tolled Lanes at different times during the day and in different combinations.

Contraflow Lanes operating in Dallas, TX (left) and Honolulu, HI (right).

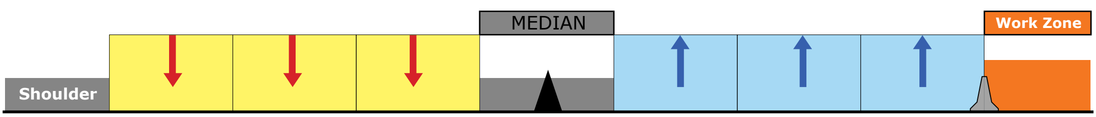
The four center lanes on this section of I-15 are reconfigured by moveable barrier.

Moveable Barrier for Work Zones

A freeway with standard width lanes can handle a throughput of 1500 – 1700 vehicles per lane per hour before traffic flow is compromised and speeds decrease. A work zone that reduces the number of available lanes, or narrows the existing traffic lanes, has effectively reduced the number of vehicles per lane per hour that can pass through the work zone, and congestion will occur with a much lower vehicle count. To optimize the work zone for both mobility and safety requires a reassessment of best practices and a review of modern, innovative strategies for work zone safety and flexibility.

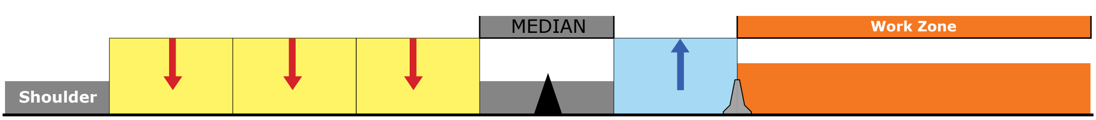
In a construction work zone, there must be a balance between the number of lanes that are available for motorists and the space requirements of the contractor. Typically, this is addressed in one of three scenarios:

1. First, to give the maximum number of lanes to traffic, the size of the work zone must be reduced. In this scenario, congestion is minimized, but the work zone is confined and inefficient. This creates a work zone environment that is prone to accidents, and it extends the construction schedule.



Traffic is free-flowing, but the work zone is confined and inefficient.

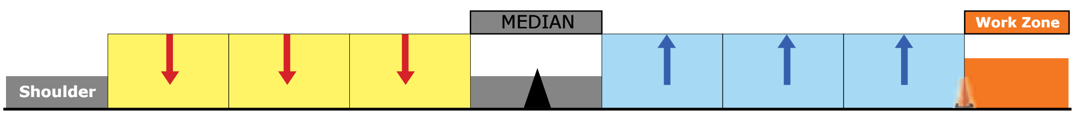
2. In the second scenario, the work zone is expanded. This allows for larger, more efficient equipment to accelerate the construction schedule, and more space means a safer work zone. The impact on traffic is seen as the number of vehicle lanes is now minimized, creating congestion and potentially increasing vehicle accident rates.



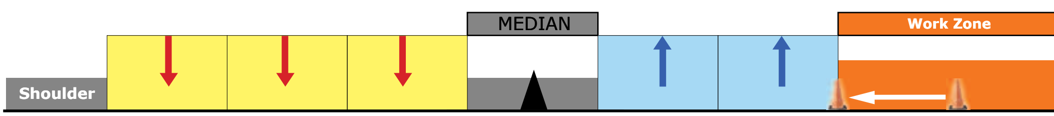
The work zone is safe and efficient, but severe congestion and user delay costs will result.

In these first two scenarios, the static, inflexible work zone is optimized for either the motoring public or the contractor, but it cannot be optimized for both. Fortunately, in either of these scenarios we can increase safety by separating vehicles and workers from each other with concrete barrier. This positive protection virtually eliminates vehicle encroachments into the work zone, which account for a large percentage of work zone fatalities. Positive barrier protection is a critical safety element, and agencies are often willing to sacrifice mobility and work zone efficiency for the safety of barrier separation.

3. The third scenario is the most efficient use of the roadway. In this case, the maximum number of lanes is made available to motorists during peak traffic hours, and the road is reconfigured to increase the size of the work zone during off-peak traffic hours. This allows the contractor to create dedicated haul lanes, use larger equipment, accelerate the construction schedule, and create a safer working environment, while maximizing mobility and vehicle throughput for traffic.



TYPICAL PEAK



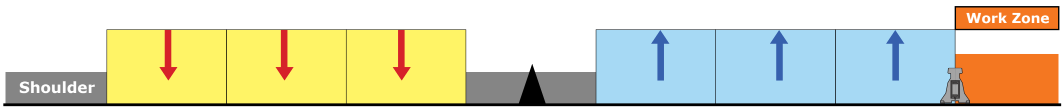
TYPICAL OFF-PEAK

With plastic delineation, traffic has more lanes during peak hours, and the work zone is expanded in the off-peak, but safety is compromised.

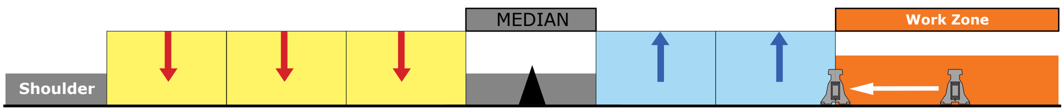
Optimizing for Both Work Zone Safety and Flexibility

Unfortunately, implementing a flexible divider between vehicle traffic and the construction work zone is traditionally accomplished by using plastic cones, barrels, and flexible delineators that offer no positive protection. Historically, road channelizers that can be reconfigured quickly enough to respond to the needs of peak traffic conditions must by definition lack the crashworthy physical attributes of positive protection. This is the essential conflict between safety and mobility: work zone intrusion accidents must be eliminated if safety and mobility are to be optimized together.

One solution to this problem is moveable concrete barrier. Moveable barrier is a crashworthy lane separator that can be reconfigured in real time to give more lanes to peak traffic or expand the work zone during off-peak hours. Vehicle mobility is maximized without compromising the safety of positive protection.



TYPICAL PEAK



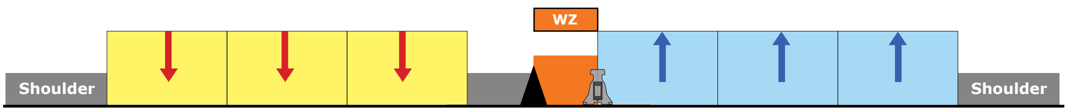
TYPICAL PEAK

With moveable barrier, traffic has more lanes during peak hours, the work zone is expanded in the off-peak, and intrusion accidents have been eliminated.

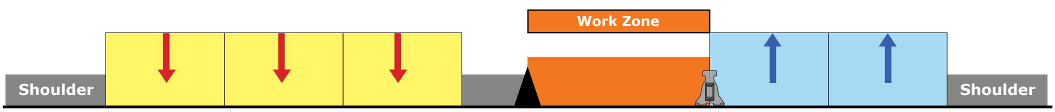
Moveable barrier is transferred under traffic to expand the work zone.

Shoulder / Median Work

For shoulder and median work, the barrier can be stored at the edge of the road and moved out during off-peak traffic periods to increase the size of the work zone. The barrier is returned to the stored position during peak traffic periods to give the maximum number of lanes to traffic. The barrier can be moved many times per day to meet the needs of both construction crews and motorists.



TYPICAL PEAK



TYPICAL OFF-PEAK

Shoulder and median work benefit from real-time road reconfiguration to expand the work zone.

Partial Closures

During partial closure construction, one side of the road is completely shut down for construction and all traffic is diverted to the other side. Moveable barrier is used as a "moveable median," shifting multiple times per day to reconfigure the road to give more lanes to the peak traffic direction.

TYPICAL PEAK

TYPICAL OFF-PEAK

Shoulder and median work benefit from real-time road reconfiguration to expand the work zone.

MOVEABLE BARRIER FOR WORK ZONES: CASE STUDIES

The following case studies explain these concepts and the benefits derived from using moveable barrier in real world situations.

Case Study #1: 3500 South, Salt Lake City, UT, USA (Shoulder / Median Work)

3500 South is a busy arterial in Salt Lake City, UT. The first phase of the reconstruction called for two traffic lanes to be open for traffic in each direction, and plastic barrels were used to separate directional traffic and to delineate the work zone. The work zone area was confined and restricted, and it lacked positive protection, which created dangerous conditions as confused motorists occasionally turned into the work zone. For the second phase of the project, it was decided that a moveable barrier system would be used to create a larger work zone, while minimizing the impact on traffic and limiting left-hand turns.

It was determined that moveable barrier could keep two lanes open to traffic in the peak direction by using a total of only three lanes. This would give the contractor an extra lane to expand the work zone, keeping workers safe and accelerating construction. The barrier was moved multiple times daily to create a 1/2, 2/1 traffic pattern.

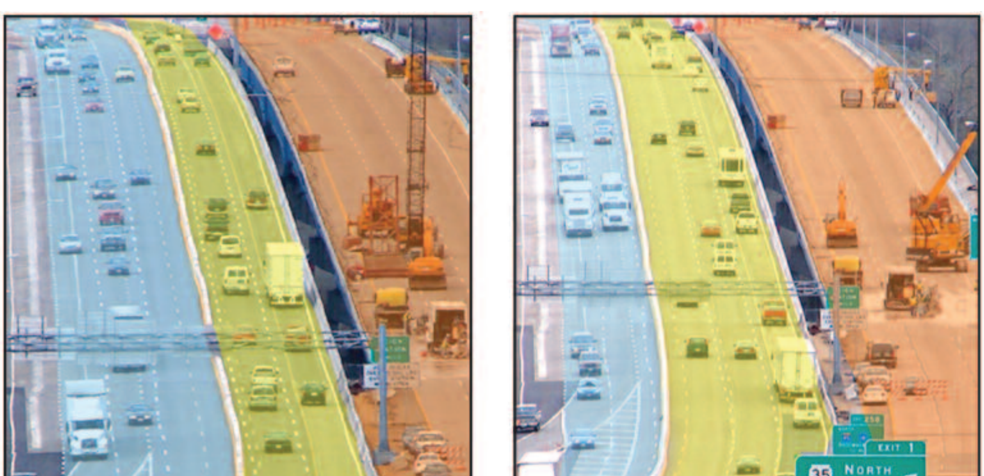
- Project was completed seven months early and saved one construction season
- Savings from early completion were estimated at US $1.3 to $1.4 million
- Reduced user delay costs
- US $1 million in crash cost reductions
- Total moveable barrier benefits were estimated at US $2.4 million
- Moveable barrier benefit/cost ratio of 4:1 to 10:1

Case Study #2: St. Croix River Bridge, Wisconsin, USA

The westbound span of the St. Croix River Bridge needed to be completely redecked. At 70,000 vehicles per day, it is the highest volume bridge in west-central Wisconsin, and traffic delays and user delay costs were a major concern. The eastern span of the bridge had five lanes, but it was determined that without three lanes available to peak traffic in each direction, vehicle queues could be as long as 40 minutes and average speeds through the work zone and over the bridge would stall at nine mph. The only way to keep enough lanes open to move traffic efficiently while positively separating oncoming traffic lanes was to deploy a moveable median barrier.

The moveable barrier kept traffic flowing at an average of 51 mph. This reduced user delay costs from a projected $1,810,000 to only $480,000, resulting in a savings of more than $1.3 million. Moveable barrier allowed the job to be completed in one season instead of two, and by eliminating staging on the westbound span the construction cost savings were estimated between $1 million and $1.5 million.

- The project was completed in one season instead of two
- User delay savings were estimated at greater than $1.3 million
- Construction cost savings were estimated at $1 million to $1.5 million
- Vehicle delay was reduced from 40 minutes per vehicle to six minutes
- Average vehicle speed was increased from nine mph to 51 mph
- There were no major traffic accidents during construction



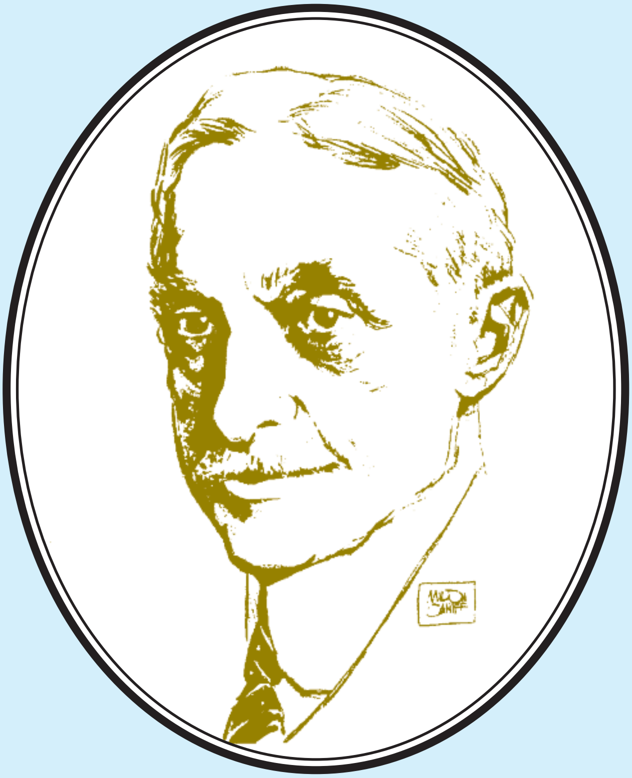
Moveable barrier provides three lanes into the Twin Cities in the AM, and three lanes back to WI in the PM.

SUMMARY

The many costs of congestion are rising around the world. Increased user delay costs, CO_2 emissions, extended construction schedules, and injury accidents and fatalities are all related to increased congestion.

For managed lane facilities, moveable barrier offers the unique option of being able to reclaim underutilized capacity and provide more lanes in the peak direction with little or no new construction. Using moveable medians and contraflow lanes with moveable barrier, agencies can solve their congestion problems for a fraction of the time and resources required by traditional construction methods.

For construction applications, moveable barrier is used to expand the work zone to accelerate construction through combining or elimination of stages or entire construction seasons, while reducing congestion and increasing safety for workers and motorists. Moveable barrier creates real savings in time-related overhead, project costs, user delay costs, and the costs associated with accidents and fatalities, while reducing harmful emissions created from work zone congestion.



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 gyropilot 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.

The 2012 Elmer A. Sperry Board of Award

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