THE ELMER A. SPERRY AWARD

1992

FOR ADVANCING THE ART OF TRANSPORTATION

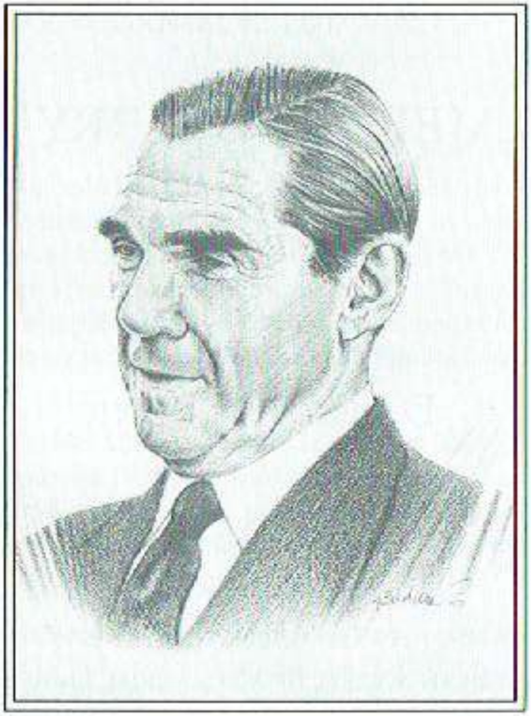
The American Society of Mechanical Engineers

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 or air.

In the words of Edmondo Quattrocchi, the 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 control for man's purposes."*



AWARD CITATION

DANIEL K. LUDWIG

for the design, development, and construction

of the modern supertanker

PRESENTATION OF

THE ELMER A. SPERRY AWARD

FOR

1992

TO

DANIEL K. LUDWIG

BY

THE BOARD OF AWARD UNDER THE SPONSORSHIP OF THE:
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS
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AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS
AMERICAN SOCIETY OF CIVIL ENGINEERS

At the 1992 Society of Naval Architects and Marine Engineers Annual Meeting

Friday, October 30, 1992

New York City

BIOGRAPHY OF AWARDEE

DANIEL K. LUDWIG

Born on June 24, 1897 in South Haven, Michigan, a small town on the shores of Lake Michigan, Daniel K. Ludwig ended his formal schooling with the eighth grade. His early working life was spent as ship chandler, machinist, sea-going engineer and operator of a tug and barge. Educated by these experiences in the fundamentals of shipping, Mr. Ludwig went on to pioneer the development of today's Supertankers. At the height of his career, he owned and operated some 60 ocean-going vessels. He established the primary concepts of each vessel constructed for his ownership and in doing so often cast aside prevailing limitations as to ship size, hull form, power, and arrangement.

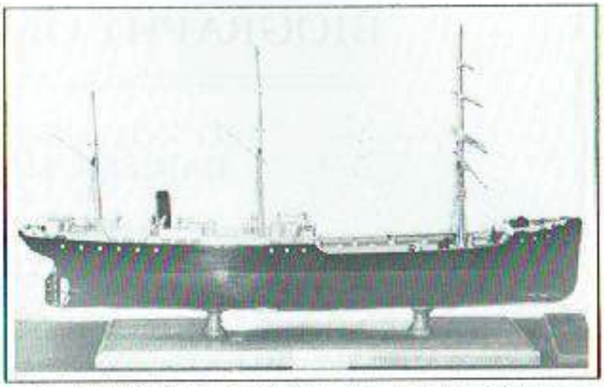
In building his fleet, Mr. Ludwig was an innovator in ship design, construction and financing. Consistently since the 1940's, he was at the forefront of the design and construction of ocean-going oil tankers and bulk carriers of ever-increasing size. The first of the world's Supertankers was designed and built to embody his concepts. He was also among the first to finance ships on the security of a long-term charter.

In the early 1940's, Ludwig built an 18,000 DWT tanker. By 1945, he had built his first 24,000 ton tanker and by 1948 he constructed his first 30,000 ton tanker. By 1953, Ludwig was operating the world's first 38,000 DWT tanker which he constructed at his shipyard in Kure, Japan. This was followed by a succession of tankers of ever-larger dimension - 56,000 tons in 1955, 85,000 in 1956, and 106,000 tons in 1959. In each case, his first vessel of a class was the largest of its kind at the time of construction.

In 1966, Mr. Ludwig began the construction of the first genuine Supertanker, a 327,000 DWT vessel - at a time when the closest competitor was of 220,000 DWT. He went on to build six of these vessels, known as the Bantry Class Tankers. In 1972, Mr. Ludwig took delivery of the newbuilding, *S/S UNIVERSE PIONEER*, the first of a class of 11 VLCCs of approximately 270,000 DWT. During that year, he also ordered the construction of a class of four 470,000 ton tankers which order was later canceled due to changes in the market.

Ludwig's tankers set the standard not only in size, but in quality of construction and operating performance as well, assembling "on-hire" records that were, and are, the envy of the world tanker fleet.

Ludwig's leadership in this progressive and continual expansion of tanker size produced substantial reductions in the cost of moving crude oil internationally and yielded significant savings to end-users of oil worldwide.



The S/S WICO, Ludwig's first oil carrying vessel, was a combination sail and power driven tanker. Originally built in 1888 for Standard Oil, its cargo carrying capacity was only 4,350 deadweight tons (DWT).

Ludwig's innovative contributions to marine transportation were not limited to oil tankers. His persistence in developing an economical transportation system for the movement of iron ore from Venezuela to the United States and other world ports led to the construction of three twin-screw 60,000 DWT ore carriers in 1954 to replace a fleet of smaller, less efficient Liberty ships of 10/12,000 tons. As a key part of this overall transportation system, Mr. Ludwig personally conceived the idea of a large, side-casting boom and hopper dredge to increase the available depth of the Orinoco River channel.

In 1956, Mr. Ludwig built the world's largest solar evaporated salt production facility, called Exportadora de Sal, on a strip of the Baja, Mexico desert. By 1967-68, production capacity reached 6.5 million tons a year. Transportation of the product from Cedros Island, off the coast of Baja, Mexico, was accomplished in Ludwig designed special purpose vessels which were mainly self-discharging. He built a deep-sea shipping port capable of loading vessels of up to 170,000 DWT at Cedros Island. This project also included a central terminal and distribution system in Japan to service the long-term contracts entered into with Exportadora's major customers.

Mr. Ludwig also participated in major oil and gas projects throughout the world, including the Balikpapan, Indonesia oil and gas development. He became a major investor and operator internationally in the production of coal, petroleum products and other minerals, conducting mining and exploration activities in Latin America, Africa, Australia, the Middle East and North America.

The Princess Hotel group was formed by Mr. Ludwig in 1964 with the purchase and rehabilitation of the Hamilton Princess Hotel in Bermuda. He went on to build or acquire seven additional luxury hotels in Bermuda, Mexico, the Bahamas and San Francisco during the 1960's and 1970's. These included the world famous resort hotels Southampton Princess and Acapulco Princess, which were conceived by him.

In addition, Mr. Ludwig engineered the development of Westlake Village in California, one of the largest new planned communities in the United States. This venture began with the purchase of 12,000 acres of land approximately 40 miles northwest of downtown Los Angeles. An elementary feature of the master plan was respect for and enhancement of the environment. Extensive landscaping and tree planting were done and more than 4,000 acres were set aside for open space, parks, green belts and trails for riding and hiking. Additionally, two lakes, along with several brooks and lagoons, were incorporated into the project. The project included housing for approximately 50,000 residents, shopping centers, office buildings and a hotel. Other investments of Mr. Ludwig included real estate, cattle ranching, orange groves, banking, insurance and other financial operations in the United States and throughout the world.

In 1966, Ludwig acquired land in Brazil for what later became known as the JARI Project. This vast enterprise embraced over three million acres in the Amazon Basin. Principally a combination forest-products and agricultural development, Jari also included the mining of kaolin (clay) and refractory bauxite. Over 250,000 acres on this tract were cleared of the native forest and three fast-growing species of trees were planted for making pulp. A complete pulp-making factory was designed and constructed in Japan on two barge-like floating platforms which were then towed to Brazil and successfully placed in service in 1979, a mere three years after conceptual engineering had been initiated. Despite the remote location in the Amazon Basin, this was accomplished within a time frame comparable to the best construction performance in the industry.

In more recent years, Mr. Ludwig's efforts were directed to the Ludwig Institute for Cancer Research, which he founded in 1971 and endowed with substantially all of his foreign holdings. The Institute is an international medical research organization dedicated to the understanding and eradication of cancer. It has a worldwide staff of more than four hundred fifty scientists and technical assistants and has expended over $350 million on basic cancer research since its inception.

Mr. Ludwig died on August 27, 1992 at the age of 95.

Daniel K. Ludwig's creativity and innovativeness are recognized internationally. His pioneering efforts in the design, construction and operation of oil tankers earned him the title of "Father of the Supertanker."

DANIEL K. LUDWIG'S DEVELOPMENT OF SUPERTANKERS

The definition of the term "Supertanker" has proven somewhat flexible with the passage of time. In 1942, the term was applied to tankers of 18,000 Deadweight tons (DWT)[1] which were just larger than the world standard T-2 tanker[2]. As tankers increased progressively in size, the term "Supertanker" was used more often for the new, larger tankers and less often for existing tankers which might have been classified as Supertanker previously. As new and larger vessels entered service, the term "VLCC" (Very Large Crude Carrier) began to appear as part of an effort to better define tankers by size. In the early 1970's, this term covered tankers of 175,000 DWT and up. Since tanker sizes continued to increase dramatically, a further effort had to be made in order to provide better size distinction. Thus appeared the term "ULCC" (Ultra Large Crude Carrier) designated for vessels of 300,000 DWT and above. Today, the term "Supertanker" includes both the VLCC and the ULCC.

ANTICIPATING THE NEED FOR A SUPERTANKER

The S/S UNIVERSE IRELAND, built in 1966, was the first of six Ludwig tankers of 327,000 DWT.

A pioneer in the development of the modern Supertanker, Daniel K. Ludwig's first effort as a shipping entrepreneur was supplying wooden dunnage to British cargo ships in New York harbor during World War I utilizing a small tug and barge. Shortly thereafter, Ludwig acquired the Great Lakes excursion steamer *IDLEWYLDE*, which he converted into a barge which carried liquid molasses in bulk. During this conversion, new bulkheads in the cargo spaces of this barge were welded using a rather primitive but effective method. This early use of welding made a lasting impression on Ludwig and had a significant influence on his future ship building endeavors. He utilized this knowledge at his Welding Shipyard in Norfolk, Virginia, at which he built all-welded tankers for almost ten years.

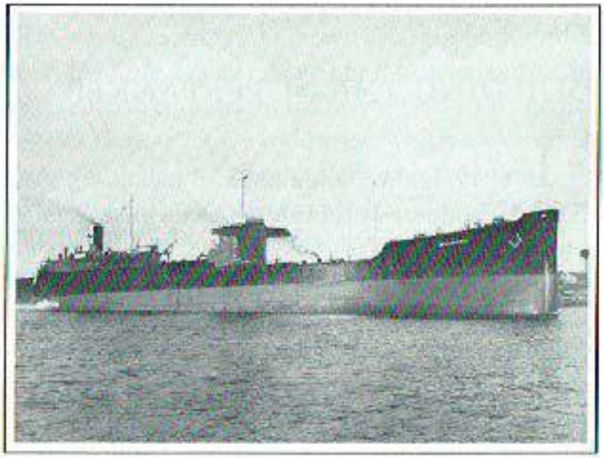
1. Deadweight is the measure of a vessel's cargo carrying capacity expressed in tons.
2. T-2 tanker had a DWT of 16,600 and was the most commonly used tanker during the 1940's. Over 500 were constructed during World War II for the U.S. Maritime Commission.

Anticipating the future growth of oil and other bulk cargo movements by water, Mr. Ludwig began to participate in these areas of transportation in the 1920's. The first oil carrying vessel he owned was the *S/S WICO*, which was a combination sail and power driven tanker of 4350 DWT originally built in 1888 for Standard Oil of New Jersey.

Constrained by limited financial resources in the earlier years, Ludwig was forced to acquire older ships available at reduced prices. He would then convert them to meet the demands of the market. Some of the older vessels he acquired and operated during the late 1920's and early 1930's were the *S/S PHOENIX, ULYSSES, JOHN JAY, CALICHE, TRANSFORD, CHILOIL and BULKOIL*. In selecting acquisition candidates, he focused on the largest available vessel because he was confident there were economies of scale to be realized in the water transport of oil and other bulk cargoes.

Early in his career, Ludwig recognized that capital and operating costs did not increase proportionately with physical size and carrying capacity. He knew that an increase in ship's draft provided the least costly means of increasing cargo lifting capacity for bulk cargos. Although his first new vessel was constructed in 1936 by Ingalls Ironworks as a 2500 DWT, all-welded tanker suitable for Great Lakes and coastwise trading, he remained convinced of the desirability of having his own facility for constructing and converting vessels. He felt that only by having such a facility could he insure control of quality, cost and flexibility in the design and construction schedule of vessels he needed.

By 1936, Ludwig had developed his own ship construction installation - Welding Shipyards, Inc. in Norfolk, Virginia. The first location of this yard was at a railway pier where, in 1937, he converted the *S/S DANIEL WEBSTER* from a dry cargo ship to an oil tanker, the first conversion under his own management. This was followed by five other similar conversions at this location, extending into 1940. In March 1941, he completed his first, newly built, deep sea tanker - the *S/S VIRGINIA* of 500' length and 18,000 DWT - by sidelaunching from a pier. He also constructed a second, somewhat smaller tanker, the *S/S BULKOIL*, at



With portable motor vehicle type cranes, Ludwig proved he could construct tankers like the S/S BULKERO (18,000 DWT) using a minimum of support facilities.

this facility. In 1941, he relocated his building operations to the Sewells Point area of Norfolk and established a more conventional end-launching, one-ship building way. Using minimum support facilities and simplified methods of construction, such as small, portable motor vehicle type cranes for placement of steel and equipment, he constructed a series of tankers, including the second *S/S VIRGINIA* of 20,000 DWT (to replace the first *VIRGINIA* sunk by an enemy submarine in World War II), the *S/S BULKERO* of 18,000 DWT, the *S/S HAMPTON ROADS* of 24,000 DWT and the *S/S BULKPETROL* of 30,000 DWT - the largest vessel that could be constructed at this site. His close involvement with his building yard and his innovative ideas allowed him to convert or newly construct 37 vessels at Norfolk by the year 1950.

Consistently since the 1940's, Mr. Ludwig was at the forefront of the design and construction of ocean-going oil tankers of ever-increasing size. Shortly after World War II, while he was constructing five 30,000 DWT tankers at Norfolk, Ludwig recognized the changing logistics of the oil industry. The oil fields of the Middle East, with enormous reserves, were coming into production and the economists following the oil industry were forecasting large increases in the future demands for oil. It became clear to Ludwig that the Middle East would be among the primary sources of crude oil in the future. For the industrial countries of Europe, Japan and the United States, these new sources involved extended voyages from loading ports in the Persian Gulf. In order to achieve economical transport over such distances, he knew that the oil would have to be moved in the largest possible carriers consistent with available water depths and facilities at either end of the haul. Anticipating this future need, Ludwig reasoned that very large crude carriers would be required for these long voyages.

Building the Supertanker

In 1949, Ludwig commissioned the manager of his Norfolk shipbuilding operation, E. L. Hann, to conduct a worldwide search for a site suitable to build very large tankers and other ships in the future. In the fall of 1949, this search culminated in Mr. Hann's approach to the Japanese Government and the U.S. Occupying Forces in Japan for approval to lease the shipbuilding facilities of the former Kure Naval Shipyard. The decision to proceed with the leasing of the Kure facility was influenced by the ready availability of an eager, highly-skilled work force with well educated engineers, naval architects and supervisors. In August of 1951, the Japanese government (with U.S. government concurrence) formally authorized his application. The Kure Shipyard had two large graving docks[3], one of which permitted construction of vessels up to 172,000 DWT. Building large ships in a graving dock greatly reduced the costs and difficulties of construction by permitting the use of a production technique which utilized large size block assemblies. The graving dock also expedited the placement of heavy equipment and outfitting,

3. Graving Dock - a ship building basin with a flat bottom below sea level equipped with a watertight closure gate.

as well as the launching procedure. In addition, scaffolding was simplified, providing easier and safer access for workers. Mr. Ludwig felt that the basic advantages of this yard, coupled with the introduction of U.S. shipbuilding technology, would provide the avenue he sought for construction of the larger, even more complex ships of the future.

The first vessels Mr. Ludwig constructed at his Kure facility were four tankers of 38,000 DWT, all delivered in 1953. These were closely followed by a succession of tankers of ever larger dimension - 56,000 DWT in 1955, 85,000 DWT in 1956 and 106,000 DWT in 1959. In each instance, his first vessel of a class was the largest of its kind at the time of construction.

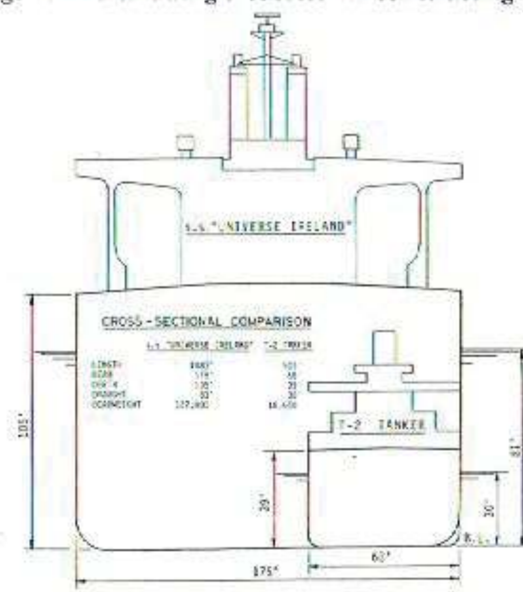
By having his own shipyard, which built vessels exclusively for his own use, he was able to take rapid advantage of favorable market conditions. Some of his competitors had to take their turns at commercial shipyards for ships of comparable size to those Ludwig was constructing, often with delivery dates well beyond those Ludwig could provide. With Mr. Ludwig's concurrence, construction methods initiated and developed by Elmer Hann and his right-hand colleague, Dr. H. Shinto, were made available to over 5,000 technical visitors from other shipyards throughout the world. This extensive technology transfer contributed greatly to the evolution of larger vessels, especially tankers and bulk carriers.

By 1962, Ludwig appreciated that he would have to change his course in building new ships since his Kure yard would require massive new capital expenditures in order to remain competitive with other building yards in Japan and elsewhere. Additionally, Japan's shipbuilding industry had made great progress and younger workers, especially engineers and naval architects, were inclined to pursue careers with major Japanese firms. They also recognized that Mr. Ludwig's lease arrangement only permitted him to build ships for his own use, thus limiting their exposure to other designs. In the same year, his Kure facility reverted to Japanese control and management and thereafter Mr. Ludwig proceeded to contract for his new vessels with Japanese commercial shipyards, primarily Ishikawajima- Harima Heavy Industries, which took over the operation of his Kure facility. Mr. Ludwig continued to work closely with this firm. IHI management was very receptive to his ideas and plans for larger vessels. The arrangement permitted Ludwig to construct the 172,000 DWT combination salt/oil carrier, *S/S CEDROS*, in 1966 (at that time, the largest combination carrier in the world), as well as larger vessels in subsequent years.

While Mr. Ludwig was building progressively larger ships, other owners were competing aggressively to provide the transportation of oil cargos at the lowest cost to the shipper. This economically driven competition resulted in Ludwig's move to the ultra large crude carrier (ULCC) - the genuine Supertanker. However, since the Supertankers Ludwig envisioned required much deeper water at the discharge terminals than was available at that time, it was evident that a new distribution system would be required if the economic benefits of the Supertanker were to be realized. Fully understanding the benefits of a central transshipping

Dwarfing a T-2 tanker (16,600 DWT), the S/S UNIVERSE IRELAND had an 81' draft. Ludwig's success in constructing and operating the 327,000 DWT tankers induced a worldwide mass-ordering of supertankers during the 1970s.

system whereby oil cargos were discharged into storage tanks and then distributed in smaller vessels to refineries located on much shallower water, Mr. Ludwig introduced the concept on a large-scale basis to the oil trade. He proceeded in 1966 to contract for six tankers of 327,000 DWT at two major Japanese buildingyards. These vessels, which had drafts of 81', entered into service in 1968 between the Middle East and three newly built transshipping terminals located on very deep water - Bantry Bay, Ireland; Okinawa, Japan; and Port Hawkesbury, Canada. The move to this size vessel prompted ports around the world to dredge channels or relocate their facilities to deeper water in order to accommodate new, larger tankers.Ludwig's success in constructing and operating these six 327,000 DWT tankers conclusively demonstrated the technical feasibility and economic advantages of constructing and operating ULCCs. This, coupled with the optimistic forecasts for future demand, induced owners worldwide to undertake the mass-ordering of Supertankers during the 1970's. This evolution of the Supertanker stimulated the construction of new building yards and drydocks on an unprecedented scale during the 1970's.



Since many ports which tanker owners and operators wished to serve still did not have sufficient depth of water to permit tankers of 81' draft, a new tanker design of 250/280,000 DWT evolved. This class of tanker had an increased beam and a shallower draft which provided greater flexibility in operation and thus became the Supertanker of popular choice. During this 1970's building boom, over 700 VLCC and ULCC tankers were constructed worldwide. Mr. Ludwig had eleven vessels of 270,000 DWT constructed for his own use and these continue to operate successfully in numerous world trades. On the other hand, some owners built even larger vessels than the Ludwig ULCCs in order to enter specialized trades. Included in this category were tankers of 370,000 DWT, 470,000 DWT and even 550,000 DWT. Ludwig himself ordered four tankers of 470,000 DWT, but canceled his order when certain oil fields in the Middle East were nationalized.

One of eleven vessels of 270,000 DWT constructed for Ludwig in the 1970s, the S/S UNIVERSE GUARDIAN had an increased beam and shallower draft. This new design provided access to more ports and greater flexibility in operation.

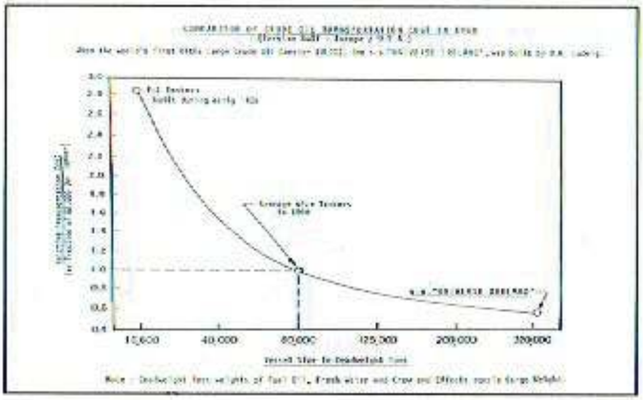
Though not a graduate engineer, his early training in diesel engine mechanics and his experience as a ship's engineer spawned Ludwig's life-long interest in, and intimate involvement with, virtually every technical feature of the ships that were built and operated by and for him. He established the primary concepts of each vessel constructed for his ownership and routinely challenged prevailing conventions as to ship size, hull form, power, proportions and arrangement. For example, his innovative use of a full hull form design (high block coefficient) without impairing speed performance of large ocean-going tankers and bulk carriers, was quickly adopted by others since this design feature provided greater cargo-carrying ability which resulted in higher earning capacity.

Economics of Supertankers

Ludwig's tankers set the standard not only in size, but in the quality of construction and efficient operating performance as well. Although perceived as somewhat of a maverick within shipping circles, D. K. Ludwig's basic tenets of ship construction were basically conservative. His consistent objective was greater productivity in construction methods and excellence in operating performance and cost control.

Ludwig was always adept at making use of materials and equipment which other owners and operators passed over. After World War II, he acquired at scrap prices a number of unused surplus propulsion turbines intended for U.S. Naval vessels. He was able to install these units on sixteen ships and dredges with only minor modifications, thereby realizing major savings in capital investment while achieving satisfactory performance.

His ships are known the world over as lean and austere in appearance, but they are recognized as exceptionally durable and reliable in machinery, equipment and basic structure. His fleet of tankers and bulk carriers enjoy "on-hire" records that were,and remain the envy of the world tanker fleet. For example, in the most recent period of operation, eight vessels of his 270,000 DWT class were only out of service for an average of nine days for each scheduled drydocking, whereas the worldwide average for this size vessel built in the 1970's was 51 days. The favorable performance of these tankers make them among the most sought after tankers in the market today. None of the more than 100 ships constructed or converted in his shipyards and operated under his direct responsibility experienced a major structural failure.

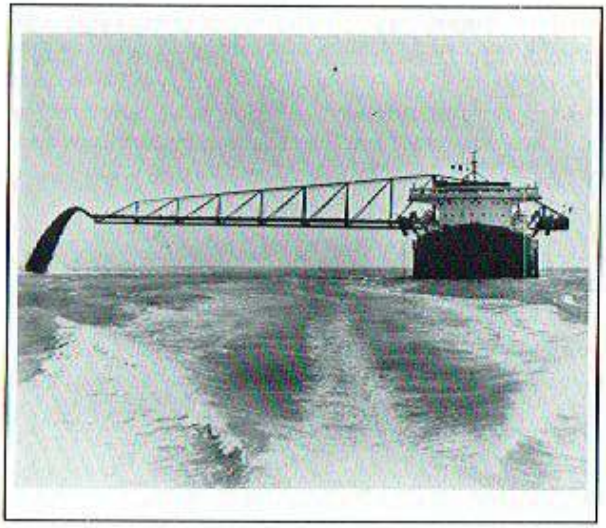


The graph illustrates the economic benefits of the Supertanker in relation to smaller vessels and shows the cost (on an index basis) for moving oil from the Middle East to either Europe or the east coast of the United States. From this, it can readily be seen that the 327,000 DWT tanker moved oil at approximately one-half of the cost of the prevailing average sized tanker (80,000 DWT). The index cost for a T-2 tanker is shown at the extreme left of this graph for comparison purposes.

D. K. Ludwig's leadership in the continuing expansion of tanker size produced substantial reductions in the cost of moving crude oil internationally and yielded significant savings to end users of oil worldwide. For example, at the time of delivery of the first Ludwig 327,000 DWT tanker, the worldwide average size tanker was approximately 80,000 DWT.

These benefits stimulated change in design of ports and terminals worldwide during the late 1960's, 1970's and 1980's. Deepwater oil transshipping terminals and offshore, deep-draft oil discharging installations such as LOOP (Louisiana Offshore Oil Port) were built. These developments greatly relieved port congestion worldwide and also reduced the risks of collision and pollution in already overcrowded loading and discharging areas. Overall, the development of the Supertanker has resulted in real efficiencies of oil transportation. For example, the crew size on a Supertanker is only fractionally larger than on a vessel of one-quarter its size. Additionally, the daily fuel consumption of a 327,000 DWT Supertanker is less than double that of an 80,000 DWT vessel, whereas the cargo carried is four times as great. It would take about four smaller tankers of 80,000 DWT to transport the same quantity of cargo as a 327,000 DWT Supertanker.

Ludwig was also at the forefront when it came to innovations in financing his vessels. Before he borrowed funds to build a vessel, whether from the building yard or a financing institution, he would secure a long-term charter for the vessel (usually from a major oil company). The charter would be added security for the financing institution, thereby facilitating his ability to secure the best rates for the longest periods. This concept found wide acceptance throughout the shipping industry. D.K. Ludwig's ingenious contributions to marine transportation have not been limited to oil tankers. Ludwig transferred his tanker concepts of increasing size to dry bulk carriers, but found this much more difficult. The loading and discharge facilities for dry bulk commodities generally were located in shallow water ports, as close as possible to the supplier or end-user. Although it was comparatively simple to construct oil pipelines extending for long distances to a tanker loading/discharge facility located in deep water, this flexibility is not available for dry bulk handling systems. Despite these constraints, Ludwig was successful in persuading end-users to utilize the



The S/S ZULIA proved Ludwig's basic concept of the side-casting dredge was practical and profitable. Ludwig personally participated in virtually all of the principal facets of its design.

largest possible dry bulk carriers when the conventional transport solution was to use much smaller ships. He worked with port authorities in numerous locations including Holland, Brazil, Australia, South Africa, as well as the United States, to take advantage of the ultimate economy of the largest feasible dry bulk carrier. His office was a frequent stopping point for consulting engineers working on new port facilities in diverse areas of the world.

Mr. Ludwig's commitment to a transportation system for the economical movement of iron ore from Venezuela to the United States and other world ports led to the construction of three, twin-screw, 60,000 DWT ore carriers in 1954 to replace a fleet of smaller, slower, less efficient Liberty ships of 10,800 DWT. Since the channel servicing the Venezuelan ore trade at the time limited vessels to approximately 22' to 24' draft, Ludwig conceived the idea for the world's first side-casting boom and hopper dredge. In order to establish the validity of his basic concept of the side-casting dredge, Ludwig converted a T-2 tanker, equipped with a fixed 250' discharge boom, at his Kure yard. The success of this conversion in deepening the Orinoco River and bar encouraged the Venezuelan government to contract with Ludwig for the construction and operation of a much larger dredge, the *S/S ZULIA*, which had a 328' long rotating discharge boom to be utilized in deepening the entrance to Lake Maracaibo. This dredge removed more spoil from the Maracaibo channel in its first ten days of operation than eight small, hopper dredges had removed in the previous two years. It permitted an increase in ship's draft from 19'4" to 45' resulting in drastic reductions in freight costs for the tankers servicing the Maracaibo oil field. Mr. Ludwig personally participated in virtually all of the principal facets of the design of this dredge.

The economic benefits resulting from the performance of the *ZULIA* convinced Orinoco Mining Co. to contract with Ludwig for a very similar dredge, the *M/S ICOA*, in 1961, in order to increase the available depth of the Orinoco River channel and mouth so that Ludwig's large ore carriers could be utilized fully loaded. When placed in service, the dredge *ICOA* was able to remove approximately ten million cubic yards per month of dredge spoil from the bar of the Orinoco River, with somewhat smaller quantities from the river channel. Within two years, a large fleet of liberty ships was replaced by a much smaller fleet of 50-60,000 DWT ore carriers, generating substantial savings to end users of iron ore worldwide. The *ICOA* remains in service today.

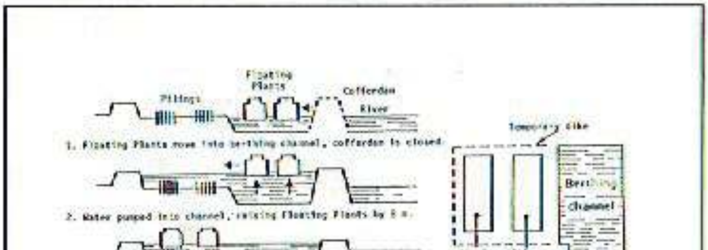
LUDWIG'S ADDITIONAL CONTRIBUTIONS TO TRANSPORTATION

Ludwig's contributions to transportation extended beyond tankers, dredges and bulk carriers. In 1966, he undertook the development of a three million acre tract of land along the Jari River in the Amazon region of Brazil for a future source of forest products. The heart of this ambitious project was a bleached kraft pulp mill. While planning the engineering and construction of the mill, studies revealed that the time and cost of a 750 tons per day capacity mill constructed by conventional methods in such a remote location would make the whole project unfeasible. In 1975, Mr. Ludwig formulated the concept of constructing virtually the entire pulp mill and associated power plant on two barge-like platforms at the shipyard in Kure, Japan, towing them halfway around the world to the Jari River site and permanently placing them on wood piling foundations.

His plan resulted in the construction of two floating plants. approximately 750' long x 140' wide, each weighing 30,000 tons (about the same weight as a Supertanker.) These were positioned at the Brazilian site by first constructing a large basin surrounded by dikes. The floating plants were then moved into the basin, the entrance was closed, and water was pumped into the basin to a depth of eight meters to elevate the floating plants. At that point, they were positioned over the piled foundations; the water in the basin was released and each plant was left in its permanent location.

Ludwig's pioneering efforts continued in the late 1970s with the concept and construction of the floating plant. Built on barge-like platforms, the plant could be towed to remote areas for operation.

Doubts had been raised by many experts in the forest products field that a steel, ship-like hull, having elastic steel foundations for pulp mill equipment, would be satisfactory for a large bleached kraft mill which traditionally was constructed with heavy concrete foundations, let alone that it could be towed 15,000 miles without serious damage. The tow, of unprecedented scale, was completed in 90 days with no damage of any nature to the floating plants. The mill entered service in February 1979 and has been operating continuously, except for routine maintenance shutdowns, since that time.

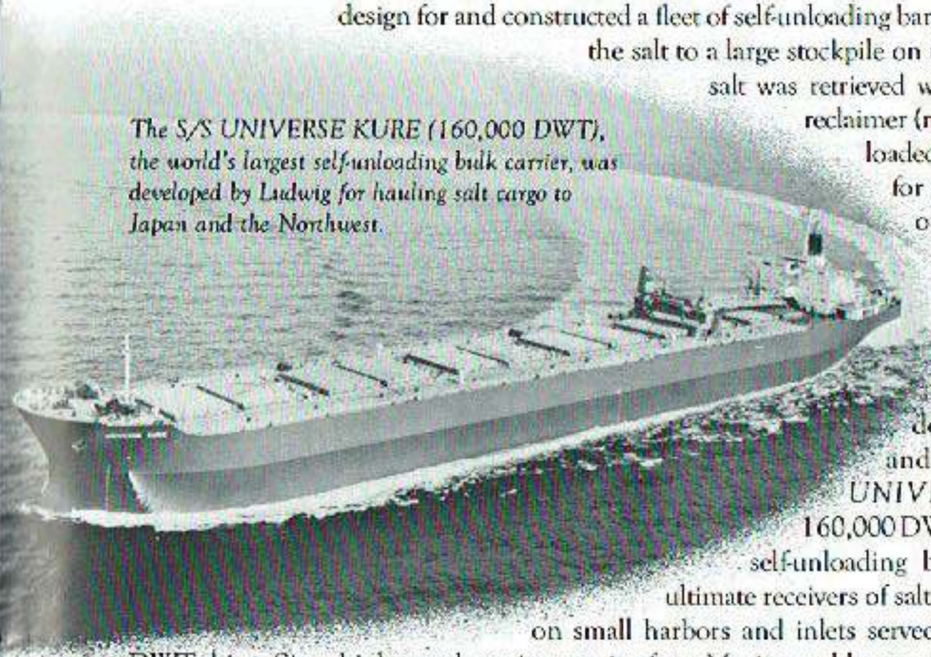


Five easy steps : Berthing and landing technique for JARI's Pulp Mill.

This pioneering effort established a basic pattern for subsequent ventures by others - including chemical plants built for the Middle East and a large water injection plant for Prudhoe Bay, Alaska.

In the early 1950's, the expanding chemical plants servicing the paper and pulp industry in the Northwestern USA, Canada and Japan, required additional sodium chloride feedstock for their operations. In the manufacture of chlorine and related products, existing economical sources of clean salt were limited. Having learned of an area along the Pacific coast of Baja California, Mexico where there were ancient salt beds, Ludwig acquired a concession to produce newly generated solar evaporated salt from seawater. Sparsely settled and with no industry of any kind, the area presented no risk for pollution of the salt.

The primary element of successful marketing of a low price commodity such as salt was in transportation, particularly to Japanese markets. Ludwig, accordingly, embarked on a program to use the largest possible vehicles of transportation on land and sea. He soon found that solar evaporated salt was a very difficult material for conventional materials handling equipment. When the major engineering firms could not provide solutions within Ludwig's budget, he took up the challenge and spearheaded the engineering effort to resolve the problems. These included a salt harvesting machine of 3000 T/Hr. capacity, a new type of stockpile reclaiming machine, both developed by him, a trucking system and self-unloading ships quite different from existing designs. At the production site in Mexico, the salt had to be transported up to 30 miles to the shiploading installation. His analysis showed that the most efficient means of moving the quantities needed was in 300-ton truck lots. However, there were no 300-ton trucks available at the time and the major truck manufacturers were unwilling to undertake the development of such a unit for a limited market. So Ludwig proceeded on his own, having his shipyard in Japan construct the truck bodies in trailer form. He persuaded one of the diesel engine manufacturers to adapt 1000 h.p. engines for truck service and then coupled the two for a successful trucking operation which grew to handle in excess of five million tons of salt per year. The movement of salt from Mexico to Japan and northwest USA-Canadian ports presented several problems. Severe draft restrictions at the production site precluded the direct use of deep draft bulk carriers. Since Cedros Island, which was 60 miles offshore, had very deep water, Ludwig developed the design for and constructed a fleet of self-unloading barges which transported the salt to a large stockpile on that island. Then the salt was retrieved with a newly designed reclaimer (referred to above) and loaded into deep draft vessels for delivery to Japan and other ports. The principal bulk carriers hauling the salt cargo to Japan and the Northwest were of unique designs, developed by Ludwig, and included the S/S UNIVERSE KURE, OF 160,000 DWT, the world's largest self-unloading bulk carrier. The ultimate receivers of salt in Japan were located on small harbors and inlets served by 6,000 to 10,000 DWT ships. Since his large salt carriers coming from Mexico could not enter these shallow depth ports, Ludwig acquired a small island in the Kure harbor area of Japan where the adjacent water depth exceeded 60'. From a stockpile on this island, he distributed the cargo to individual customers in vessels of the size and type they had been using. Implementing this overall transportation system resulted in a significant reduction in the total cost of salt, as well as insuring a steady flow of high quality salt to the individual industrial customer.



The S/S UNIVERSE KURE (160,000 DWT), the world's largest self-unloading bulk carrier, was developed by Ludwig for hauling salt cargo to Japan and the Northwest.

Although Mr. Ludwig was involved in many aspects of marine transportation, he was probably best known as the innovator of the concept of "Supertanker." There is little doubt that Daniel K. Ludwig has left an indelible mark on the history of the maritime industry.

Elmer A. Sperry, 1860-1930

After attending Cornell University in 1879-80, Sperry invented an improved electric generator and arc light and opened an electric company in Chicago. He invented 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 Founding of 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.

An additional endowment to support the award was received in 1978 upon the death of Mrs. Lea. 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 benefitted 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, together developed.

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:

The 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; and 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.

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 custodianship of The American Society of Mechanical Engineers. This organization is empowered to administer the fund and has generously agreed to assist in handling the Award procedures. The fund has been placed in an interest bearing account, and earnings are used to partially cover the expenses of the Board. The principal account is augmented from time to time by donations from interested individuals and organizations.

The Elmer A. Sperry Board of Award Secretariat is administered by the American Society of Mechanical Engineers, which has generously donated the time of its staff to assist the Board in its work. The Secretary is appointed by the ASME from among its senior staff personnel.

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

1955 to William Francis Gibbs and his Associates for development 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 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 aircraft and engines.

1960 to Frederick Darcy Braddon and Citation to the Engineering Department of the Sikorsky Aircraft Division, 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 application of the ignition rectifier to railroad motive power.

1963 to Earl A. Thompson and Citation to his Associates for design and development of the first notably successful automatic automobile transmission.

1964 to Igor Sikorsky and Michael E. Gluhareef 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 Oishiand 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, an Robert A. Wolf 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 Puiseax and Citations to the employees of the Manufacture Francais des Pneumatiques Michelin for the design, development and application 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 and 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 Jorg Brenneisen, Ehrhard Futterlieb, Joachim Korber, Edmund Muller, 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. Andre Turcat, Ld'H, GG; 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, which revolutionized the economics of Great Lakes transportation.

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 and 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. Frohlich, 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 FAA enroute air traffic control system.

1991 to Malcolm P. McLean for his pioneering work in revolutionizing cargo transportation through the introduction of intermodal containerization.

THE 1992 ELMER A. SPERRY BOARD OF AWARD

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