LIBERTY SHIPS

American shipyard workers lay down the keel of one of the 2,710 Liberty Ships built at 18 US shipyards during World War II. These humble vessels helped win the war and build a new world in the decades afterwards.

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AN ENDURING LEGACY

September 2016 marked a small but important anniversary in merchant shipping: 75 years since the launch of the first Liberty Ship during World War II. It is noteworthy because the Liberty Ship can be considered the great-grandfather of the modern merchant fleet, in the sense that it pioneered the manufacturing techniques, the welding science and the standardization philosophies affecting just about every commercial ship afloat.

Officially designated vessel type EC2-S-C1, the Liberty Ship was a 10,000-dwt freighter, the main part of a huge fleet designed to carry desperately-needed supplies and materiel to the Allied forces fighting in Europe and the Pacific. The idea behind them was simple: build more than the enemy could sink. In what became history's biggest shipbuilding program, the U.S. Maritime Commission launched a total of 2,710 Liberty Ships from 18 shipyards between 1941 and 1945, along with 531 'Victory' class ships (a larger, faster freighter type), 521 'T2' class tankers and a much smaller number of other designs.

Conceived as expendable instruments of war with a life expectancy of two trips across the Atlantic, the Liberties instead displayed great durability and ended up delivering some two-thirds of all Allied cargoes, at the Herculean rate of 6,000 tons per hour. Then, in the post-war world, the Liberty story spun out in some very interesting threads that helped shape the future of an entire industry.

The first major industrial impact of the emergency shipbuilding program was to change the way ships are constructed and establish welding as the shipbuilding technology of the future. Up to that time, even steel hulls were built on the logic of their wooden and iron forbears: a keel was laid, ribs were raised and shell plating was riveted in place. Because riveting was a slow process, the Maritime Commission took a calculated risk and adopted welding as the only way to meet its need for rapid, high-volume deliveries, and industry grudgingly accepted the decision. A few welded ships had been built before the war, but most builders still considered the technology unproven, and many opted for a hybrid approach that produced welded hulls with a mixture of riveted frames, seams and deckhouses – an inelegant solution, but it worked.

The revolution in ship construction came when industrialist Henry Kaiser got into the game. Although he had never built a ship, he reasoned that modern manufacturing methods could be applied to any product, including one shaped like a ship. Introducing what later generations would call 'Group Technology', Kaiser brought assembly line logic into what had been an artisanal industry. He assembled ships from prefabricated, all-welded modules – the first time ever that such had been done – and organized his shipyards according to manufacturing needs and product flow rather than to the types of work being performed.

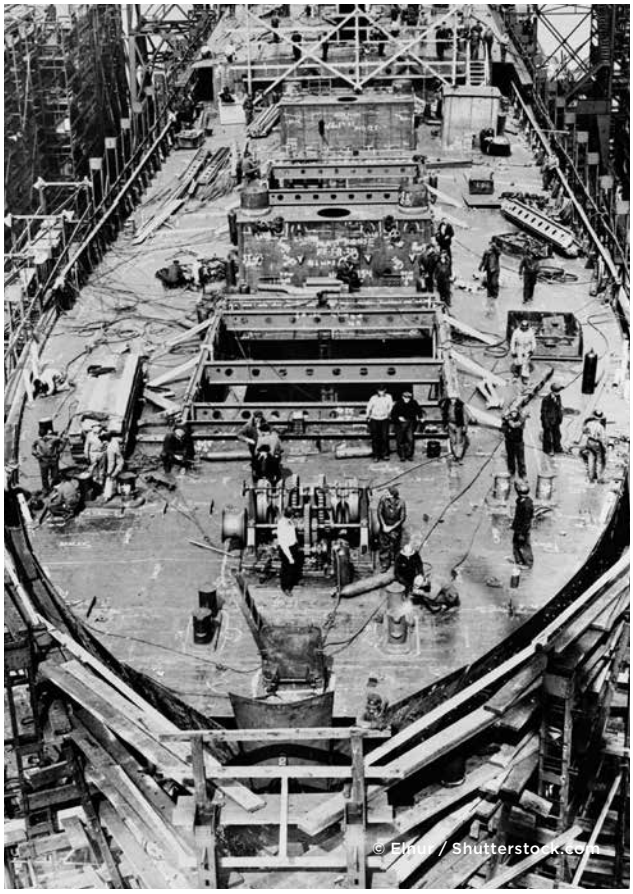
For example, the down-hand welding technique (holding the torch below the waist and letting the weld flow by gravity) was by far the easiest to teach unskilled workers, so the workflow and parts to be assembled into ships were organized to accommodate it: forepeaks were built sideways, sides were built lying flat, deckhouses were built upside down, and bottoms, bulkheads and decks were built as discrete units. The method was considered strange and the whole process was ridiculed by many, but it worked. The Liberty Ship project brought revolutionary advances to shipbuilding that, in terms of manufacturing logic, organization and quality control, remain with us today.

Kaiser's yards performed with astoundingly great efficiency, completing vessels in two-thirds the time of the other yards and at 25 percent lower costs. It is estimated that the 821 Liberty Ships he built saved the Government more than $226M (almost $3B today).

Despite the success of Kaiser's methods, after the war U.S. shipbuilders rejected his assembly-line approach and returned to traditional construction methods – setting their ultimate demise in motion. Meanwhile, Kaiser's model got a warmer reception across the Pacific, where American shipowner Daniel Ludwig had leased a Japanese naval shipyard to build large tankers for his company, National Bulk Carriers. In 1951, Ludwig brought in Elmer Hann, formerly Kaiser's General Superintendent, to run the facility. Hann taught his Japanese colleagues Group Technology methods, and his belief that a modern shipyard's success rested on having college-educated middle managers who knew shipbuilding and understood the importance of data analysis – in particular, the Statistical Quality Control methods invented by American engineer W.E. Deming. One of Hann's students, Dr. Hisashi Shinto, became the acknowledged father of Japanese shipbuilding. Expanding on what he learned from Hann and Deming, he worked with Japanese-owned yards to develop a constantly self-improving ship construction system founded on basic Kaiser logic, enhanced through statistical process control, which quickly made shipbuilding a pillar of Japan's post-war reconstruction. By 1964, Japan was building 40 percent of the world's merchant ships and remained the number one shipbuilding nation for 40 years. The methods developed in its shipyards were copied around the world and are the foundation of today's standard shipbuilding practices.

Although welding ultimately proved to be the way forward for ship construction, it did not attain that recognition seamlessly. A number of Liberty Ships and T2 tankers suffered sudden, mysterious, extensive and even destructive fractures, some involving loss of life, which led to outraged allegations against the shipbuilders of everything from carelessness to fraud. By 1944, it was estimated that some 12.5 percent of the Liberty fleet had weld defects and that one ship in every 30 had suffered major fractures. This led the Secretary of the Navy to appoint a "Board to investigate the design and methods of construction of welded steel merchant vessels" to solve the mystery. The Board, made up of technical personnel from the Coast Guard, the Navy's Bureau of Ships, the Maritime Commission (which led the emergency shipbuilding program) and ABS (the classification authority for the entire war-built merchant fleet), convened a nearly two-year program of data collection and laboratory analyses that involved some of the best engineering minds in the country. The understanding of fracture mechanics, so important to industry today, began during this work.

Eventually, the causes of the problem were identified and solutions developed, and by 1946 the fracture problem had virtually disappeared. Even so, the Board members realized that the true understanding of the behavior of ships at sea was only just beginning. Before it disbanded, the Board recommended the establishment of a permanent committee to continue its work, whose duty would be "to investigate and study problems pertaining to the structure of ships, in order to improve design details, materials and methods of fabrication used in the construction of ships."



This led to the founding of the U.S. Ship Structure Committee, which since 1946 has been a leading force in identifying and tackling future marine engineering challenges.

If the Ship Structure Committee (SSC) can be considered as part of the Liberty Ship legacy, then so can its work, including the spark of the rational ship design revolution.

In a 1959 report, the SSC concluded that achieving a better understanding of loads (the forces a ship experiences at sea) was key to establishing "rational, less empirical design procedures." That report, *A Long-Range Research Program in Ship Structural Design*, kicked off a research program that ran throughout the 1960s and led to the first true understanding of the loads and responses of ships in service. One of its stated goals was to develop a theoretical basis for analyzing new designs.

The report introduced rational ship design as the means by which: the functions and requirements for a hull structure can be explicitly stated at the outset of the project; all loads expected in service can be determined and combined; structural members can be arranged in the most efficient manner to resist those loads; and adequate, but not excessive, scantlings can be determined using a minimum of purely empirical factors. Ultimately, the rational ship design movement brought computer-aided design and engineering into the maritime world and led development of the analytical technologies that marine and offshore engineering depend on today. This technology thread connects the ancient history of the Liberty Ship to the futuristic vessels of tomorrow.

The Liberty Ship also left its mark on the business side of shipping. After the war, the United States sold 781 Liberty Ships and 399 T2 tankers into commercial service; most of them went to U.S. allies, sold under extremely favorable terms in order to jump-start the rebuilding of their merchant fleets. The modern merchant fleets of Greece and Italy, for example, grew out of 100-ship lots sold to those countries in 1946.

Able to access virtually all ports, the Liberty Ship became not only the backbone of the global dry bulk trade, but also sparked a revolution in the business of shipping. Greek shipping legend George P. Livanos once remarked to *Surveyor* magazine that, "through the Liberties, Greeks were exposed to new world financing and American banks learned that shipping finance could be secure and profitable."

The vessels also helped shipowners modernize their operations. Italian shipping patriarch Giuseppe d'Amico, whose company Fratelli d'Amico Armatori began its post-war buildup with four Liberties and two T2 tankers, once told this magazine that the Liberty Ships were a "double gift" to shipowners, for the favorable financing and for the effect the vessels had on the shipping business.

"The Liberty Ships were absolutely modern vessels filled with rational concepts; such ships did not exist in the mercantile world before the war," d'Amico said. "With its simplified technology, the Liberty was an enormous advance for us. Studying the rationalized technology of the Liberties, we learned to change our ways of working and improve our methods. It was the start of the professional evolution of the Italian shipowners – and of the crews, too, from whom the ships required higher-level skills."

Further, the growth of ABS as an international organization began with the Liberties, when it had to open offices in ports around the world to support the ships, because all had been built to ABS Rules and, under the sale terms, had to be maintained in ABS class.

As the Liberties entered the last phase of their commercial lives in the early 1960s, they brought one more gift to the shipping industry, at least by inspiration. Of the 2,710 Liberty Ships built, 2,580 were virtually identical from stem to stern. The standardized design was highly prized across the industry: owners knew their characteristics before purchase, charterers knew their capabilities before hire, and crews and stevedores knew their vessels

before ever stepping aboard. The maritime industry desired a modern replacement but did not believe mass production of ships could be done commercially. In response, a marine consultant named George T.R. Campbell developed a methodology that effectively resurrected Liberty-type series shipbuilding in a commercial format.

Campbell did this by developing his own standard-design vessel, which he branded *Freedom*, and worked with the IHI shipyard in Japan to optimize procurement, production and unit pricing. Through project supervision by his company GTR Campbell International (GTRC), he was able to guarantee owners consistent pricing over a long string of ships, as long as they did not ask for design changes or 'extras' or otherwise interfere with the building process. The ship was technologically innovative and priced attractively and, as a result, became the best-selling ship design in maritime history – 176 Freedom series ships were built over the next decade, and established series shipbuilding as a viable, economical commercial practice.

Although conceived as short-life vessels whose only value was in numbers, the Liberty Ships instead left a broad and far-reaching legacy that touches even the present day. Those wishing to personally appreciate that legacy are in luck, because two functional Liberty Ships remain, restored to their wartime condition (but with the guns deactivated) and open to the public: the traveling museums *John Brown*, docked in Baltimore, and *Jeremiah O'Brien*, whose home port is San Francisco. Lovingly tended by volunteers, with operations and upkeep funded solely by ticket sales and donations, the vessels are maintained in seaworthy condition and take the public out on cruises several times a year. The *Jeremiah O'Brien* even made it across the Atlantic for the 50th anniversary celebrations at Normandy in 1994 – the only American ship that had been present at the invasion to do so. Together these ships hold the ends of a long thread of service in war and in peace, to remind and inspire and, with silent nobility, help the present understand the past so as to build the future. ■