Container Carriers Transport the World

With the vastness of oceans as their limit, gigantic ships carry the goods of a globalising economy. Already, 80 percent of all general cargo is ferried in containers.

At a time of strong economic growth such as much of the world is presently experiencing, three types of ship are bound to be in big demand: the tanker to deliver energy, the bulk carrier to transport raw materials and the container ship to distribute the resulting semi-finished and finished products around international markets.
Of these three vessel types, the container ship is the most recent development. While the modern super tanker, or "very large crude carrier" (VLCC), and the mega-bulk-carrier are the evolutionary products of smaller predecessors, the container ship is the result of a veritable revolution.

CHANGING THE FLOW OF TRADE

Since the 1970s, the growth of containerisation has been dramatic, traditionally outpacing overall global economic growth. Today, approximately 80 percent of general cargo moves by containers stacked in—and on—specialized ships, and more than 200 million containers are moved each year. During the 1970s, container port turnover increased by an average of 22 percent annually, during the 1980s by 9 percent per year, and accelerated during the 1990s to 10.5 percent and 10.7 percent for 2000 to 2005. Annual growth has remained high, is currently gaining pace and remains above the overall economic growth rate, as the container continues to penetrate the general cargo market. Since there is almost no limit to the type of commodities that can be transported in containers and container ships, it is expected that even more product groups, such as cars, will be transported in that ways. "The developments of the last few decades have changed the economics of transportation and thus the flow of world trade," says Professor Berthold Volk from the Oldenburg University of Applied Sciences in Germany. "Without containers, there would not be the degree of globalisation we are experiencing today—and the integration of the world economy will continue." As the cost of transportation is increasingly determining the economic success of a product, it can give companies a make-or-break competitive edge. And since shipping via container is very cost-effective, it is expected to increase on a worldwide scale.
Transporting a rapidly growing number of containers has resulted in container ships growing in size and number. As in the equivalent phase of super tanker and bulk-carrier development a few years ago, the shipbuilding industry is presently in a period where almost every new construction in the large container sector sets a new world record. In fact, today's largest ships, either in service or on order, are expected to be dwarfed in a few years' time by ships that are 25, 50 and, eventually, 100 percent bigger. The main reason for this trend is, of course, economy of scale: the considerable operating-cost reductions per payload unit.
Currently, one of the world's largest container ships is the 9,200 TEU MSC Pamela, built by Samsung Heavy Industries of Ulsan, South Korea, for the Hamburg ship owner Claus-Peter Offen (TEU= twenty foot equivalent unit – the earliest containers were 20 feet in length). Now sailing under Panamanian flagging for its owner Mediterranean Shipping Company (MSC), with headquarters in Geneva, Switzerland, the ship was de-signed for Asia-Europe express trade routes.

GIANT ENGINE FOR SEA GOLIATH

These routes demand a vessel of both high capacity and high speed. Accordingly, the MSC Pamela's prime mover stems from MAN B&W Diesel and with an output of over 68 MW, is

one of the biggest diesel engines ever built. “One of the largest vessels of its kind demands—and gets—one of the largest engines of its kind and with one of the highest-rated outputs,” notes Thomas Knudsen, head of engine development at MAN B&W Diesel in Copenhagen. Designed in Denmark and built under license by Hyundai in South Korea, it produces a maximum continuous rating (MCR) of 68,520 kW at 104 revolutions per minute and is presently the engine of choice for the generation of container vessels that the MSC Pamela belongs to. This immense power gives the ship a service speed of 26 knots, a level now expected to become the standard for this generation of large container ships. Increases in container ship size have always been accompanied by demand for higher ship speeds. In the recent past, 23 to 25 knots was standard in the 4,000 to 6,000 TEU class and 24 to 26 knots in the 6,000 to 8,000 TEU class. Still, the MSC Pamela’s 26 knots are expected to remain the maximum achievable for some time. Higher speeds would involve disproportionately high fuel consumption increases and hence operating costs per TEU.

Due to environmental considerations, speed can be only one factor when choosing the propulsion system for a container ship. A balance must be struck between vessel speed, economy and ecology. Clearly, economy and ecology are closely related in combustion engines, as lower fuel consumption means lower exhaust emissions.

Fittingly, the MSC Pamela is powered by a type of engine that traditionally achieves the lowest specific fuel consumption values of any prime mover and burns heavy fuel oil (HFO), one of the cheapest fuels. But the advantages of the slow-speed two-stroke do not stop there. “The fact that these largest container vessels employ only one slow-speed two-stroke diesel engine is testimony to the almost legendary reliability of our engines,” observes Knudsen. “Similarly, the inherent efficiency of the two-stroke is further enhanced by its ability to transmit power directly to the propeller without the friction losses associated with an intermediate reduction gear stage. Ship owners appreciate that the low operating speeds and relative simplicity of two-stroke engines make them very long-lived and very economical to maintain and service.”

TO DOUBLE OR NOT TO DOUBLE

Record size notwithstanding, MAN B&W Diesel is prepared to handle even bigger projects. With its K98 (bore 98 cm) and K108 (bore 108 cm) engines and power outputs of almost 75,000 kW, the current MAN B&W Diesel two-stroke engine program is very well suited to meeting the main engine power requirements of both current large container ship types and the sizes expected in the foreseeable future, namely 100,000 kW and more. “The development pace is very fast, and ships with a capacity of approximately 9,600 TEU are already under construction. We are now looking into container vessels almost twice the size of the MSC Pamela,” says Knudsen.

These investigations indicate that a main engine producing 103,000 kW and directly coupled to a propeller of six metres diametre and with six blades can meet the expected power and speed requirement of about 25.5 knots for an 18,000 TEU container vessel. Although such an engine is currently not in the product program of MAN B&W Diesel, the company is confident of either up-rating the cylinder outputs of its existing engines or, if needed, developing yet larger engine variants.

The further direction is not yet determined, since a debate is underway in the shipbuilding industry as to whether vessels of this size would not be better served by twin-engine, twin-propeller propulsion systems. Basically, the technical considerations concern the investment needed in new hull shapes to accommodate twin-engine systems. A twin engine, twin-propeller vessel actually can achieve almost the same efficiencies as a single-engine, single-propeller vessel because of the similar hull shape in front of the propellers. It also is possible to install somewhat smaller propellers with fewer propeller blades but with a larger total blade

area, improving propeller efficiency by about 4 percent. However, the total hull surface needed to accommodate twin propellers is estimated as about 5 percent larger than for the single-prop vessel because of the extra rudder needed and the modified aft-body. Thus, MAN B&W calculations show that the improved propeller efficiency will be almost offset by the increased hull resistance. In addition, a container vessel with two engines and two propellers, including the necessary auxiliary systems and modification of the hull, will no doubt be more expensive.

No matter whether a single-screw or a twin-screw propeller system may be preferred for the future ultra-large container ships, MAN B&W Diesel can deliver the main engine power. “If a single-engine, single-propeller plant is needed for a 25.5 knot 18,000 TEU container ship, we could supply the proposed 103,000 kW single engine for a six blade, 10-metre propeller” says Knudsen, “And if a twin-engined vessel is preferred, we would offer combinations such as two of our 9-cylinder K98MC-C/ME-C engines and two five-blade propellers, each of 9 metres, to meet that power demand”.

REDESIGN FOR A WORLD RECORD

Looking at her other features, it becomes clear that the record size of the MSC Pamela is reflected in many other aspects of her design, besides her engine. For example, she can also load 10 tiers of containers below decks within the cargo holds and features a division of her wing ballast tanks into separate top and bottom tanks as a measure to counter the stability problems typical of large container vessels.

Still, while all her containers would stretch a massive 56 kilometres if laid end to end, the 337-metre-long MSC Pamela is not the longest of container ships, in spite of her record status. On the other hand, at 45.6 metres she has the broadest beam, about 2.4 metres wider than the previous largest container ship. This allows an extra, 18th row of containers.

Indeed, determining the beam dimension was the critical calculation in the MSC Pamela’s remarkable, even dramatic, development story, for rarely can a vessel have been designed and built more quickly. In a sequence of major changes, which give a fascinating insight into container ship design, the ship’s principal dimensions underwent a transformation at a very late stage in her development. “In just three days, the parties involved had transformed an 8,200 TEU ship into a 9,200 TEU ship!” notes Jan-Olaf Probst, Ship Type Manager Container Ships at the Hamburg head office of Germanischer Lloyd.

To get the desired capacity there were two options: increase either the length of the MSC Pamela or her beam. Because of manoeuvrability issues in most ports, adding an 18th row of containers seemed the way to go. In fact, it is simple geometry to calculate that achieving the targeted increase in TEU capacity would require an increase in length considerably greater than the necessary 2.4 metre increase in beam. Also, a wider, shorter ship requires less docking length and can be turned around in a narrower channel. Even at the new width, the 18th row of containers is still within the reach of existing cranes—an aspect that could very well become a limiting factor on container ship dimensions in the immediate future. And, perhaps most critically, an increase in length causes more problems in terms of vessel rigidity than an increase in width. “The greater length could only have been bought at the expense of greater distortion of the hull, so the lengthened hull would have required a lot of extra stiffening,” confirms Probst.

Following three days of intense decision-making came a period of equally intense, fast-track ship design. With only 10 months left between the design changes and starting to cut steel in Korea, analysis had to be greatly accelerated. Consequently, the MSC Pamela may not keep her world record much longer, but the story of her design phase will remain an interesting chapter in the history of shipbuilding.