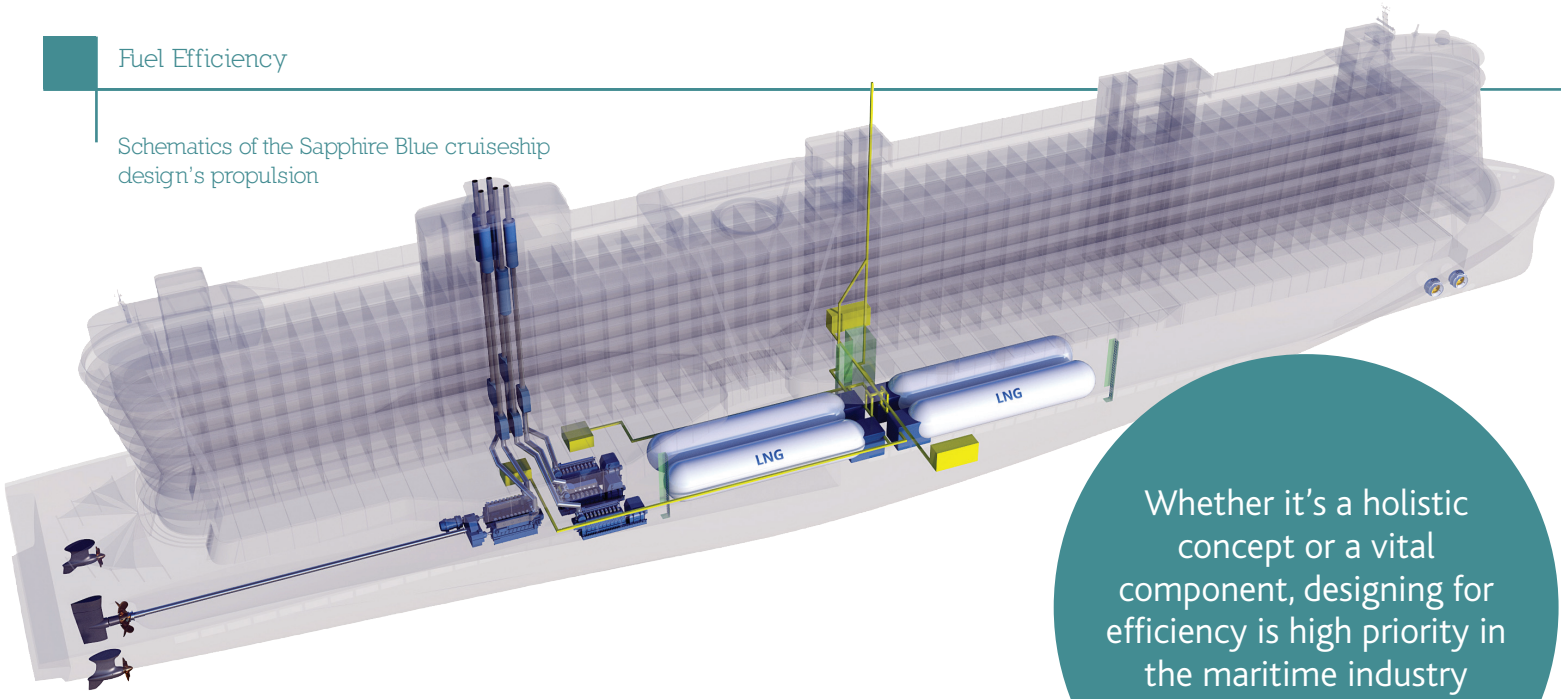

Schematics of the Sapphire Blue cruiseship design's propulsion

Whether it's a holistic concept or a vital component, designing for efficiency is high priority in the maritime industry

Design difference

Saving fuel is the holy grail for shipowners nowadays and the whole industry has evolved to provide a variety of ways to make that happen. Alternative fuels to HFO could be more cost effective too, as well as meeting stricter environmental legislation.

One of Rolls-Royce's objectives as part of a new LNG cruiseship design its forward-thinking Blue Ocean Team has created was that it would be fuel efficient to operate, as well as being cost-efficient to build. The Sapphire Blue concept is 223m long, 32m beam and would be able to accommodate 950 passengers and 410 crew. The 42,000gt vessel would be powered by four or five Bergen B35:40 pure gas engines.

"Running costs of the machinery are very attractive compared to diesel or HFO," says Blue Ocean Team's Esa Jokionen. "Emissions are also substantially lower, compared with diesel, and of importance to a cruise vessel close to shore or in port, NOx is greatly reduced, sulphur emissions are zero and there is no smoke."

Power levels were selected to enable a 19kts design speed with a maximum endurance of 16kts. Between 20 and 21MW of power should cover propulsion and hotel loads. Four LNG tanks would provide 480m³ capacity each, and would be located in the hull, forward of the engine rooms. This would equate to a three week fuel duration, which may provide an interim solution to the current dearth of global LNG bunkering facilities. The design calls for the tanks to be well protected against potential collision damage, and bunkering connections are available port and starboard. For safety, access to the tank spaces would only be from the outside, with no doors to other decks.

Four options were proposed for the propulsion, one using a twin electric Promas propeller/rudder, which Rolls-Royce says would provide high reliability, low investment cost and good efficiency. The second option was twin pods, enabling high efficiency, low noise generation and good manoeuvring. The Promas and wing thruster combination in the third option should also allow high propulsion efficiency, this time the proven technology providing excellent manoeuvring and good total economy. The last option was large area propeller and wing thrusters, which should enable the best propulsion efficiency, with low propeller loads and low noise. It would also provide good manoeuvring and the best total economic performance. An owner's choice would depend on the type of cruise itinerary and the cruise line's preference.

The hull is designed to have low resistance, and a modular method would be utilised for construction. "With a superstructure much narrower than the beam of the ship, the shape of our innovative cruise concept is governed by function," says Oskar Levander, vice president of innovation, engineering and technology.

Hydrodynamics

Hydrodynamic optimisation is another area where significant fuel savings may be obtained. According to Christian Damsgaard, senior naval architect at Danish designers Knud E. Hansen: "To ensure a vessel has an efficient passage through the water, resistance can be reduced by hydrodynamically efficient hull lines and appendages. Quality steelwork and low friction paint also help. Furthermore, there are design considerations and devices that improve the flow to the propeller and the efficiency of the propulsion. In operation, trim optimisation can also bring some benefit."

His colleague Edwin Pang sounds a cautionary note against a simple mix and match approach: "Installing more devices doesn't necessarily mean that the efficiency gains will stack together; there are sometimes interactions and implications that need to be evaluated. In general, a whole ship view of efficiency serves shipowners best."

Damsgaard continues, "Hydrodynamic

The Knud E Hansen-designed *Bahri Abha* features smooth hull lines for efficiency

optimisation is only one aspect of achieving fuel efficiency. Efficient ship design also goes hand in hand with low fuel consumption. Not all owners realise that if you save time in port due to an efficient design, you can slow down when sailing. Fuel consumption is related to the speed in the third or fourth exponent."

For example, Knud E Hansen's design for con-ro vessel *Bahri Abha*, on behalf of Bahri, (NSCSA) Kingdom of Saudi Arabia, featured much model testing to provide smooth hull lines. However the design process also investigated multiple layouts and resulted in the 225m-long vessel having a cargo layout that facilitates fast loading and unloading, as well as cargo lifting capabilities greater than its larger predecessors in the Bahri fleet. The end result is an estimated 45% fuel savings compared to the ships that will be replaced.

Holey grail

Sometimes it's the smallest things that can make a difference. For instance, MAN Diesel's fuel atomiser optimisation programme has resulted in an update that could save 2% of fuel. Based on analysing the angle and diameter of the atomiser's holes, the engine manufacturer believes it can now direct the spray into the combustion chamber better and ensure every fuel particle mixes with the air more efficiently.

Christian Ludwig, head of retrofit and upgrade, reports: "We identified a number of engines and atomisers for testing and the results suggest we can save 3-4g/kWh on an S50MC-C engine. Saving

2% of fuel on an in-service engine just by changing the fuel atomiser is almost like a gift, as it is a standard wear part that owners have to buy anyway."

MAN is currently checking on the test-bed that the engines are still NOx Tier I and II compliant ahead of NOx approval by class. Tests should also prove whether the new spray pattern is compatible with the existing combustion chamber. The assessments were due to run in Japan during May to test various spray patterns, directions, timings and angles, and if all are successful, the new atomiser will be commercially available for selected S50MC/MC-C engines some time in the third quarter of this year.

Furthermore the manufacturer is looking to develop low load optimised atomisers. "For owners who have very large engines in their vessels which do not utilise the top part of their power, say for between 5 and 50% load, this could gain an additional 2-3g/kWh saving," says Ludwig. "These are really cost-efficient retrofits that bring an attractive saving and that the crew can install themselves. The only additional cost is for paperwork from class."

Four holes equals 2%: MAN's updated fuel atomiser saves fuel

Rudder release

A propulsion product released to the market this year designed to save energy and therefore fuel is Becker Marine Systems' Cross Over Rudder. The rudder's inflow is less than optimal but the resulting swirl can be converted into driving power. This optimisation between the propeller hub cap and rudder is performed by a rudder bulb and is said to result in continued optimum manoeuvrability.

Designed for stern optimisation, the Cross Over Rudder can be used in conjunction with both the Becker Mewis Duct and Twisted Fin. Dirk Lehmann, managing director of Becker, predicts: "If the stern, propeller and rudder unit are perfectly matched with one another, energy consumption can be lowered in a double-digit percentage range."

Sales manager Walther Bauer adds: "Some shipping companies continue to buy just a rudder and not take the overall systems into consideration. Substantial percentages of efficiency are still being lost here. Propellers are often being sold without performance optimisation."

Becker's optimisation is independent from the propeller manufacturer but its close collaboration with those such as MAN and Wärtsilä means it can design complete drive propulsion systems along with manoeuvring systems. It has developed a rudder matching both manufacturers' specific propellers.

The Cross Over Rudder should be particularly suited to fast ships with high propeller loads such as ferries, containerships and passenger ships. "The cost savings are so huge the return on investment is usually achieved within one year," believes Bauer. "A retrofit is often worthwhile as well, because if ships completely change their operational profile it may be necessary to rebuild the propellers."

Becker's current rudder orders include those for five 14,000TEU containerships under construction at Hyundai Heavy Industries in South Korea and five 18,800TEU boxships for the United Arab Shipping Company. Furthermore it is involved with seven 8,800TEU containerships for China International Marine Containers at Dalian Shipbuilding that are being chartered by the Mediterranean Shipping Company and the new con-ro ships for the Grimaldi Group.

Lehmann concludes: "The Cross Over Rudder systems are in such high demand that they may take a 20-30% share of orders in the coming years. The resonance from shipowners continues to be very positive – and more than 530,000t of CO_2 could be reduced overall."

enginei fuel monitoring sensors being installed

Measure to save

Knowing how much fuel is being used by an engine is a useful tool to discern where savings can be made. UK manufacturer Royston believes its real time fuel monitoring has a distinct advantage, as the data collected onboard the ship can be re-

layed back to a shore office where the technical staff can track a vessel's fuel consumption on a variety of templates and also on a map, and avoid giving instructions that will negatively affect the ship's fuel efficiency. "Although the mapping is now being copied by some other manufacturers, we believe that these are more akin to simple tracking data and none of them offer the graphic presentation of fuel consumed at each point along the route," says Damian McCann, Royston's enginei product manager.

The enginei system works by fitting fuel flow meters to the in and out-flow pipes of each monitored engine. Since last year the system has used Coriolis meters (in addition to mechanical measurement), which are devoid of moving parts, unlike previous meters, and Royston believes they are more accurate. They are linked to a central processor which combines this information with GPS position data to calculate the vessel's 'litres per mile'.

The data is presented on a touch-screen display on the bridge and anywhere else required, as well as being sent back to shore using a Sat-C satellite link. The system should not be too bandwidth-heavy, as the total amount of daily data should not exceed 1.75MB. The Google Earth map image onshore shows the vessel's track recorded at 15 minute intervals along with its fuel consumption. In the future Royston plans to monitor engine torque, NOx and SOx emissions and by around September a new website interface will be launched.

Recently a Danish-owned anchor handling tug supply (AHTS) vessel was fitted with enginei, with the system displaying options available for running the four MAK 9M32C engines more economically and with reduced CO_2 output. This can be a vital component of the 90m ship's Clean Design requirements and its Ship Energy Efficiency Management Plan. Additional meters fitted on the auxiliary engines also give a fuller consumption picture.

Other AHTSs working off the coast of West Africa have had enginei fitted to monitor their Yanmar and Caterpillar engines. As well as total consumption, these installations also display the total fuel bunkered and discharged, allowing the owner's shore office to compare the masters' daily fuel data input with its own figures for bunker usage.

The meters are fitted on the common supply and return from the day tanks to all engines thereby reducing the amount of hardware required. The meters also measure fuel density which enables the system to identify the presence of any liquid impurities that might affect its volume. The readings will tie-in with what has been bunkered through the 3inch bunker meter on the load and discharge manifold.

One of the first adopters of the system was UK owner James Fisher Everard in 2009 (though enginei was formally launched in 2010) onboard its clean products tanker, *Shannon Fisher*. The installation indicated that savings of 4.5% could be made when under ballast, and of 3% when loaded. Since then, enginei has been fitted to 13 clean product tankers in the company's fleet. Overall approximately 85 systems have been installed on vessels for Svitzer Tugs, Maersk, Brittany Ferries, P&O Maritime, Lafarge Tarmac and Hanson Aggregates. "All appear to be pleased with the system and several are undertaking to have it fitted to all newbuilds or on other vessels in their fleet," remarks McCann. □