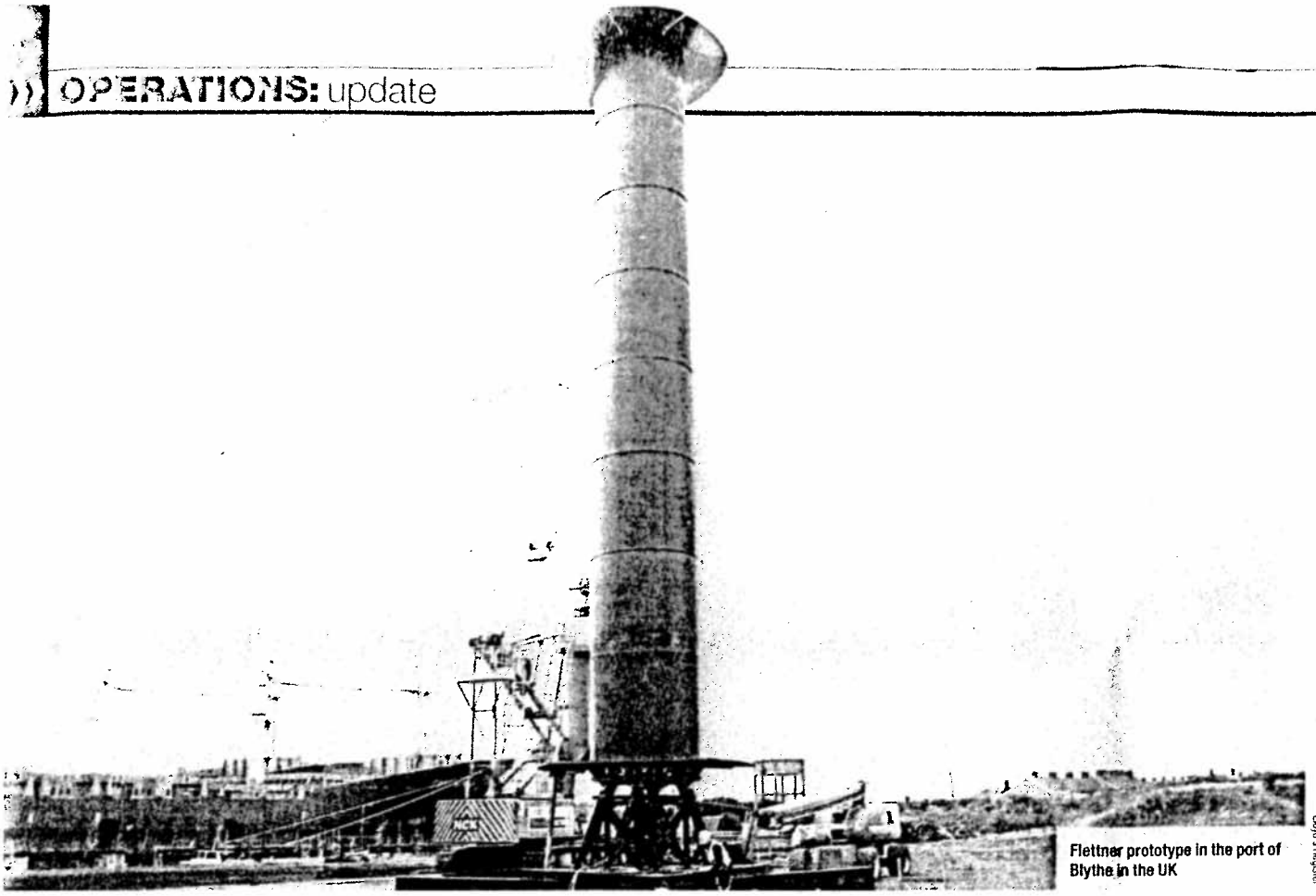

Flettner prototype in the port of Blythe in the UK

Lloyd's Register

Emissions regulations could make wind a viable option

Innovative research is under way to understand how shipowners could utilise wind power or wind-assisted power generation to reduce fuel consumption against an increasingly tightening regulatory framework

Interest in wind-assisted propulsion has enjoyed something of a resurgence as successive rounds of stricter emissions legislation have been introduced and technological advances made in cutting fuel consumption and emissions. The only real unknown is how relevant wind energy as a source of marine power is to modern shipping, current and future trading patterns, and increasingly automated operations.

Classification society Lloyd's Register is collaborating with several organisations that are developing wind power technology so that the shipping industry can make confident decisions. Since 2012 it has been working with Totempower Energy Systems (a spin-off from City University London) and Zodiac Maritime Agencies to assess the potential of wind energy for commercial ships. Under this particular project an autonomous wind-monitoring system designed and assembled by Totempower was installed on the bulk carrier Cape Flamingo, managed by Zodiac.

The sensors were installed in strategic places to measure wind speed, direction, and turbulence to determine the most effective locations for onboard wind engines, such as Flettner rotors and generators, Lloyd's Register's head of marine engineering systems, Ed Fort, explained.

The project successfully identified and measured the potential generating capacity from wind power for the ship's trading patterns. This data will be used to support the development of computational fluid dynamics-based simulation models suitable for predicting the potential energy yields on other Zodiac ships.

Wolf Dietrich, chief executive officer at Totempower Energy Systems, told Lloyd's Register's *Horizons* magazine the project demonstrated that wind-assisted power generation on board commercial vessels could be used for auxiliary power generation in the future. Wind power could help shipowners and charterers to reduce their fuel bills significantly as it could lower the amount of fossil fuels needed to power the vessels. "The ideas look promising, subject to further design and implementation studies," said Kalliopi Xypolita, the company's environmental superintendent.

Among the most promising concepts for wind-assisted propulsion are versions of the Flettner rotor concept, developed by aviation engineer Anton Flettner in the 1920s. Today's advancement deploys the so-called Wind Engine, led by registered charity Greenwave International in the United Kingdom. Speaking to *Solutions*, Nick

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Contopoulos, a spokesperson for Greenwave International, said the company was in the middle of the project and hoped to complete a land-based prototype of the Wind Engine later this year. Greenwave describes the Wind Engine as a 'mechanical sail' that is a sustainable source of power because it harnesses the wind in a far more efficient way than a conventional sheet sail.

Wind Engines also use the Magnus effect, but unlike land-based wind turbines the Wind Engine is operated by electric motors. When wind hits the spinning rotor it passes on either side. The wind is accelerated in the direction of rotation while it is resisted against the rotation. This sets up a high and low pressure differential like an aircraft wing, creating a thrust at over 90° to the wind direction.

A vessel sailing with the wind on the beam is given forward thrust from the spinning Wind Engine. When the wind moves from port to starboard, a sail boat needs to tack. With a Wind Engine, this is achieved by stopping the rotor and spinning it in the opposite direction. It provides a ship's master with what Greenwave describes as "push-button sailing from the bridge". Reefing in high winds is also a matter of simply stopping the rotation of the rotors.

Greenwave said that although the theory of the Wind Engine remains the same as that of Anton Flettner's 1926 rotor, the company has used modern design, manufacturing materials and technologies to create a patented design. This includes creating the Wind Engine in a modular form that enables it to be containerised for easy transport to any port around the world. The way in which the rotor cylinder (or skin) is manufactured, mounted, and supported on deck is also original.

Greenwave has compared Wind Engine test performance with real life voyages using four years of data from ships' logs from a small bulk carrier fleet and says the results show an average annual saving equivalent to about 1,000 tonnes of fuel and more than 3,000 tonnes of CO_2 per ship, per year.

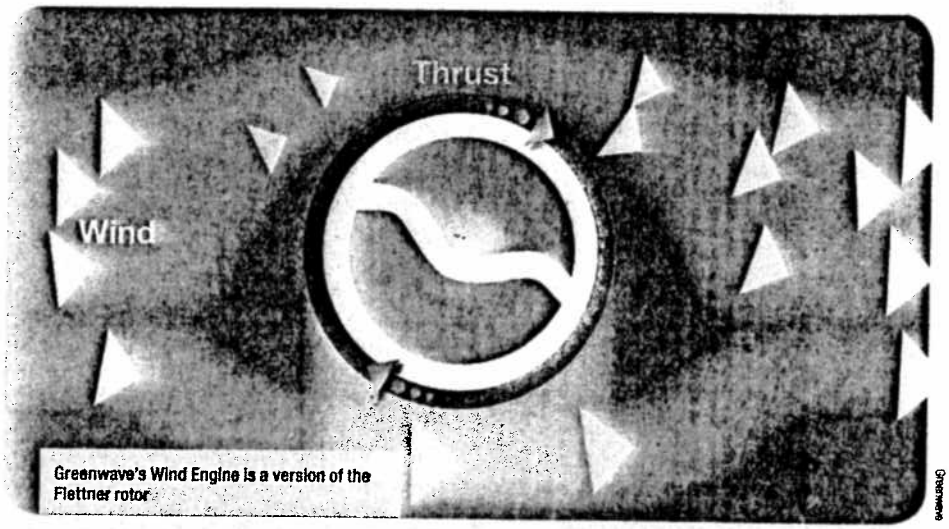
Another company that is investigating wind-assisted propulsion based on the Flettner rotor concept takes its name from the Magnus effect. James Rhodes, CEO and founder of Magnuss, has developed a patent-pending concept called the Vertically-variable Ocean Sail System (VOSS), a mechanical sail that also offers potential fuel savings and hence the potential to reduce emissions.

After meeting with shipowners/operators, industrialists, charterers, and brokers to understand their needs and concerns, Magnuss called on an expert team of engineers from the Massachusetts Institute of Technology and the maritime industry to run thousands of computer simulations, adjusting parameters including sea and wind conditions to develop the optimal design, materials, and installation of the VOSS – a rotating cylindrical metal column that would be installed on the deck of a ship. Also using the Magnus effect, the VOSS converts wind into forward thrust perpendicular to the direction of the wind. Like the Greenwave Wind Engine, the VOSS is a modern, more technically advanced version of Flettner's original concept.

According to Rhodes, one key difference and advantage of the VOSS is that it is retractable, allowing it to be stowed below deck during loading/unloading and in adverse weather conditions.

The driving force created by the wind over the VOSS means the vessel needs less power from its main engine, resulting in lower fuel consumption. In typical operating conditions, a ship's average annual fuel costs can be reduced by 10–35%.

"In many cases, customers can recoup the cost [of installing the VOSS] in just two to three years," said Rhodes, adding that the company is working with Lloyd's Register to validate and demonstrate the concept and investigate vessels on which it could be installed.



Greenwave's Wind Engine is a version of the Flettner rotor


Demonstration model at Warsash Maritime Academy, showing positions of Flettner rotors