Reduction of risks from ship kites through attention zones

The safety implications of kite-assisted propulsion are examined by Torkell Pettersen Stavdal and Thomas Mestl of Det Norske Veritas.

The Beaufort on one of her test voyages (Photo: Skysails)

The recently high oil prices and focus on emissions from ships have renewed the interest in kite technologies for additional ship propulsion. The use of kites may however introduce new risks to maritime traffic as ships or low altitude air traffic may be entangled in kites. The concept of attention zones may provide a reduction of these risks.

Throughout maritime history wind power has been the dominating ship propulsion source until the emergence of coal fired and later oil burning ship engines. The originally clean industry has thereby turned into a significant source of global pollution and greenhouse gas emissions. Recent sharp rises in oil prices as well as the desire to make the industry appear somewhat 'greener' have lead to the rediscovery of wind power as an unused and valuable power source.

Various wind-using concepts have been suggested - but only very few have even reached the prototype stage. An exception is the use of kites as a towing aid, where demonstrations and performance tests are currently being carried out, for example the SkySails and KiteShip systems. Tests done by SkySails indicate an annual average fuel cost reduction in the order of 10-35% and an increase of ship speed by 10% depending on actual wind conditions and achievable operational period as well as a number of other factors.

The desire to cut costs by harnessing wind power may lead to a widespread retrofitting of kites to ships. It is estimated that between 40,000 and 60,000 ships operating on long range routes as well as fishing trawlers could benefit from such an additional propulsion system.

As ship kites are still in their developmental phase their design and operation will still have to undergo optimisation both with respect to physical properties like kite shape, material, and also with respect to optimising kite control.

According to SkySails, the various kite concepts work with an operation height between 100m and 500m and with a sail area between 160m^2 and 5000m^2. The delivered power can be equivalent to a 5000kW engine. Depending on wind direction and ship heading the position of the kite can actually be within 200m or so on either side of the ship.

The kite's vertical position is computer controlled to always obtain high traction for any given wind condition. An automated system launches and retrieves the kite between 10 and 20 minutes for normal operation; however in an emergency it would be possible to use a much faster procedure to retrieve the kite.

Risk	Description
Air borne traffic	Helicopters, search and rescue air activity or air surveillance may encounter high flying kites.
Reduced own manoeuvrability	A dropped down kite with its cable could interfere with the ship's own rudder or propulsion system The kite is entangled with a large object, e.g. reef or fixed installation and thereby reducing manoeuvrability of own ship
Entanglement of a nearby ship	The kite could entangle with nearby ships leading to dangerous situations

Currently the greatest challenge is in the kite control systems, as wind does not always blow steadily. Gusts of wind or lulls can often lead to plunging and crashing of the kite.

Traffic risks of kites

The use of kites will introduce new risks, not only to the crew when handling the new equipment but also to the ship itself as well as the nearby maritime traffic. The table lists some of the traffic risk associated with kites.

These risks may not only occur in situations where the kite has crashed into the water but may even be present under normal kite operation. For instance, at night or in foggy situations with reduced visibility there is indeed the possibility that helicopters, for example, on their way to or from offshore oil fields could be confronted with high flying kites. Similar risks exist for all low flying air activities such as military or coast guard operations. A meeting with a kite could then lead to catastrophic consequences.

Plunged kite

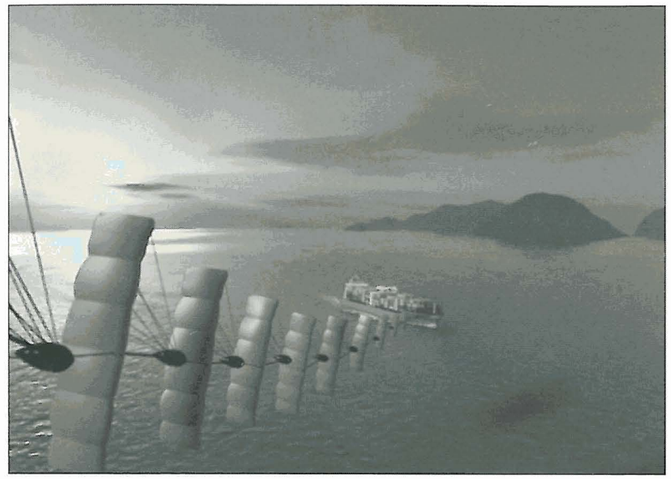
It might be difficult to guarantee that kites will never plunge - although some concepts even suggest the use of helium filled kites. Nevertheless, a regular kite will sometimes be exposed to weather situations with high turbulence or fall winds plunging the kite down into the sea.

Depending on the kite concept, the length of the cable between ship and kite may be several hundred of metres, and for instance in a concept by Delft University, known as BeauForce, it could be as long as 6000m. The kite will almost certainly be operated by an automated control and retrieval system. It is of outmost importance to prevent the kite(s) from plunging as they could get entangled with their own ships, or other nearby vessels or maritime objects such as buoys. An entanglement with a small fishing vessel may even result in its capsizing.

Concerns may therefore be raised by authorities or industry that may slow down the acceptance of this environmental friendly technology.

Attention zones for risk reduction

In a joint industry project between DNV, Kongsberg Group and Jeppesen, the so-called 3-dimensional attention zone (3dAZ) concept was developed. It basically places a dynamic and scaleable zone around a maritime object that is intended to reflect its risk potential. Objects with a higher risk get assigned a larger zone.



A kite-towing design made by TU Delft. It would result in a quite large area around the ship where there is the possibility of entanglement in case of a plunged kite (Source: TU Delft)

Information about the object is partly drawn from AIS data as well as from other information resources to allow an estimation of the object's risk potential. The attention zones are then shown on a chart system, such as ECDIS, and thereby direct the attention of navigators or vessel traffic system (VTS) controllers to potentially dangerous upcoming situations.

The prototype implementation of the 3dAZ concept was carried out by Kongsberg Maritime and by Kongsberg NorcontrolIT for the ship systems and VTS respectively. The basic shape of the 3dAZ is a trapezoid with a constant height and elongation depending on the ship direction and velocity. If a vessel flies a kite the zone's height and breadth can be modified correspondingly. This ensures that the kite is always inside the box (also when plunged into the sea). Alternatively, the kite could be equipped with an own AIS transponder revealing its exact position but not necessarily its altitude.

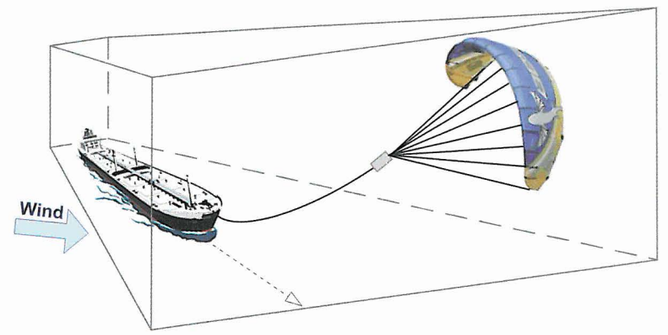
The current implementation of DNV's prototypes for the ECDIS and VTS systems show attention zones in the charts only when they intersect each other. This means the attention of the navigator or the VTS controller is directed to situations when, for example, a vessel approaches the area where a kite could potentially crash down. The navigator would thereby be more attentive to this situation or could perform minor course alterations.

The height of the 3dAZ would inform the VTS controller about a high flying kite who in turn could advise air traffic about this potential obstacle.

The research on the 3D attention zone was partly funded by the Norwegian Research Council, and cooperation has been received from SkySails.

Conclusion

High energy prices will certainly encourage the development of new wind harvesting technologies such as kites. Although these technologies may sometimes bring in new types of risk to maritime traffic, new developments within electronic navigation such as attention zones may mitigate these risks.



A 3-dimensional zone (3dAZ) is placed around the kite flying vessel that is large enough to encompass any plunged kite