Roll stabilisation

Mike Perkins* discusses the technologies available for large yachts

During the past five years there has been a marked trend in the yacht-building industry to build larger and larger vessels to satisfy the demands of yacht owners. Over the past two years this trend has become even more pronounced. These large yachts present a multitude of technical challenges for the builders, suppliers and operators. One of these is roll stabilisation.

This article will focus on those systems that have the capability to deliver not only conventional roll stabilisation when the vessel is sailing but also the ability to deliver roll damping when at anchor or drifting. It will attempt to identify what technical approaches and technologies are currently available, their advantages, disadvantages and performance capabilities.

The systems and technologies currently identified that can deliver dual purpose roll damping (underway and at anchor) include:

- Fixed fin stabiliser systems
- 'Magnus effect' stabiliser systems
- Hybrid systems.

Fixed fin systems

For the purpose of this comparison, fixed fin systems will include those that have been developed and proven to have a true 'dual purpose' capability. These systems employ fixed geometry fins for use when sailing and use those same fins when the vessel is at rest to provide roll damping.

These systems were first introduced in 1999–2000 and have gained rapid acceptance. Quantum has over 160 of these systems in service and an additional 250+ in various stages of production, installation and retrofit. Other suppliers claim smaller but nonetheless important applications. The range of Quantum applications in service is for vessels between 28m and 115m and the company also has systems in production for vessels of 130m and 164m.

Focusing on large yacht applications of 80m in length and above, the fixed, dual purpose systems have been shown to be able to deliver quite impressive results in terms of roll reduction in both model testing and full scale application.

Typical model test results for 80m+ vessels averaged over 12 such test programmes show that fixed fin systems are capable of delivering the following roll reduction capabilities in the typical test conditions defined below:

Significant wave height	Frequency of swell	Wave spectrum	Roll reduction (%)
0.5m	Resonant	JONSWAP	78–92%
1.0m	Resonant	JONSWAP	69–90%
1.5m	Resonant	JONSWAP	58–81%

Advantages:

- True dual purpose capability
- Well understood by the builder community in terms of installation requirements
- Proven performance capability in both conditions (sailing and at anchor)

Disadvantages:

- Requirement for large appendages
- Difficulty in keeping fins within the vessel's beam/keel boundaries
- Potential need for multiple fin pairs to achieve target performance

'Magnus effect' systems

These systems are a very recent development. Quantum introduced the first Zero Speed, MagLift system some three years ago. At the time of writing, there is one system in service, three more delivered, and additional systems in design and production. The technical approach is based on the past history of applying rotating cylinders in aqueous media to generate lift applied to correct vessel roll movements. The technology has, in its simplest form, been employed for decades for conventional roll damping of vessels underway.

■ Graphic representation of a fully retractable MagLift rotary stabiliser

Quantum has patented the Zero Speed version of this technology and believes that the technology has great potential but limited applications due to the fact that the underway performance is limited by vessel speed. Whereas conventional fin stabilisers generate higher lift at higher vessel speeds, the MagLift begins to lose its lift capabilities at speeds over 13kts. This limits the possibility to apply MagLift as a

true dual purpose system for larger yachts that have higher vessel speeds due to their waterline length.

One major advantage of these systems is the ability to retract or fold the effectors during sailing to reduce appendage drag and the attendant impacts to vessel operating efficiency.

For very large (80m+) vessels, MagLift Zero Speed systems are deemed to be single purpose systems for damping the yacht's roll at anchor. For large vessels where MagLift is being employed or considered, they will typically have to fit another system for roll damping when the ship is sailing.

MagLift systems have been shown to be able to deliver quite impressive results in terms of roll reduction in both model testing but no full scale results are available for this technology at this time.

Typical model test results for 120m+ vessels averaged over four test programmes show that Magnus effect systems are capable of delivering the following roll reduction capabilities in the typical test conditions defined below:

Significant wave height	Frequency of swell	Wave spectrum	Roll reduction (%)
0.5m	Resonant	JONSWAP	84–93%
1.0m	Resonant	JONSWAP	78–92%
1.5m	Resonant	JONSWAP	69–82%

Advantages:
- High lift to footprint capacity
- Reduction in appendage drag
- Ability to deliver roll stabilisation at relatively low vessel speeds (3–13kts)

Disadvantages:
- Not a dual purpose system for very large yachts
- Developmental stage at this time
- Relatively high power requirements for Zero Speed operation

Hybrid (extendable) fin systems

For the purpose of this comparison, hybrid fin systems will include those that have been developed and proven to have a true dual purpose capability. These systems employ variable geometry fins for use when sailing and use those same fins when the vessel is at rest to provide roll damping.

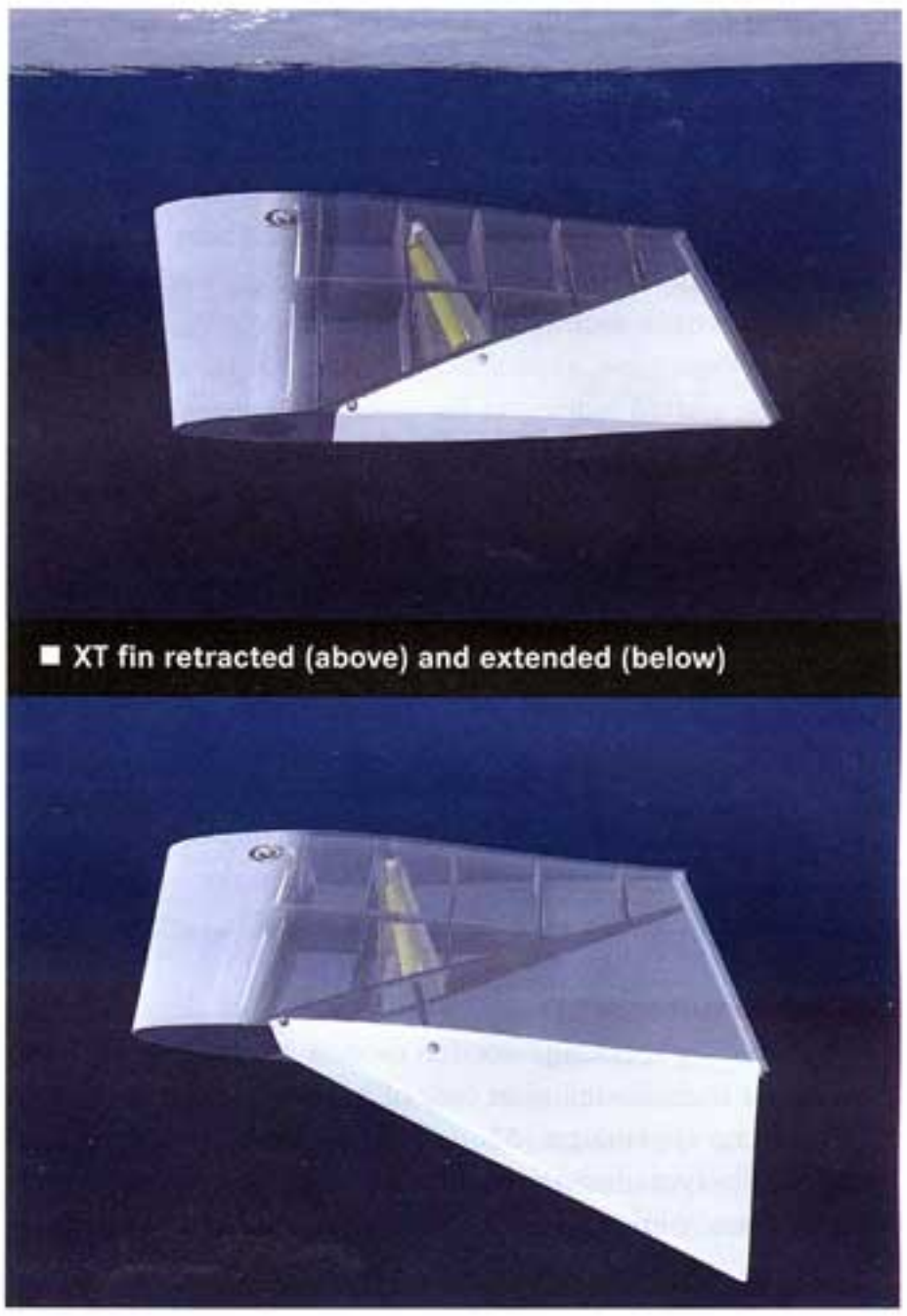
This system was introduced in 2006 by Quantum. The development was directed initially at the very large yacht market to solve some of the problems that the developer had encountered in the application of large yacht, fixed fin, dual purpose stabilisers. The trend for large yacht design has been focused on high volume (high block coefficient) hull forms. These modern hull forms typically have little space for fitting the large appendages required to deliver good roll damping when the ship is anchored.

Quantum directed its efforts at development of a 'variable geometry' fin where the fixed portion of the fin would satisfy the area requirements for stabilisation when the vessel is in sailing mode, and to augment that area with an extendable foil for when the vessel is at anchor. This development is being marketed at the XT (Extendable) Fin.

Significant wave height	Frequency of swell	Wave spectrum	Roll reduction (%)
0.5m	Resonant	JONSWAP	82–90%
1.0m	Resonant	JONSWAP	78–84%

Advantages:
- True dual purpose capability
- Smaller footprint for sailing conditions
- Reduced appendage drag
- Greater potential to employ a single fin pair in some applications
- Improved performance capability for roll damping at anchor.

Disadvantages:
- Submerged mechanical and hydraulic components
- Early stage of development.



■ XT fin retracted (above) and extended (below)

The XT fin, dual purpose systems have been tested in model scale and have been shown to deliver exceptional results using less fin area when the ship is at anchor. At the time of writing, there are two full scale applications in service and Quantum is now building a significant number of systems for both new construction projects and retrofits.

Model test results (see above) for the XT system have shown that the extended foil section, while only 30–35% of the main fixed area, can almost double the roll damping capabilities due to the favourable fin geometry. □

* Mike Perkins is VP Business Development at Quantum Marine Engineering