

# MAKING PASSENGERS COMFORTABLE

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*Tassie Devil 2001*

Ride control systems have become an integral feature of most fast ferries. The development of these systems has required a continuous joint international development effort involving builders, operators, and suppliers. In the early days, it was believed that larger vessels and sophisticated hull forms would completely alleviate motion problems. However, the operating profile of fast ferries requires operation at high speed in high waves to maintain schedule. It was discovered that passengers, hull structure, and shipboard machinery were adversely affected by the motions encountered when these groundbreaking vessels ventured into previously untried conditions. Builders and operators continue to play a key role in the improvement of ride control systems, however the efforts of a few pioneers deserve special mention. This article, the first of an occasional series, explores the evolution of ride control and highlights the key contributions of Incat's customers, staff, and suppliers such as Maritime Dynamics, Inc. (MDI) on one very important aspect of making passengers comfortable.

Incat's Robert Clifford first entered the fast ferry industry as an operator, and not a builder, over a quarter of a century ago when he chartered the

British-built hovercraft Michael Howe to ferry passengers across the Derwent River after the accidental knockdown of the Tasman Bridge. While passengers enjoyed the smooth ride and fast transit time, the vessel's high operating cost led Robert and his associates to search for alternate hull forms. After tinkering with conventional catamarans for ten years, Incat launched the 31 metre wave piercer Tassie Devil 2001 in late 1986. The vessel proved very successful in passenger-only service during the 1987 Americas Cup regatta in Fremantle due to a good combination of speed and passenger comfort. The Tassie Devil 2001 is considered to be the first vessel to display the classic Incat wave piercing lines that are recognized around the world today.



*Hoverspeed Great Britain*

Sea Containers drew similar conclusions about the seakindliness of Incat's wave piercers and placed orders in 1988 for the first five 74 metre vessels built by Incat. These 36 knot wave piercers were acquired to replace hovercraft on challenging cross-channel routes between England and France. Sea Containers, like Robert, understood the importance of passenger comfort.

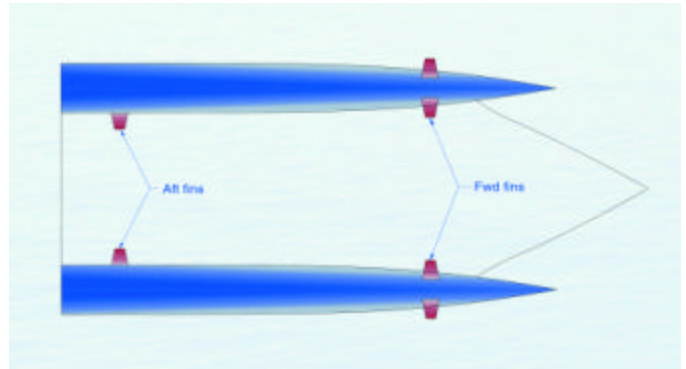


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An entire family can be lost from an operator's potential customer base if one member of a family becomes seasick. It was believed that increased vessel speed would minimize the duration of passenger exposure to heavy seas, the advancements in Incat's wave piercing hull form and the increase in vessel size would minimize vessel motions in a seaway. However, as discovered during the Hales Trophy challenge taken up by Hoverspeed Great Britain for the Blue Riband of the Atlantic, increased speed through high seas brought higher accelerations. The increased vessel size and improved hull form were not enough to reduce motions to an acceptable level in all sea conditions. The vessels were operating in a combined speed and sea regime that was previously untried. However, Incat and Sea Containers were not alone in their adverse experience.

At about the same time, Condor Ltd. took delivery of Condor 9, a 49 metre wave piercing catamaran designed by Phil Hercus of Incat Designs and built by Aluminum Shipbuilders Ltd. in the UK. After only three days of operation in the summer of 1990, the vessel was withdrawn from service due to unacceptable motions and other problems similar to those experienced on Hoverspeed Great Britain. Although Condor 9, like any of the then-new Incat wave piercing catamarans, offered groundbreaking economies of scale with respect to high passenger capacity and low transit time, Condor was not willing to have its reputation tarnished by unacceptable motions. MDI approached Condor with a proposal for a retrofit ride control system. At that time, MDI had been working on seakeeping simulation tools and surface effect ship / air cushion vehicle ride control systems for almost twenty years. As is necessary for any development project for an innovative new product, a good co-operative relationship formed between Condor, MDI, and Incat Designs in the development of a ride control system for the vessel. Condor preferred a configuration with moveable foils mounted on struts below each hull in a T-foil configuration. This arrangement would ensure that the forward control surfaces would not ventilate, even in heavy seas, and would ensure operation free of bothersome cavitation induced noise. However, time constraints for the design, fabrication, and installation of the ride control system on Condor 9 dictated use of six identical hull-mounted fin units.

The MDI ride control system reduced vessel motions on Condor 9 in excess of fifty percent in 2.4 metre seas. During the first month of service, passenger sickness was reduced to acceptable levels even though the seas were frequently in excess of 2.5 metres. However, as suspected by Condor, the forward fins produced intermittent cavitation noise that was audible to passengers. Although one aspect of passenger comfort had been addressed, a better solution would have to be found.



*Condor 9 Fin Arrangement*

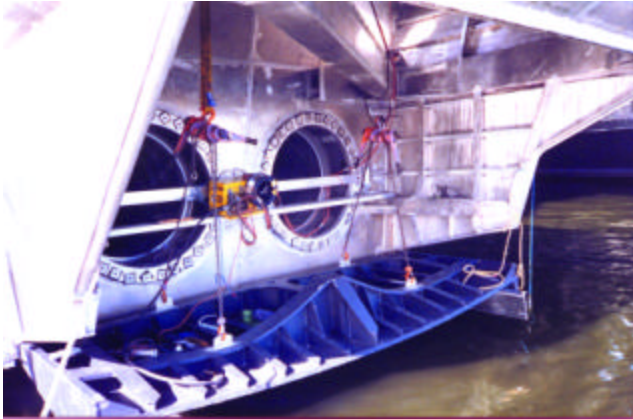
Ride control system design is heavily integrated with the builders' knowledge of fast ferries and their operation. Robert Clifford was particularly well positioned to manage the integration of the first MDI ride control system on Incat-built vessels due to his experience with ferry operation and his experience with the practical realities of the product, engineering, and production development processes required to deliver some of the world's most sophisticated catamaran vehicle-passenger ferries. In addition, Robert and the Incat team do not suffer from the "not-invented-here" syndrome and are willing to learn from the experience of others. Sea Containers was also motivated to drive the ride control development process forward because of the motions problems encountered on the Portsmouth-Cherbourg route by Hoverspeed Great Britain.

Incat pushed for an incremental approach to the development of a ride control system for their wave piercing catamarans. Candidate effectors for the system were T-foils, fins, and trim tabs; separately or in combination. Relying on simulations that MDI produced, Robert suggested the use of trim tabs, in lieu of fins, for the initial assessment because they would impose the lowest weight increase, create



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practically no drag increase from exposed appendages, maintain the vessel at near-optimum trim in a seaway, and require only a moderate increase in the amount of installed hydraulic power. Although the retrofit of Condor 9 with fins was considered a success, Robert and his team felt that additional improvements were possible with alternate techniques and deserved a trial. Sea Containers was also committed to improving passenger comfort and funded the installation and initial trials of the MDI trim tab ride control system on Hoverspeed Boulogne (027).



*Trim Tab Installation*

MDI conducted tests on Hoverspeed Boulogne late in 1991 on Storm Bay and on the coastal waters off Tasmania. Accelerations and vessel motion (pitch angle and roll angle) were systematically recorded over a nine-minute duration, first with the system off, then with the system on, and then with the system off again for three minute periods each. This ensured that sufficient data was acquired for valid statistical conclusions and ensured that the sea state remained consistent for the duration of each data point. Vertical accelerations, which are the key parameter for passenger comfort, were reduced by up to forty-two percent in 2 metre seas and twenty-two percent in 4 metre seas. The qualitative performance of the system was quite remarkable in 4 metre head seas: With the ride control system off, the vessel was taking green sea impacts on the centerhull at the bow fairly often.

With the system on, the number of impacts was dramatically reduced to the extent that the operators refused MDI's request to obtain additional ride-control-off data points until the seas subsided!

Based on the success of the trials, Sea Containers retrofit MDI trim tab ride control systems on Seacat Tasmania (023), Hoverspeed Great Britain (025), Hoverspeed France (026), and SeaCat Scotland (028). These vessels operated very successfully on short sea crossings between Dover/Boulogne, Dover/Calais, Newhaven/Dieppe, Stranraer/Belfast, Goteburg/Frederikshavn, Liverpool/Douglas, and Liverpool/Dublin. Buquebus Espana also retrofit the MDI trim tab system on Patricia Olivia (024). MDI trim tab systems were subsequently installed on the next 24 vessels that Incat built.

Although Condor's experience with fins and Sea Containers' experience with trim tabs was positive, both operators believed that additional improvements in motion control was required to offer improved passenger comfort on longer crossings and in higher sea conditions.



*Portsmouth – Cherbourg Route*

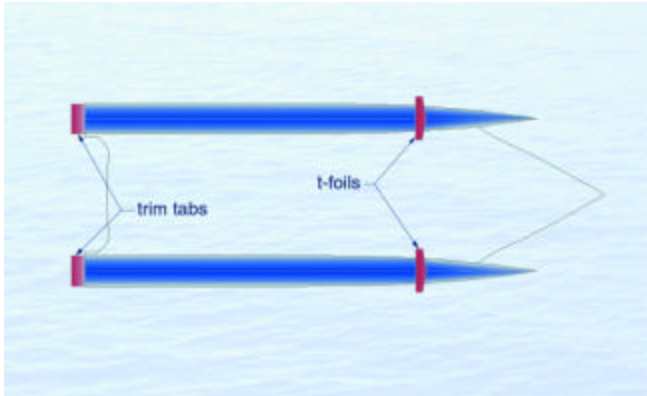
The history of ride control systems on fast catamaran ferries is relatively short; just over ten years. In our last article we took a look at the incremental development history of ride control systems and saw how operators like Condor were instrumental in the introduction of fin systems on



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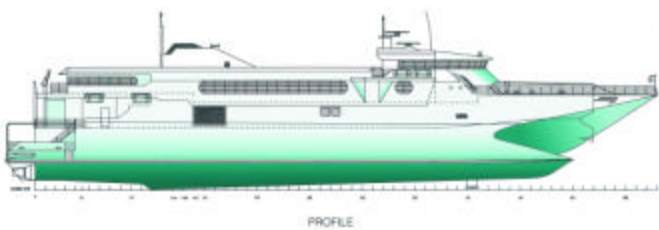
wave piercing catamarans, and operators like Sea Containers were leaders in the installation of trim tab systems. While both the Condor fin-only installations and the Sea Containers trim-tab-only installations successfully reduced the accelerations that cause seasickness by about 50%, further reductions were sought by operators wishing to keep their passengers comfortable.

This article looks at the development of the T-foils, which are common place on all of Incat's latest generation of vessels.



*SeaCat Scotland*

The development of ride control systems for Incat's fast ferries has been an incremental process. In basic terms, an effector system (such as fins or trim tabs) is fielded, motions data is acquired, feedback from operators is obtained, a revised



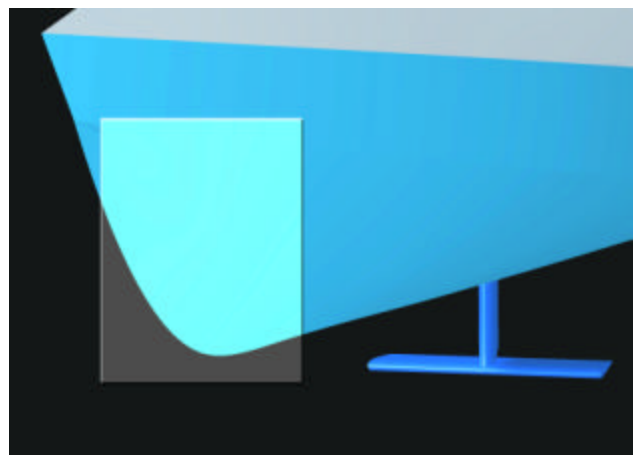
requirement is defined by Incat, and the ultimate result is a new product developed by Maritime Dynamics Inc. (MDI). This is a joint effort that requires considerable communication and the free exchange of ideas. Trade-offs, such as manufacturability, integration with vessel structure, weight, cost, and performance are all examined in detail by both Incat and MDI.

The performance of ride control systems available on the market today are measurably

different. Varying combinations of effectors (trim tabs, interceptors, fins, and T-foils) affect system cost and performance. However, performance is the critical factor for most operators because of the adverse affect that seasickness, or even the fear of seasickness, can have on the potential customer base.

An inadequate ride control system will quickly and adversely affect market share on a competitive route. Entire families will be lost from the potential customer base if even one member of a family becomes seasick. Incat has been an industry leader with respect to vessel motion reduction and has made improvements in vessel hull form and ride control systems, key elements of their design and development program. Volume 1 issue 3 of Incat the Magazine, pages 12-13, contains a summary of the motion reductions made to Incat vessels supplied with MDI ride control systems.

The fins-only installation on the 49 metre Condor 9 (built by Aluminium Shipbuilders Ltd in the UK) consisted of six hull mounted fin units. Four fins were installed forward and two fins were installed aft on the inboard sidehulls. Although vessel motions were reduced in excess of fifty percent in 2.4 metre seas, the fins frequently broached in rough seas and subjected the fin units to high slamming forces. In addition, the fins operated very close to the free surface in a seaway and cavitated, producing noise and losing lift. Recognizing these problems, Condor and Incat set about investigating better ride control options for the 74 metre wave piercer Condor 10 that was at the time under construction at Incat.



*View of wave piercing bow showing bolt-on T-Foil below the keel. The deeply immersed T-Foil remains*



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*submerged preventing slamming and reduces cavitation.*

MDI performed simulations to predict the performance difference between hull mounted fins and T-foils for a 35 knot operation in 3 metre head seas on Condor 10. It was determined that the hull mounted fins would be out of the water 6% of the time, while the T-foils would remain submerged. T-foils were the clear choice to prevent slamming and loss of lift. There was some initial skepticism about the T-foil concept because of the added appendage drag. However, it was subsequently proven during trials that the speed reduction is very small (less than 1 knot) as the MDI ride control system includes well-designed and hydrodynamically fair T-foils that maintain near-optimum trim and a horizontal thrust line in a seaway. Further, the deeply immersed foils do not broach (except in extreme seas) and perform free of objectionable cavitation noise.

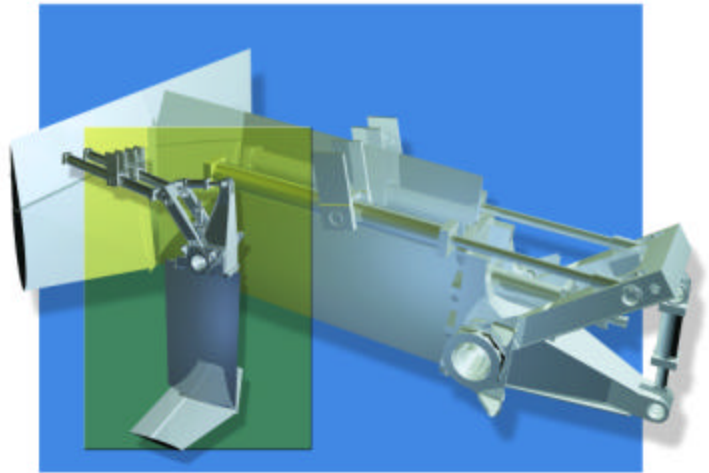
The ride control system on Condor 10 consisted of two pivoting T-foils near the bow and two trim tabs at the transom. The T-foils were provided with both incidence and flap control. Incidence control is provided to both modulate lift and optimize the angle of attack of the foil to prevent the onset of cavitation. Flap control is provided to modulate foil lift.



*T-Foil*

The design of the T-foil system required a joint effort between Incat, Condor, and MDI to insure that performance, integration, reliability, and maintainability issues were addressed. The installation was very successful. Motion reductions

of over 70% were recorded during trials in 2.5 metre seas. More significantly, it was observed that motions were similar at most passenger seats, whether inboard, outboard, forward, or aft. The similarity of motions throughout the public spaces gave passengers a good impression of the vessel's motions and ride quality, and allowed the vessel to engage in year-round service across the English Channel.



*Retractable T-Foil*

The installation on Condor 10 proved the viability of the T-foil concept. Variations of the concept, such as bolt-on and break-away styles were installed on subsequent Incat vessels to address cost and strike/grounding concerns. Again, the T-foil designs which evolved were based on feedback from Incat and the operators.

Higher vessel speeds in large seas require high performance ride control systems. The motions performance of Incat vessels fitted with MDI ride control equipment is recognised around the world. The incremental approach and developments undertaken with ride control systems has ensured that operators are provided with a good return on their performance investment, with the selection of appropriate effectors such as fins, trim tabs, interceptors, and T-foils constantly assessed from both a cost and performance standpoint. Ride quality is a very important fast ferry factor, and the experts at Incat and MDI continue to work hard to advance this state-of-the-art-technology.



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Incat's 96 metre wavepiercing catamaran Milenium (056) features the latest evolutionary change in T-foils. Developed jointly by Maritime Dynamics Inc.(MDI) and Incat; the new retractable T-Foil will stow out of the water and into the centre bow when not in use. Lowered, it will perform all of the same functions as the T-Foils previously mounted under the port and starboard sidehulls near the bow.

The benefit of the new retractable T-Foil is that it is completely out of the water during calm water operation; consequently, no speed loss is experienced and fuel savings will occur. In addition, the system is fitted with hydraulic dampers that absorb energy and allow the foil to pivot upwards in the event of a foil strike while deployed.

Previous T-Foils, though extremely efficient, were exposed to damage or loss from submerged objects and required the vessel to be dry docked for installation or servicing. The new retractable T-Foil will greatly reduce maintenance and operational problems, being able to be serviced while the vessel is afloat.

All of these features were developed by MDI, based on feedback from Incat and operators. In particular, opinions were that trim tabs alone provide acceptable ride quality on the larger Incat vessels in low sea state conditions.

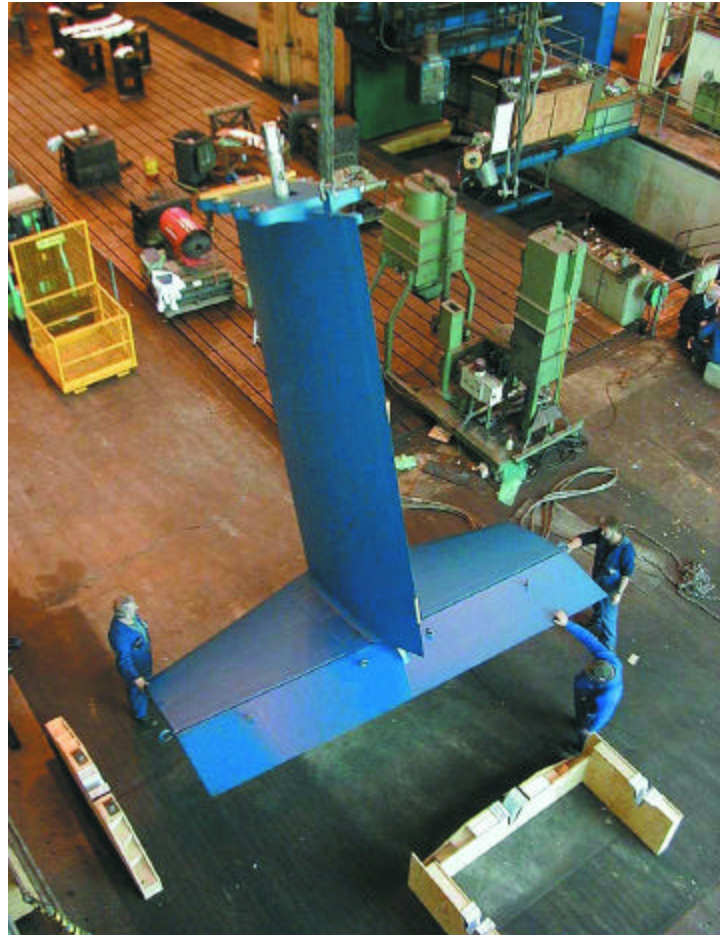
The design and fabrication of the foil was carried out by MDI. Incat's design department, in close cooperation with MDI, ensured that there was no impact to the arrangement of the car deck that would reduce car capacity. The designers also ensured reliable structural integration and provided adequate access for maintenance of the foils mechanical components.

The foil selected for the vessel has a shape that will allow cavitation free operation well into the 45 knot speed range and features MDI's standard trailing edge flaps and inverted-T design. The new retractable T-Foil will bring the following benefits to vessel operators:

- All mechanical and hydraulic components are above the water, allowing servicing to take place while the vessel is afloat.
- In calm water operation of the foil is retracted, increasing vessel speed and resulting in fuel savings.

- While in its operational position the T-Foil will retract immediately if an object is struck, reducing the possibility of damage by submerged objects.

Incat vessels, including the new 98 metre wavepiercing catamarans currently under construction, or the larger 120 metre in advance stages of design, will be fitted with the new Retractable T-Foil.



*Retractable T-Foil*



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