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## **THE PANAMA CANAL EXPANSION: business as usual or game changer for ship design?**

### **The question has to be posed in the right way**

Ever since the development of panamax vessels around fifty years ago the beam limitation of 32.3m imposed by the Panama Canal's locks has presented a fixed constraint for the design of ships, defining a parameter that is etched into the minds of naval architects. This constraint is set to disappear with the opening of the expanded Canal in 2014 but is this likely to lead to a change in ship dimensions?

In the Port Focus section of edition 51 of this journal, Dr. Jean-Paul Rodrigue and Dr. Theo Notteboom considered the question "*The Panama Canal expansion: business as usual or game-changer?*". They considered this question from the point of view of trade development, noting the "divergence of opinion" on the subject due to the complexity of trade and the number of variables and feedback loops involved. Research by Paul Stott and Peter Wright of Newcastle University has looked at this question from a different perspective – what effect may the expansion have on ship design?

Whilst at first reading it may seem counter-intuitive, not least because shipping is famously a 'derived' demand and only exists to service trade, the conclusion in terms of ship design is to some degree de-coupled from the question about trade developments. The reason for this is because within certain size bands ships will comply with the Canal's constraints whether they will be trading through it or not, to maintain flexibility. The imperative to do so is simply expressed in terms of maritime economics: reduced flexibility leads to increased volatility of earnings and therefore increased financial risk for the ship owner. The capital value of a higher risk vessel will also be compromised.

The impact of the panamax constraint on ship design is therefore greater than would be suggested by analysis of trade alone. In 2010 around 208 million tonnes of cargo

passed through the canal, barely 2.5% of the total global trade figure of 8.4 billion tonnes recorded by UNCTAD in that year. Set against this the ocean-going commercial sector of the fleet, defined here as being over 5,000 Gross Tons, numbers about 33,500 ships of which about 8,500, namely 25%, have panamax beam. Ship types that comply with the constraint include both wet and dry bulk carriers, passenger ships, car carriers and others in addition to container ships at which the expansion is primarily targeted.

The implications of the expansion of the canal on ship design are therefore significant, irrespective of the final effect on trade patterns, potentially affecting one quarter of the ocean-going fleet. Having said this there has been remarkably little research on what the future shape of ships might be post-expansion, even though the new locks are due to be opened in about two years and there remains on order significant numbers of vessels with panamax beam, some of which may be delivered after the anticipated opening date in 2014. In the face of this uncertainty Newcastle University School of Marine Science and Technology has conducted research to start to define the possible effects on ship design resulting from this change in infrastructure. This has been undertaken in the context of the Low Carbon Shipping Research Consortium, of which the University is a member.

### **The unexpected link to carbon reduction**

The starting point for this research was originally a question relating to the design of ship repair drydocks. Up to now the dimensioning of a new dock has been, at least within certain size categories, simple. The panamax beam constraint can be used and many drydocks have an internal width of between 36m and 40m for this reason. This constraint has now become redundant in the designing of drydocks.

The research took a turn, however, when reviewing ship performance and in particular the potential for increased ship efficiency that the relaxed constraint will afford. Increased efficiency means less fuel per unit of cargo carried and less fuel means less carbon produced in direct proportion. This is important given that much effort is currently being expended in the development of designs, operations, logistics and systems to reduce the output of CO<sub>2</sub> and other noxious emissions from ships. The IMO predicts that shipping will be responsible for between 12% and 18%

of global CO<sub>2</sub> emissions by 2050 unless the industry does something significant to improve.

The reduction of fuel consumption is also, of course, of great interest to ship operators for less altruistic reasons than the saving of the planet. With bunkers costing between \$650 and \$750 per tonne the industry is focused on cost saving. Clarkson Research in their 'Shipping Intelligence Weekly' of 20 Jan 2012 estimated that bunkers in the 1990s accounted for 28% of daily voyage costs but that this has now risen to 78%. Minimising fuel costs has become a matter of survival in a shipping market subject to low freight rates that appear to show little prospect for recovery in the near future and it turns out that the expansion of the canal can assist significantly in this quest.

Newcastle University's research so far has concentrated on the most numerous panamax sector of the fleet, the dry bulk carrier sector, of which in 2010 there were 1,700 ships with a further 914 on order. The limitation of the beam restricts panamax bulkers to around 85,000 deadweight tonnes maximum and dictates some compromise in the optimisation of the hull form. The optimisation of a dry bulk carrier includes the requirement to maximise internal hull volume to maximise the volume of grain that can be carried within the deadweight capability. This requires the ship to be longer than would perhaps be chosen if the beam could be increased further instead. Empirical research, based on existing designs, suggests that the efficiency of the hull could be around 5.5% higher for a panamax ship if it were designed without the constraint. That is 5.5% saving in fuel and emissions. Research is underway to quantify this and the mechanisms involved more precisely.

### **The dry bulk sector appears to be ready for a new ship class**

Further saving could be made through economy of scale if panamax bulkers could increase above the current 85,000 dwt maximum. The first question is whether the market wants a larger bulk carrier between 85,000 dwt and the next size class up, that being "capesize" at around 180,000 dwt. Examination of the parcel size function, the distribution of cargo parcel sizes being fixed on charter, shows that over the last decade this has moved to skew firmly up against the 85,000 dwt limit. The research team are proposing that this provides evidence that shippers are ready for larger parcel sizes in this sector, at least to some extent. There are already early adopters

for this new ship size with an emerging class of ship currently referred to by the shipping industry as the 'mini-cape'. In 2010 there were around 150 ships in this size range, typically around 100,000 dwt. Orders in hand will increase this new class to around 450 by 2014. Newcastle University's research estimates that through economy of scale a 110,000 dwt dry bulk carrier would use around 16% less fuel per tonne-mile than a conventional panamax bulk carrier.

A further question is whether or not infrastructure is ready for the larger ship class. After all, inflexibility and port access problems have seen the demise of ship developments in the past, not least the pursuit of the million dwt tanker in the 1970s. In terms of port access the larger ship should be achievable without a significantly deeper draft, so for many ports there may not be an issue. For ship repair infrastructure the drydock capacity for larger ships is adequate unless the ship is constrained to the Mediterranean or Baltic Seas.

### **The conclusion and unexpected consequences**

The conclusion of the research in the dry bulk sector is therefore that panamax ships are likely to get larger and that this will lead to significant gains in efficiency and reduction in emissions. This will be additional to the other technologies and strategies being developed to reduce shipping's carbon foot print. It further begs the question: what about other sectors of the fleet that have panamax beam and how far can this carbon reduction windfall stretch? Research has already started on the next most numerous fleet sector: panamax tankers. Initial results suggest that market demand for a larger ship is limited but that the gains to be made from hull optimisation are greater than the 5.5% seen for bulk carriers. Further and more significant gains could be made through optimisation of the logistics of refinery and products trades between the East and West coasts of the Americas, to allow larger vessels to operate as afforded by the Canal expansion, with resulting economies of scale.

It is concluded therefore that the expansion of the Canal will be influential in ship design irrespective of the effects on trade. The expansion also has a part to play in the goal of reducing shipping carbon emissions, a side-effect that has thus far been largely un-acknowledged. This is a positive example of the "unintended consequences" of the changes under way in Panama, referred to by Dr. Rodrigue

and Dr. Notteboom, resulting from the extreme complexity of the Panama Canal expansion conundrum.