The effects of the Panama Canal expansion on Panamax

Paul Stott
6th March 2013
The Panama Canal

- Provides a short-cut route between Atlantic and Pacific, across the Isthmus of Panama.
The Panama Canal – some key statistics

• Provides a short-cut route between Atlantic and Pacific, across the Isthmus of Panama.
• The route saves about 3,000 miles for a vessel travelling from US East Coast to Japan.
• The route saves about 5,000 miles for ships carrying bananas from Ecuador to Europe.
• The Canal is 80km long and rises to 26m (85ft) above sea level at the highest point.
• Transit through the Canal takes 24 hours, of which 8 to 9 hours are underway.
• Opened in 1914 and administered by the United States until 31st December 1999. It is now administered for the benefit of the Panamanian economy by the Panama Canal Authority.
Existing vessel limitations

- The limiting dimensions for vessels transiting are imposed by the system of locks.
- The locks are 110 feet between the walls and vessels, which are pulled through by trains known as ‘mules’, can clear with 2 feet either side – leading to the ‘panamax’ dimension of 106 feet or 32.3m beam.
- This dimension has been an important constraint in Naval Architecture since panamax vessels were developed around 50 years ago.
Changes to the Canal

- New locks are being installed that will accept larger vessels through the Canal
- Certain parts of the Canal are being deepened to facilitate this increase in size
- Due open in 2014, although currently 6 months behind schedule (at least)
- This (arguably) presents the greatest change in ship routing in the 100 years since the Canal first opened
Aims

• The aim of this presentation is to identify how the changes in Canal constraints are likely to change ship designs.

• Before doing that we will look at a quick review of why the Canal was developed in the first place. It would be tempting to conclude from our current standpoint that this was for trade reasons. In reality the Canal was developed with strategic aims.
Pre-Canal

- Prior to the development of the Canal the main route between Atlantic and Pacific was through the notorious ‘Drake’s Passage’, around Cape Horn
Why was it notorious?

• At that latitude there is no land to stop the circular build-up of wind and seas in the Southern Ocean
• This made the passage around the Horn difficult and dangerous
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- This made the passage around the Horn difficult and dangerous

We made the longitude of the Cape about the 18th of December, having experienced headwinds for nearly the whole distance. We anticipated a moderate time in passing this noted land, from the season of the year at which we were there, being considered most favourable; but instead of this, we experienced heavy westerly gales, and a most tremendous sea, that detained us off the Cape five weeks, before we had got sufficiently to the westward to enable us to put away. Of the passage of this famous Cape it may be observed, that strong westerly gales and a heavy sea are its almost universal attendants: the prevalence and constancy of this wind and sea necessarily produce a rapid current, by which vessels are set to leeward; and it is not without some favourable slant of wind that they can in many cases get round at all. The difficulties and dangers of the passage are proverbial:

Owen Chase, first mate, whale ship ‘Essex’ (Nantucket), 1819
From “Narratives of the wreck of the whale ship Essex”, Owen Chase et al
Pre-Canal

- It took the whale ship “Essex” 5 weeks to get around the Horn
There was an alternative

- The Straits of Magellan a little further North provide an ‘inland’ route but at the narrowest point (Punta Delgada) the strait is barely two nautical miles wide.
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• The Straits of Magellan a little further North provide an ‘inland’ route but at the narrowest point (Punta Delgada) the strait is barely two nautical miles wide.
• The narrowness coupled to a treacherous crosswind known as the willawaw ("a sudden violent, cold, katabatic gust of wind descending from a mountainous coast of high latitudes to the sea and are most common in the Strait of Magellan or the Aleutian Islands" (www.weatheronline.co.uk)) meant that it gave insufficient sea room for safe passage of sailing ships.
Early attempts to build a canal

- The narrowness of the isthmus joining North and South America had long attracted attention as a possible short-cut route between Atlantic and Pacific.
- The first significant attempt to create a Canal was by French investors in the 1880s, who tried to build a sea-level route, similar to the successful Suez Canal.
- Treacherous ground conditions and tropical diseases led to an estimated 22,000 deaths of Canal workers between 1881 and 1889 and the sea-level attempt was abandoned.
- A new plan conceived the use of locks to raise ships over the isthmus but the French investment attempt eventually ran out of funds.
US interests in the Canal

- Following the opening up of the Western seaboard in the second half of the 19th Century, the US conceived a strategic interest in a shorter route between the two coasts.
- In 1901 the land that is now Panama was then part of Colombia. The US tried unsuccessfully to conclude a treaty with Colombia to cede control of a strip of land on which to build a Canal.
- The US response was to use gunboat diplomacy (using USS ‘Nashville’) to support secessionist rebels to secure independence for the country that became know as Panama.
- The US bought control of the ‘Panama Canal Zone’ for $10 million and held that control up to 31st December 1999.
The development of panamax ships

- When the canal opened the average size of merchant vessel was around 7,000 dwt and the lock chambers could have accommodated two ships abreast and almost three in line.
- The concept of a ship large enough to be constrained by the chamber would have been almost unthinkable.
The development of panamax ships

- Given the strategic importance of the Canal to the US it is no surprise that the first ‘panamax’ vessels were military – the USS ‘Iowa’ class, of which four were completed in 1943 and 1944.

USS *Missouri* passing through the locks in 1945. These ships had 109ft beam, leaving only 6 inches clearance either side.
The development of panamax ships

- The first commercial panamax ship was the 70,000 dwt crude oil tanker *W Alton Jones*, built by Newport News, Virginia, in 1954.
- Modern panamax tankers are almost exclusively products tankers, not crude, and the first modern panamax tanker appeared ten years later in 1964, built by Mitsui Tamano in Japan.

MT Tanja Dan – the first modern panamax tanker
The development of panamax ships

• The first tanker was followed by a series of three panamax OBOs built at Mitsubishi in 1955 and 1958.

OBO
Pennsylvania
Getty, 1958
The development of panamax ships

• The first bulk carrier followed closely in 1959, with the 58,000 dwt *Pacific Maru* built by Kawasaki.

58,000 dwt is very small by modern standards: a modern panamax bulker would be over 80,000 dwt.

But, this was right at the start of the transition of bulk cargos from tram ships to dedicated bulk carriers, which happened in around 1957.
The development of panamax ships

- The first panamax container ship appeared in 1971, the 2,450 TEU Kamakura Maru.
- This is very small in the modern context where panamax container ships carry up to around 4,800 TEU.
The development of panamax ships

• By the 1970s the term ‘panamax’ had come to designate not only a beam constraint but also classes of tanker, bulker and container ship.
Panama’s interests in the Canal

- Following the transfer to Panamanian control the *raison d’être* of the Canal changed.
- The US interest was strategic and the price charged to pass through the Canal was set to cover costs.
- Panama’s interest is to generate revenue for the Panamanian economy from the Canal as a national asset and prices are set accordingly.
- Charges for transits are based on the estimated benefit for the shipper, not the cost of running the Canal.

<table>
<thead>
<tr>
<th>Market Segment</th>
<th>Number of Transits</th>
<th>Cargo (thousand long tons)</th>
<th>Tolls (thousand Balboa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container</td>
<td>3,031</td>
<td>50,305</td>
<td>763,988</td>
</tr>
<tr>
<td>Dry Bulk</td>
<td>3,050</td>
<td>86,890</td>
<td>250,692</td>
</tr>
<tr>
<td>Refrigerated</td>
<td>1,718</td>
<td>4,811</td>
<td>61,722</td>
</tr>
<tr>
<td>Tankers</td>
<td>2,233</td>
<td>44,941</td>
<td>171,152</td>
</tr>
<tr>
<td>General Cargo</td>
<td>834</td>
<td>6,948</td>
<td>31,124</td>
</tr>
<tr>
<td>Vehicle carriers</td>
<td>607</td>
<td>2,664</td>
<td>118,770</td>
</tr>
<tr>
<td>Others</td>
<td>893</td>
<td>8,257</td>
<td>42,378</td>
</tr>
<tr>
<td>Passengers</td>
<td>225</td>
<td>0</td>
<td>40,727</td>
</tr>
<tr>
<td>Total</td>
<td>12,591</td>
<td>204,816</td>
<td>1,480,554</td>
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Table 1: Summary of Canal traffic by segment in 2010

- Target revenue is $6 billion by 2025
- Average transit cost:
  - $82,000 – bulk carrier
  - $180,000 – passenger
  - $252,000 – container
Panama’s interests in the Canal

• Studies showed that the Canal was approaching capacity, particularly for lucrative container transits.
• The number of transits can’t be increased but the size of vessels, and therefore the volume of cargo per transit, can be increased.
• In 2006 the PCA announced a $5.8 billion expansion programme to introduce a set of larger locks and to deepen restricted channels.
• This will change the rules for what constitutes a ‘panamax’ ship.
The underlying reason for the expansion

Source: PCA Update, Jan 2013
The biggest concrete pour in history
Changes to the Canal

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<td>366.0</td>
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Since the 1960s this has been the panamax-defining dimension. It is equivalent to 106 feet, giving 2ft clearance either side in the 110ft wide locks.
## Changes to the Canal

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The new panamax limits are more complex, with length and beam determined by the new lock chambers but draft by the approach channels.

**Source:** Panama Canal Authority ‘notice to shipping’, known as “vessel requirements”. Can be obtained from the PCA web site.
What effect will the changes have on the design of ships?

Shipping is a “derived demand”. That means to say that the demand for ships is incidental to the demand for transport services.

Naval Architects do not have a free hand in designing cargo ships – they must be designed to transport the size of ‘parcels’ that shippers want to ship.

This has led to generic ship sizes such as VLCC, aframax, capesize, etc.

To answer this question, therefore, we would ordinarily need to answer the question as to how the new Canal will change shipping patterns.
What effect will these changes have on shipping?

- No-one really knows
- The problem has proven to be too complex to solve theoretically in advance
- The PCA anticipates a significant increase in container throughput, which is the target of the expansion
- How will the liner sector and other sectors respond to the expanded route?

“Soren Skou, CEO of Maersk Line, said the largest ships will be deployed to the Asia-Europe trade routes, and those deployments could cause a cascading effect that increases the size of ships calling on other ports as ocean carriers take larger ships that were on Asia-Europe routes and deploy them elsewhere. Skou also highlighted another trend that’s sending larger ships to the East Coast. In 2008, he said, 90% of ships calling on East Coast ports traveled through the Panama Canal. In 2013, that figure fell to 60%, while the remaining 40% traveled to the East Coast through the Suez Canal, a deeper channel that allows for larger vessels. “This trend is going to continue,” Skou said. “We can’t figure out how to make a profitable service from Asia to the U.S. East Coast via the Panama Canal.”

Charleston Regional Business Journal, 5th March 2013
What effect will these changes have on ship design?

- The lack of knowledge of trade outcomes is not a barrier to answering this question

- Seaborne trade
  - 2.5% passed through the Canal in 2010

- Deepsea fleet
  - 25% (8,500 ships) have panamax beam
What effect will these changes have on ship design?

- The lack of knowledge of trade outcomes is not a barrier to answering this question.

Ships adopt the panamax beam by default within certain size ranges, for reasons of flexibility. Not to do so would lead to a lower re-sale value and reduce operating flexibility.
How will expansion affect ship design?

- This depends on the ship type
- In most cases the hull is currently beam limited
- The shift in new panamax will be:

  Container => Length limited

  Bulk vessels => Draught limited
How will the expansion affect ship design?

- The shift to draught limits is significant
- As with the Suez canal larger ships will be able to transit in ballast or partially laden
- Suezmax tankers (c. 160,000 dwt) will be able to transit in ballast
- Capesize bulkers (c. 180,000 dwt) will be able to transit in ballast
Container ships

- The expansion is targeted at container ships
- 25% of transits but 50% of revenues for PCA
- The initial plan was to increase the maximum size of container ship from 4,800 TEU to 12,000 TEU

- The largest container ship within 366m length is 13,200 TEU
- BUT
- Such a ship has a registered draft of 15.5m, whereas the new draught constraint is 15.2m
- The register quotes “scantling” draught
- Operating draught is significantly lower
Container ships

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- Maersk Edison
- 13,100 TEU
- Example of the new panamax container ship
- Limit around 13,200 TEU
Container ships

- How important new panamax will be in the container fleet is too early to say
- New post-panamax ships, up to 18,500 TEU, have been developing just as fast
Container ships

• How important new panamax will be in the container fleet is too early to say
• New post-panamax ships, up to 18,500 TEU, have been developing just as fast

A new series of APL ships reported in *The Naval Architect* in October 2012 give cause for thought.
• The ships are revolutionary because they are designed for a much slower speed than previous container ships.
• At 13,800 TEU they are only 5% greater capacity than new panamax but the ships are too large to get through the expanded canal.
• Does this also make the statement that APL is ignoring the canal expansion in the development of container shipping?
• APL have track record of being ahead of the game, having built the first post-panamax in 1988, three years ahead of anyone else.
Dry Bulk Carriers

- The new length and beam constraints will accommodate capesize
- BUT
- Draught limits a fully laden vessel to about 120,000 dwt
- And, critically:

Does the bulk shipping industry want larger vessels to take advantage of this potential size increase?
Dry Bulk Parcel Sizes

- Container ships are effectively ‘inflatable’ due to the high subdivision of the cargo parcels
- Bulk carriers have to be built to carry the size of parcel that shippers want to ship
- Research has shown that there is pressure to increase the parcel size in the dry bulk sector

Bulk cargo parcel size distributions

Panamax parcels have skewed up against the physical limit of ship size
Dry Bulk Parcel Sizes

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![Graph showing the proportion of total number of ships with respect to Deadweight]

Early adopters of new panamax.
Dry Bulk Carriers

• The economy of scale achievable from larger panamax bulk carriers is significant in terms of the potential for carbon reduction.
• This is the largest sector of the panamax fleet: 2,400 ships.
• The new limit is about 120,000 dwt but early adopters are being cautious with size at present and brokers suggest that mini-capes are not currently very popular with charterers.
Dry Bulk Carriers

- Panamax bulkers are up to about 85,000 dwt max.
- Smaller vessels often use the panamax beam to maximise their internal volume. These vessels, up to about 55,000 dwt, are generally known as handymax or supramax.
- Smaller vessels with panamax beam should probably not increase beam due to ship repair drydock capacity restrictions.
- Another issue for smaller ships is that transits through the new locks are likely to become more expensive than transits through the old locks, which will remain in action.
Tankers

- The panamax tanker fleet is surprisingly small – 426 ships in total.
- Far larger is the handymax sector with panamax beam – 1,365 ships in total, but the cautionary note regarding ship repair capacity and transit costs applies to tankers as well as dry bulk.
Tankers

- There is no indication from parcel size analysis that operators are looking for a larger panamax ship in the tanker sector.
- The most common parcel moved in panamax ships in 2008/9 was 55,000 tonnes, well below ship capacity.
- The average load factor in all sectors of the oil products trades (handy/panamax/aframax) was only 78%.

No increase in panamax ship sizes

Increase in Aframax size towards the new limit
• It could be said that aframax is the new panamax in the tanker sector but developments in refineries and receiving tank farms will be needed to support any increase in the size of vessels moving products through the Canal.
• The consequences of this on shipping carbon reduction is likely to be limited – certainly less than for dry bulk and container
• The potential to get suezmax through in ballast may be of more significance
### Overall summary

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- Also, note that existing panamax remains relevant, as the old locks will stay in service.
- The panamax constraint is therefore moving from a simple beam constraint to a complex constraint that depends on circumstances.