RINA / IMarEst

Is the global commercial shipbuilding industry running out of steam?

School of Engineering Dr Paul Stott

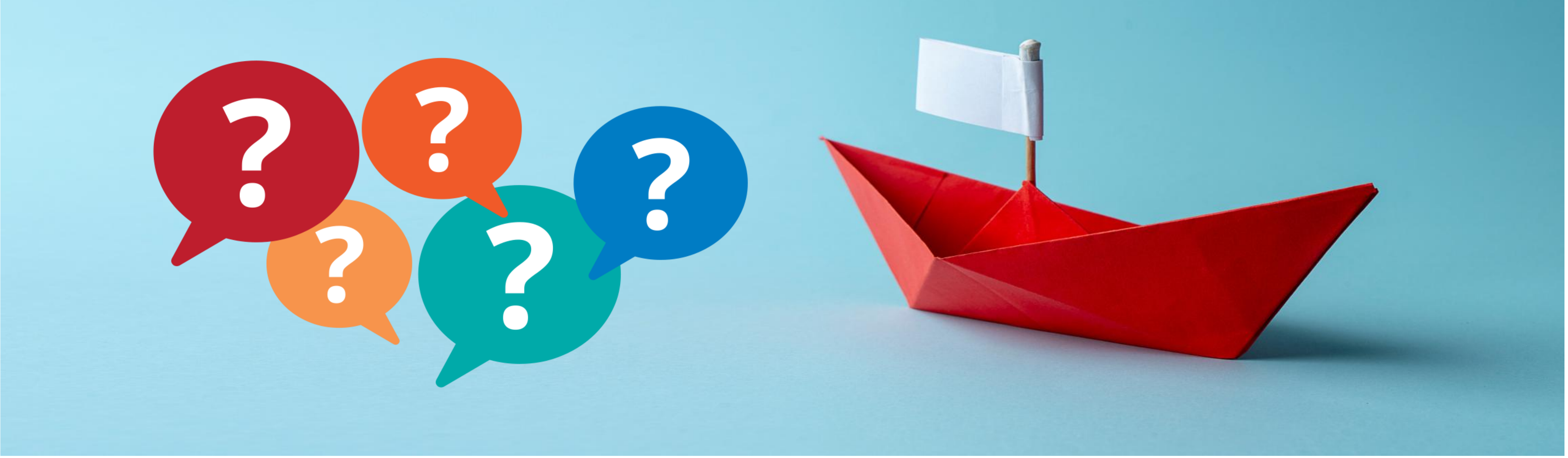
paul.stott@newcastle.ac.uk 44 7825 428932

Newcastle University

What does the title mean?

- Essentially, the question I am asking this evening is about whether the prevailing shipbuilding strategy in global commercial shipbuilding is sustainable – to which my answer will be probably not: we need to find a better way.

First question: what is the strategy I am talking about?



The prevailing shipbuilding strategy

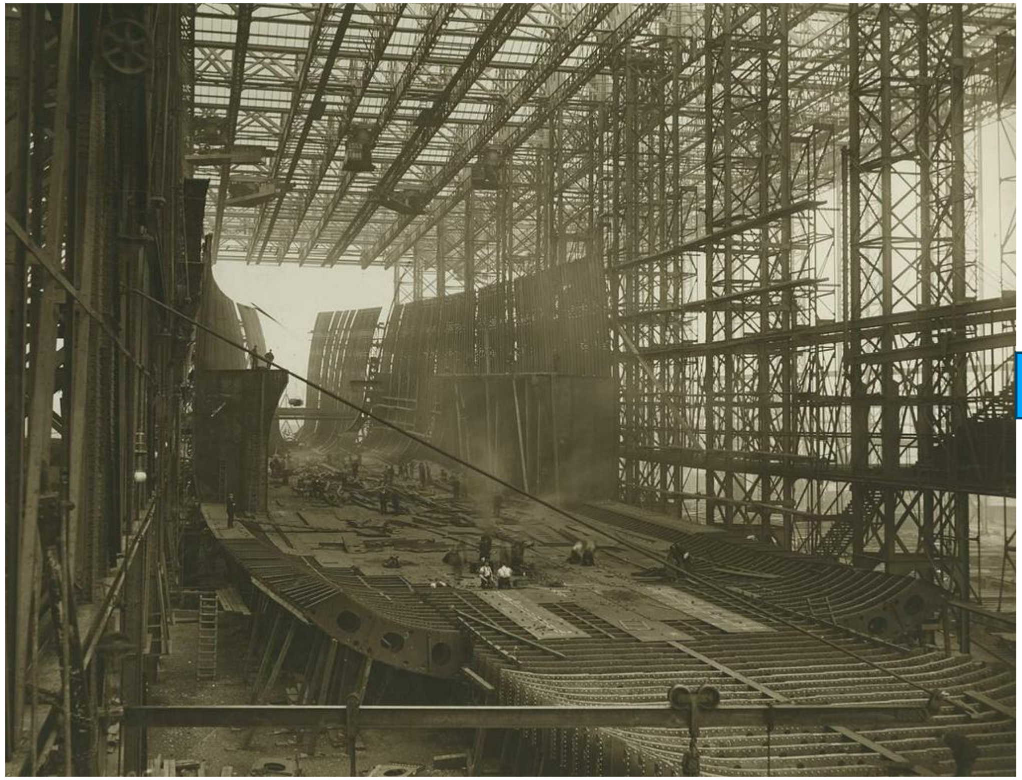
The prevailing strategy has its roots in WWII and the **liberty ships**, where welding became the primary joining method and this enabled pre-fabrication of sections of ship for assembly – rather than assembling piece by piece at the final assembly site.

Welding was a disruptor – it changed everything

For more information, see: Stott, P., *Shipbuilding Innovation: Enabling Technologies and Economic Imperatives,* Journal of Ship Production and Design, Vol. 33, No. 3, August 2017, pp. 1–11

The leap forward due to welding

Welding and pre-fabrication enabled the shape of shipbuilding to change, from:



To

The leap forward due to welding

And the shape of shipyards to change, from:

Doxford shipyard, Pallion, Sunderland

To

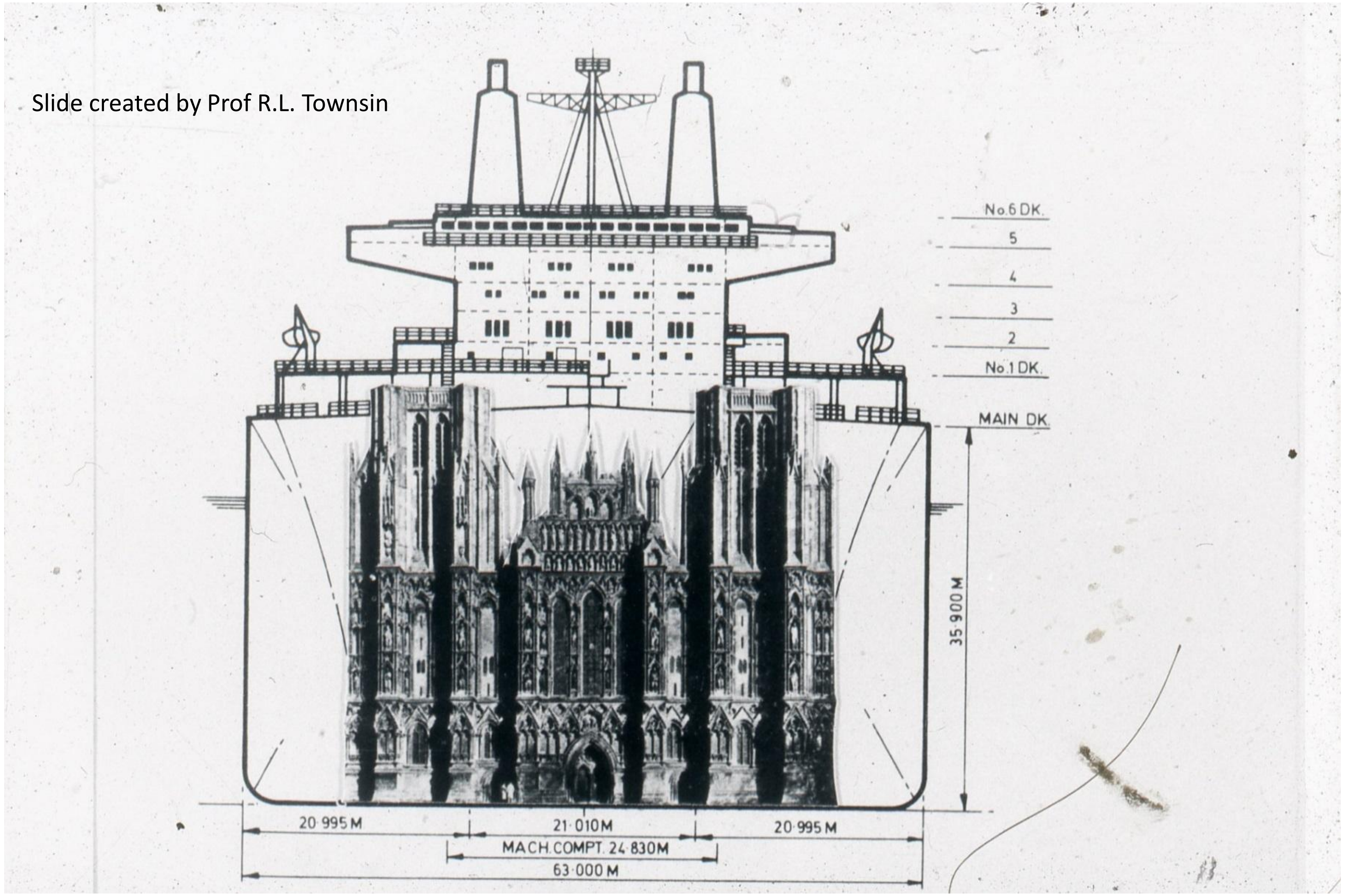
Mitsubishi Kawasaki – market leader in 1976

The effects of globalisation

As well as shipbuilding technology, the change in the industry between 1945 and 1975 was stimulated by another force: globalisation.

Globalisation meant that the capacity of the merchant fleet grew by orders of magnitude, as did the size of individual ships….

The effects of globalisation



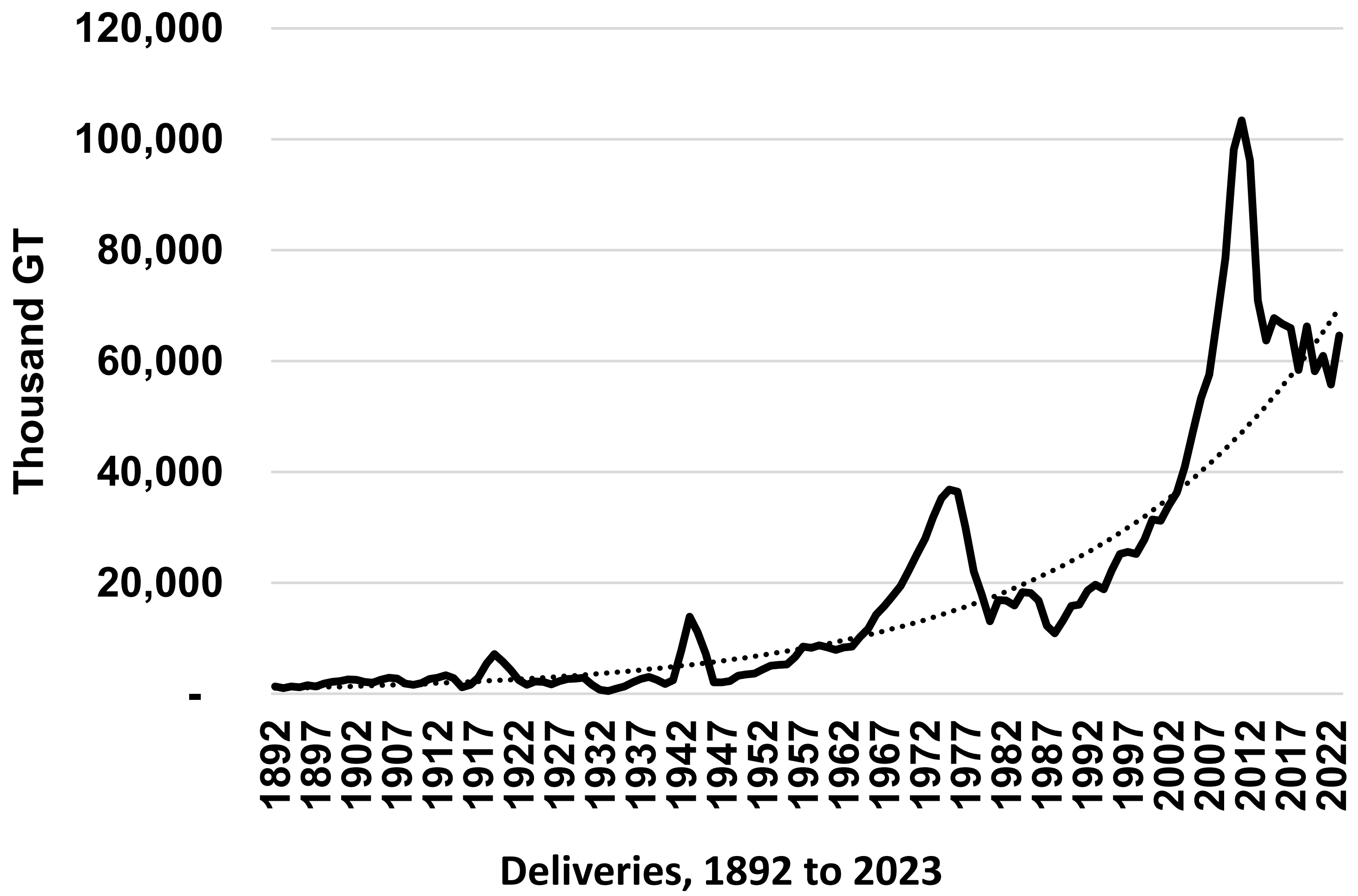
ULCC Bellamya, 1976, built in St Nazaire, France, 553,652 dwt, with Wells Cathedral superimposed in the tanks!

The effects of globalisation

Globalisation also provided the opportunity for the development of scale.

Economy of scale has become the dominant route to shipbuilding competitiveness, at least in the large cargo ship sectors.

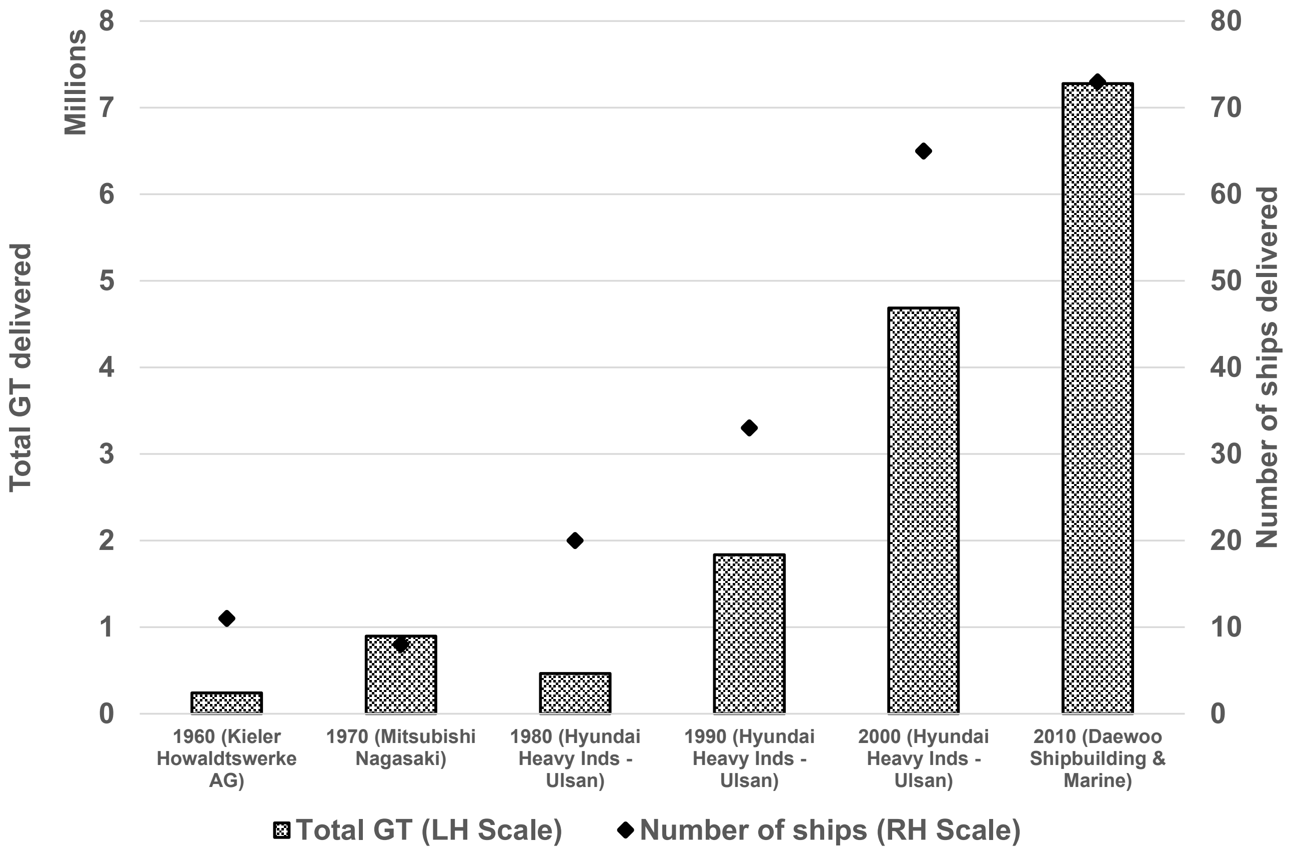
Demand increased exponentially



Over the past 130 years output has appeared as a series of ‘waves’, with the peaks appearing on average around every 30 years.

The underlying trend has shown a relatively steady exponential increase.

Shipyard capacity also increased exponentially

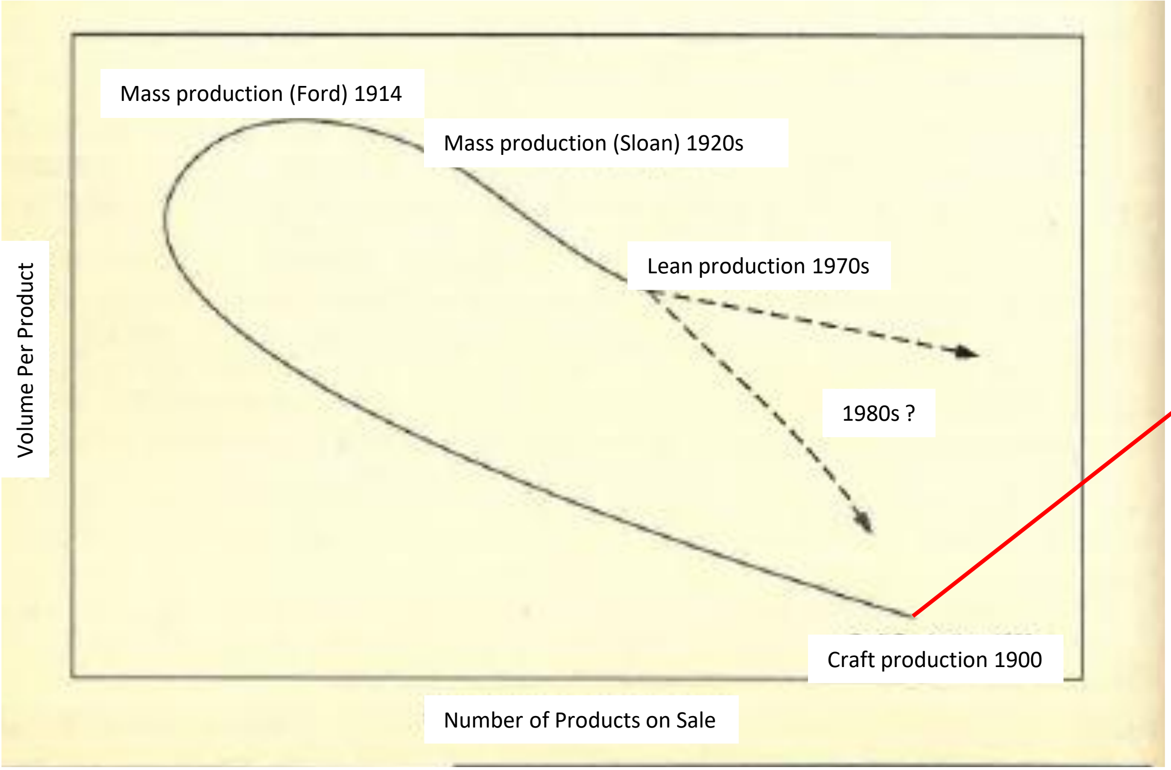


Market leading yard at the start of each decade since 1960

The largest shipyards are now capable of processing around 3 million tonnes of steel per annum and can install more than 80 main engines per annum.

The pursuit of volume in automotive

The pursuit of volume in shipbuilding mirrors the pursuit of volume in automotive, as described in the book: “The machine that changed the world” by JP Womack of MIT.



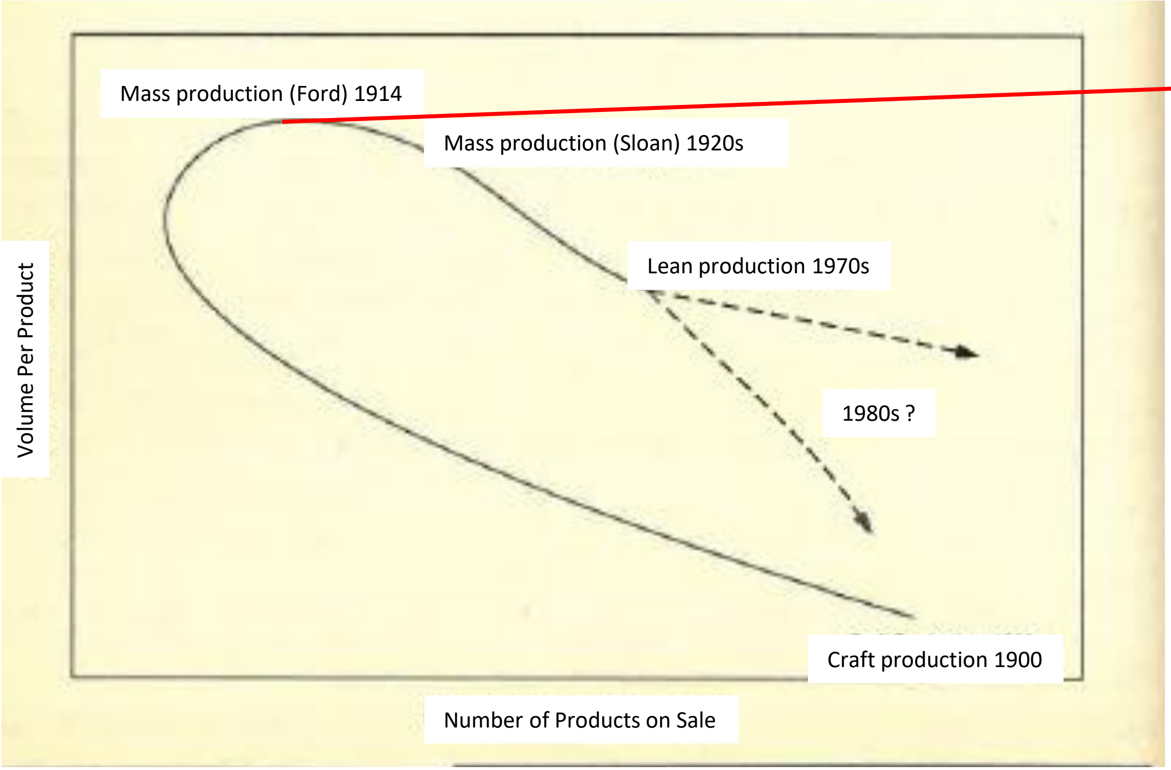
Coach-built one-off motor carriages.

Very expensive – the preserve of aristocracy.

Each car unique

The pursuit of volume in automotive

The pursuit of volume in shipbuilding mirrors the pursuit of volume in automotive, as described in the book: "The machine that changed the world" by JP Womack of MIT.

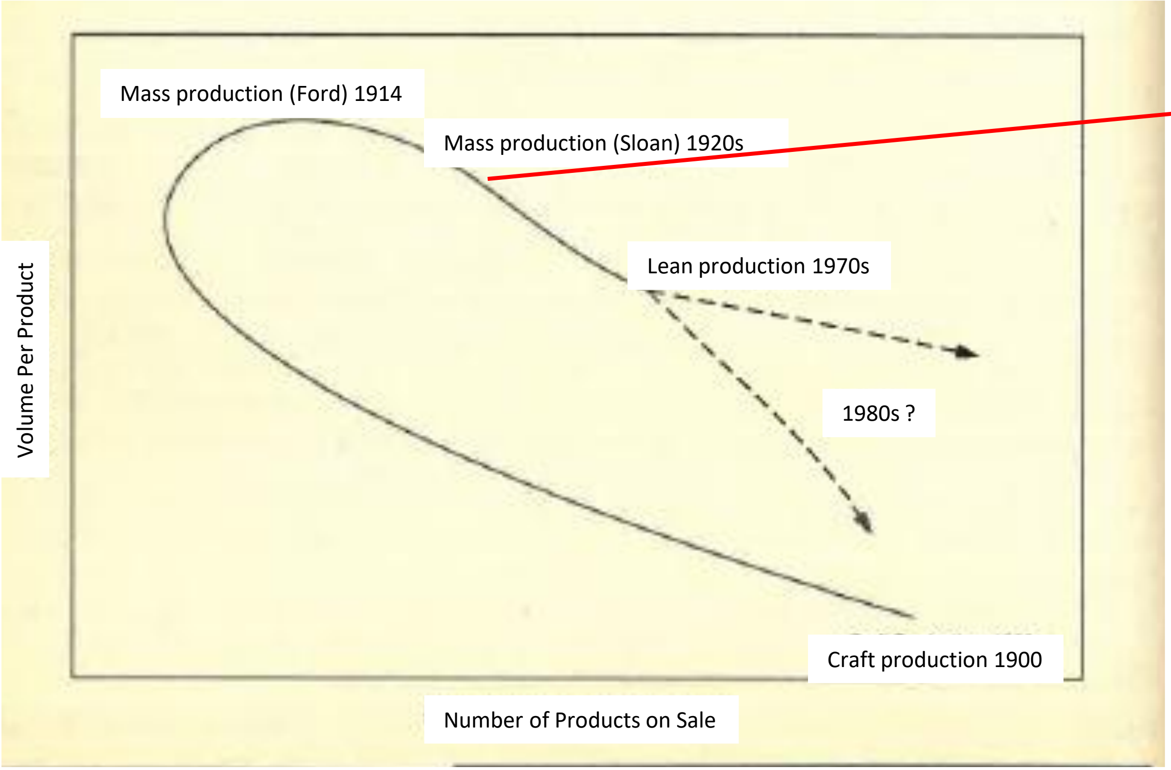


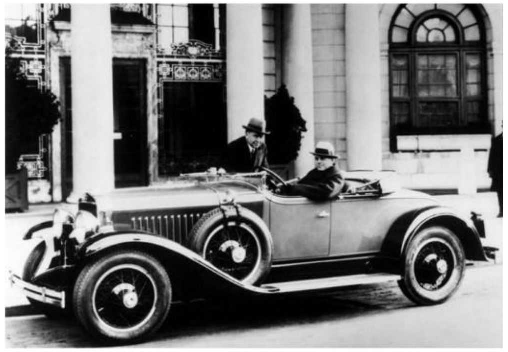
Model T – "any colour as long as it is black".

Mass production of a limited range of identical products.

The pursuit of volume in automotive

The pursuit of volume in shipbuilding mirrors the pursuit of volume in automotive, as described in the book: “The machine that changed the world” by JP Womack of MIT.

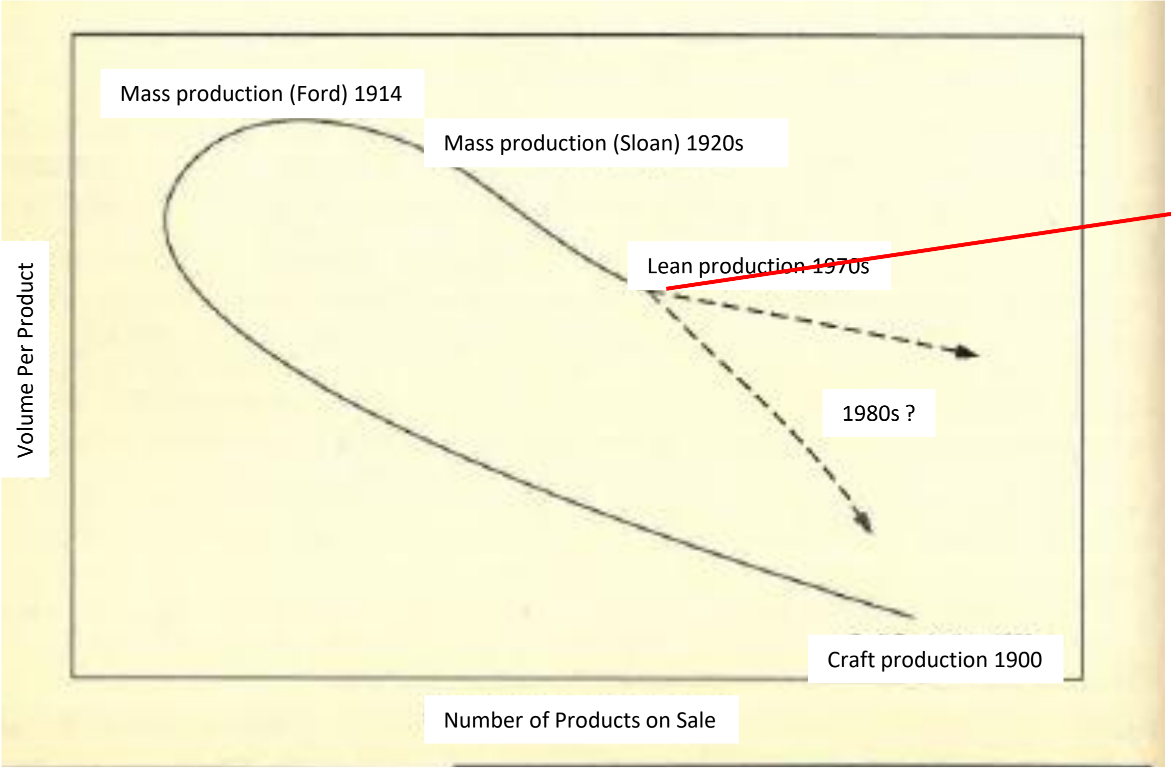




General motors realised that not everyone wanted black.

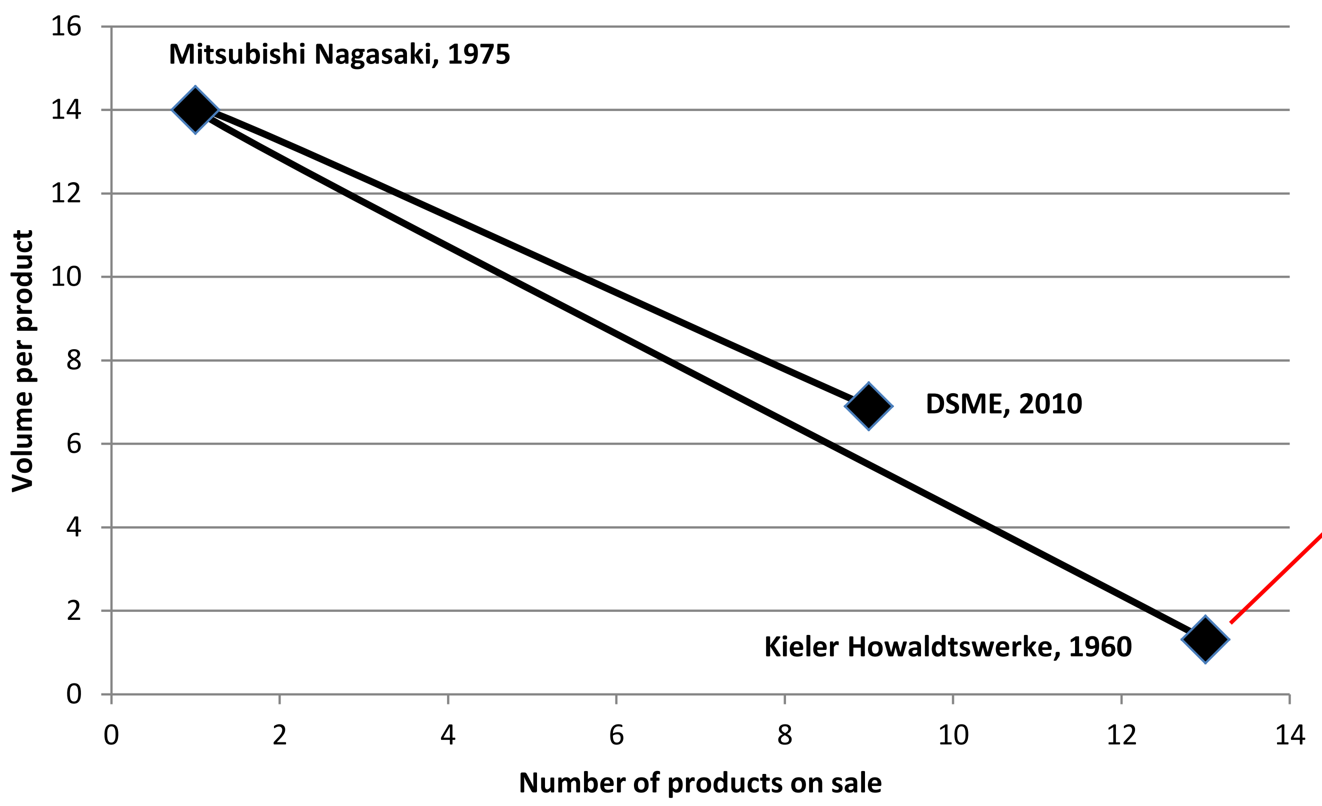
Product variety increased.

The pursuit of volume in shipbuilding mirrors the pursuit of volume in automotive, as described in the book: “The machine that changed the world” by JP Womack of MIT.



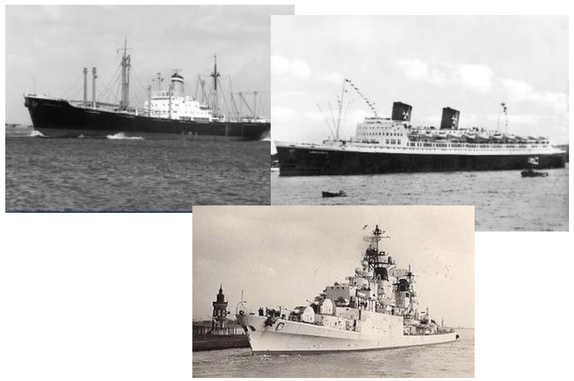
Toyota increased product variety and efficiency even further using lean production.

The progress of volume in shipbuilding



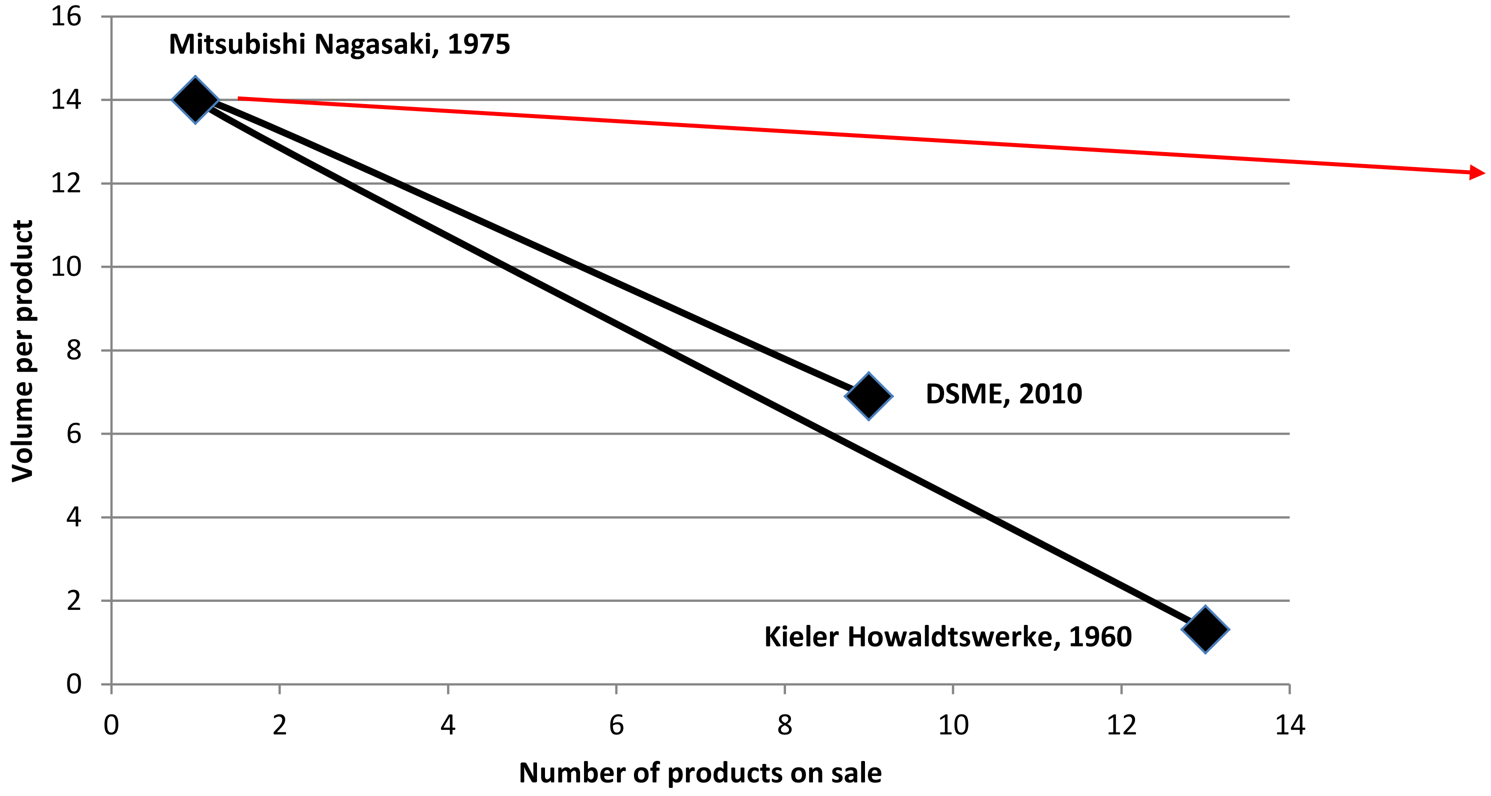
Typical 20th century European shipyard up to 1960.

Built a wide variety of products as one-off or short series



Market leading yard at 1960 and demand peaks of 1975 and 2010

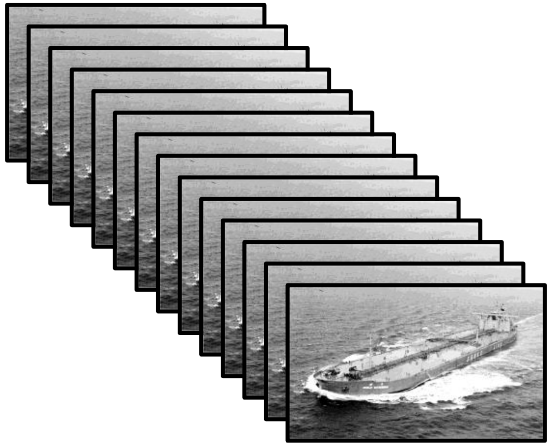
The progress of volume in shipbuilding



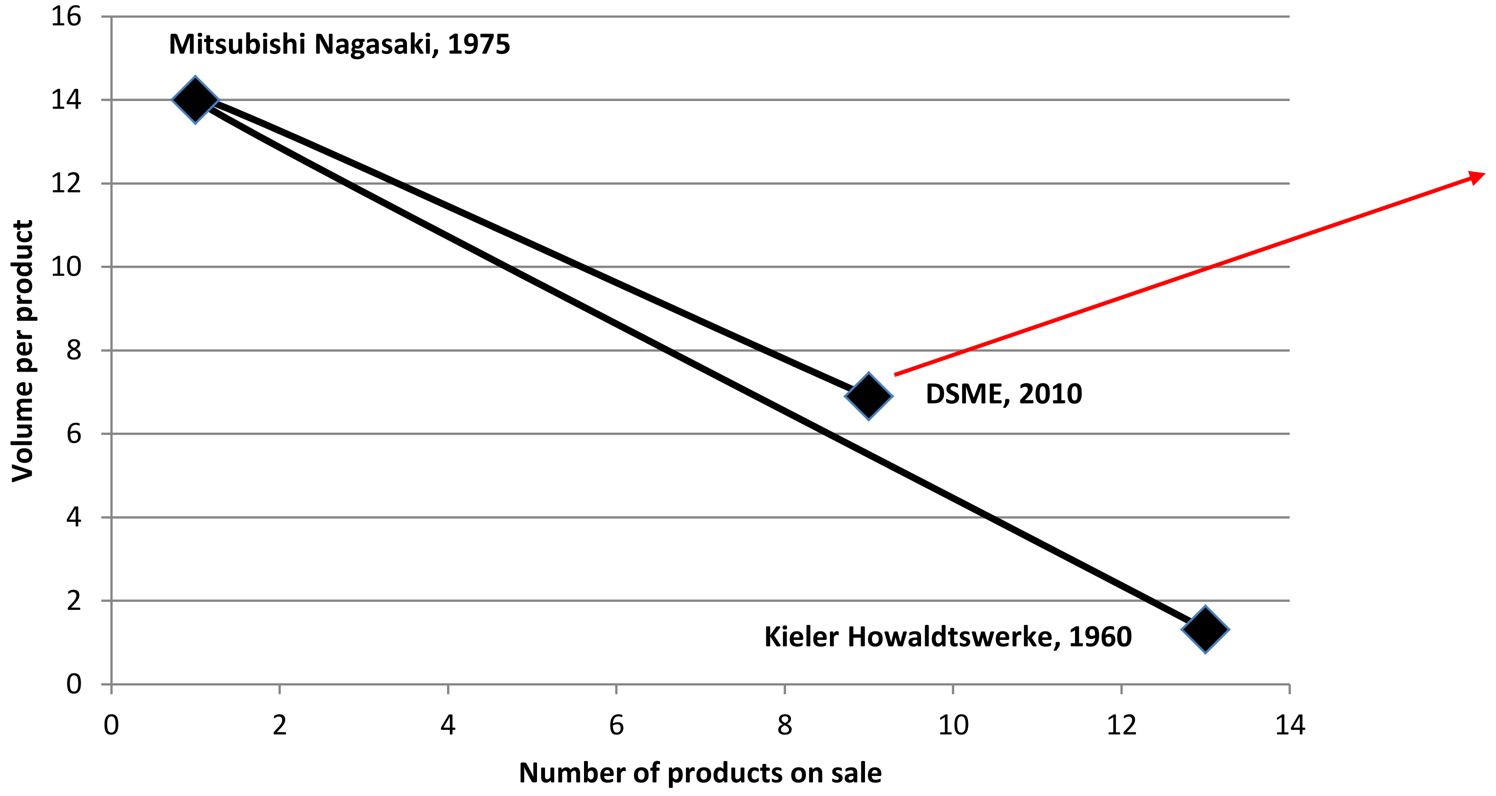
Market leading yard at 1960 and demand peaks of 1975 and 2010

Series-built identical VLCCs at a rate of 1 per month.

Possibly the most efficient shipyard ever.



The progress of volume in shipbuilding



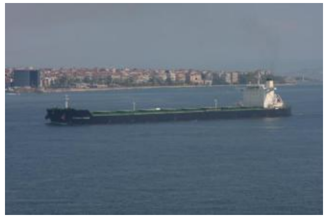
Market leading yard at 1960 and demand peaks of 1975 and 2010

No market sector is sufficiently stable to support the single product paradigm for ever – the VL market dried up after 1975.

Product mix of long series of different ship types developed, using lean technology.

An example of product mix in a modern volume yard

In 2009, HHI Ulsan yard delivered 109 ships of 7 main types.



11 capesize bulkers

12 VLCC

7 Suezmax

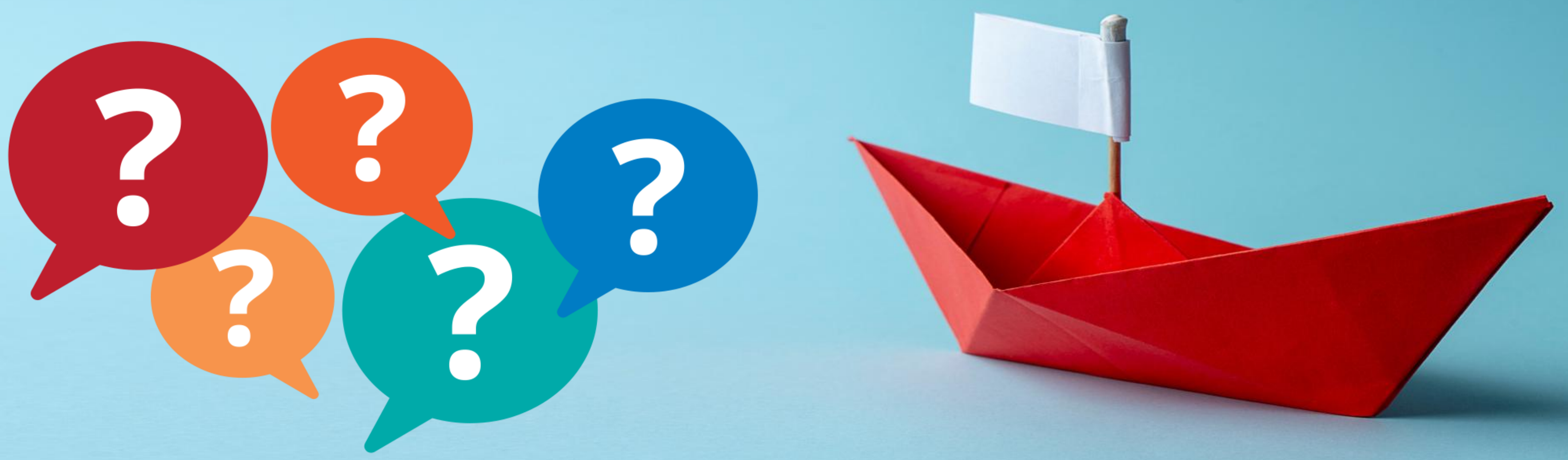
19 Aframax (7 crude 9 products)

4 LNG

14 LPG

42 CC: (in 6 size classes from 2556 TEU to 11,300 TEU)

Second question: why am I saying that the current strategy is flawed?



The state of competitiveness

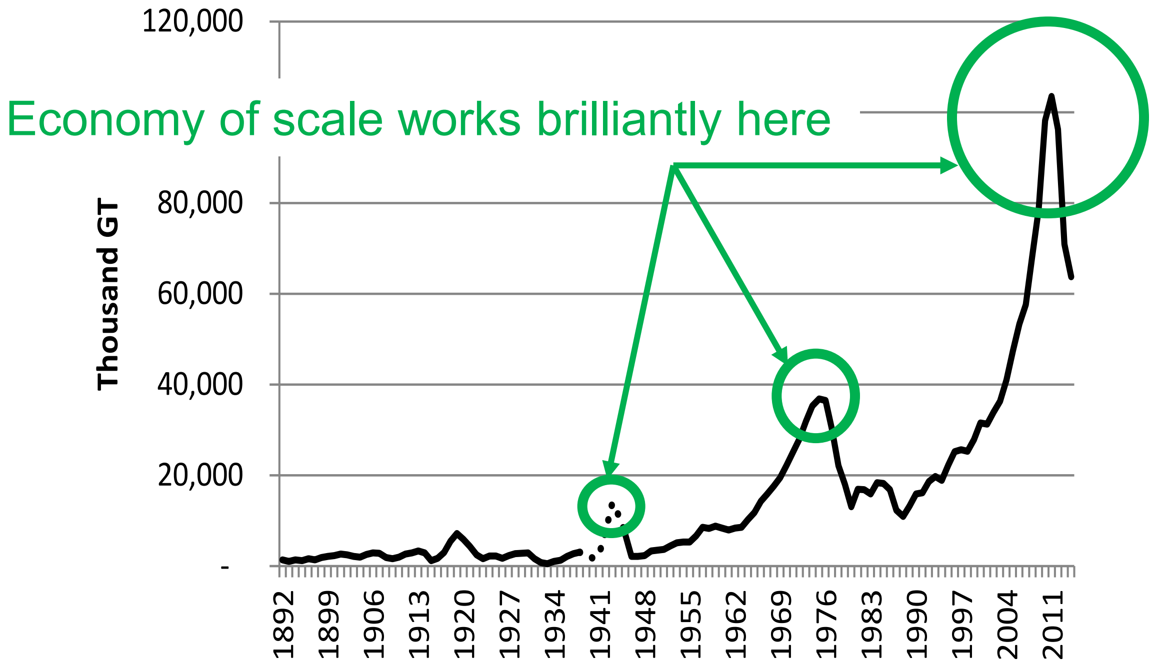
We have arrived at a point where competitiveness through scale is dominating the shipbuilding sector.

So, why am I questioning it?

There are two flaws in the strategy that, in my opinion, lead it to being un-sustainable.

Flaw 1 – demand volatility

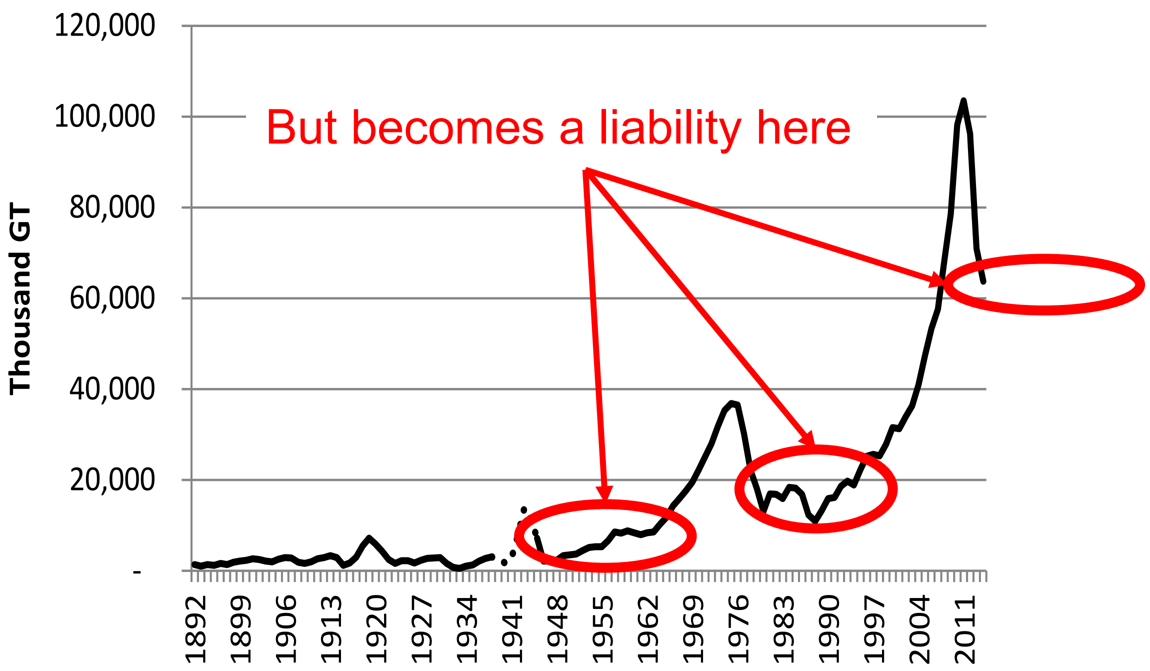
Demand is far from constant.



Commercial shipbuilding output (in gross tons), 1892 to 2014

Flaw 1 – demand volatility

Demand is far from constant.



Commercial shipbuilding output (in gross tons), 1892 to 2014

The strategy doesn't work without periodic government intervention to shore up volume during the trough periods.

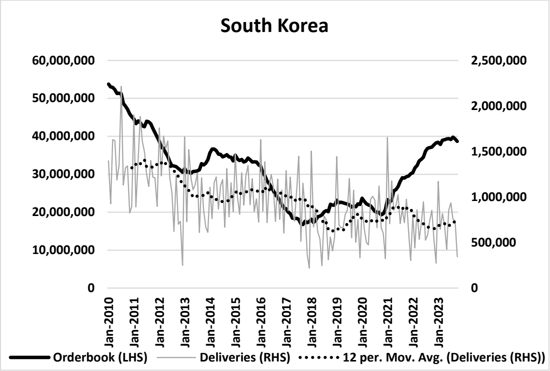
Under-utilisation of capital is the norm.

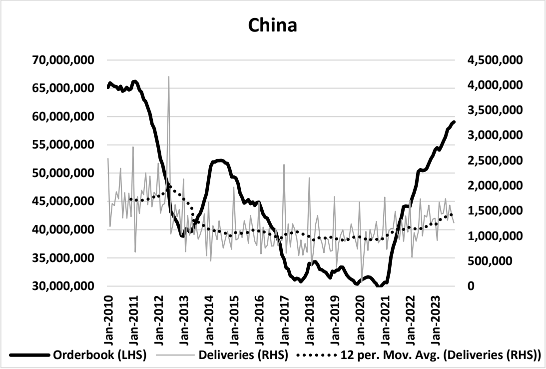
This is very expensive.

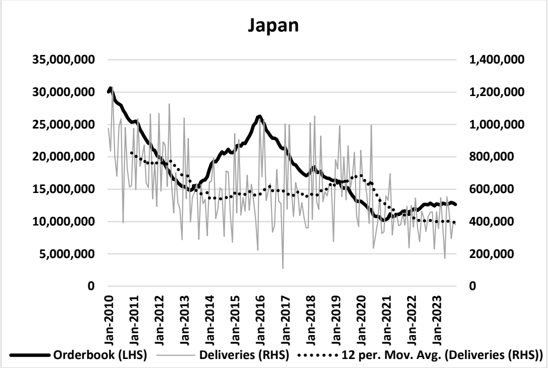
Flaw 2 – Labour shortage

- Capacity is the combination of capital investment plus human capital.
- Even the largest facility has capacity 0 if it has no workers.
- There is increasing concern in shipbuilding that shortage of human capital is becoming a problem across the globe.
- Put bluntly: people don’t want to work in shipyards any more.

Flaw 2 – Labour shortage

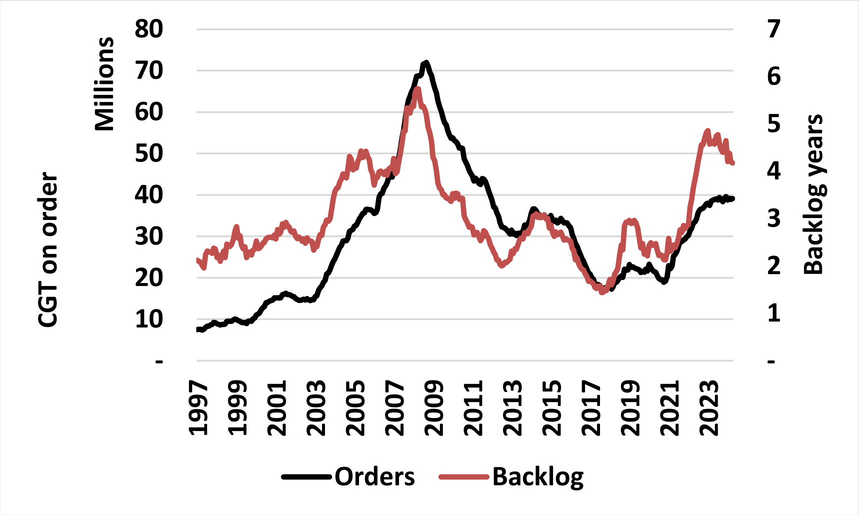


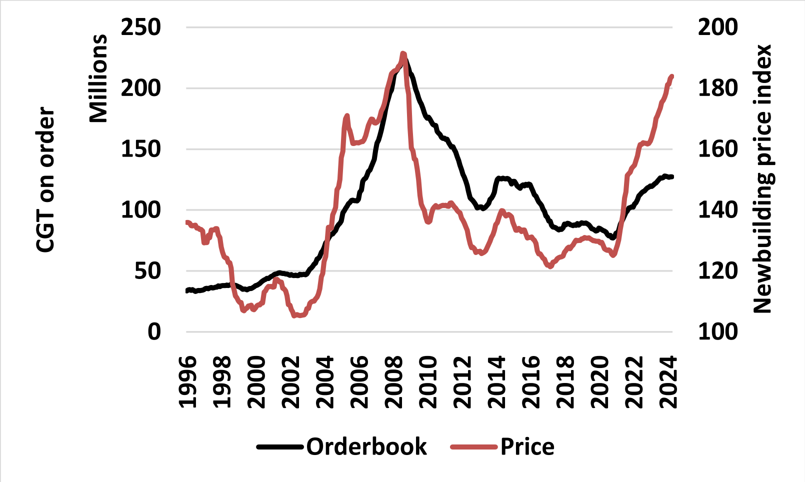




Output in commercial shipbuilding has been falling for some time and has not (yet) respond to recent upturns in ordering.

Flaw 2 – Labour shortage





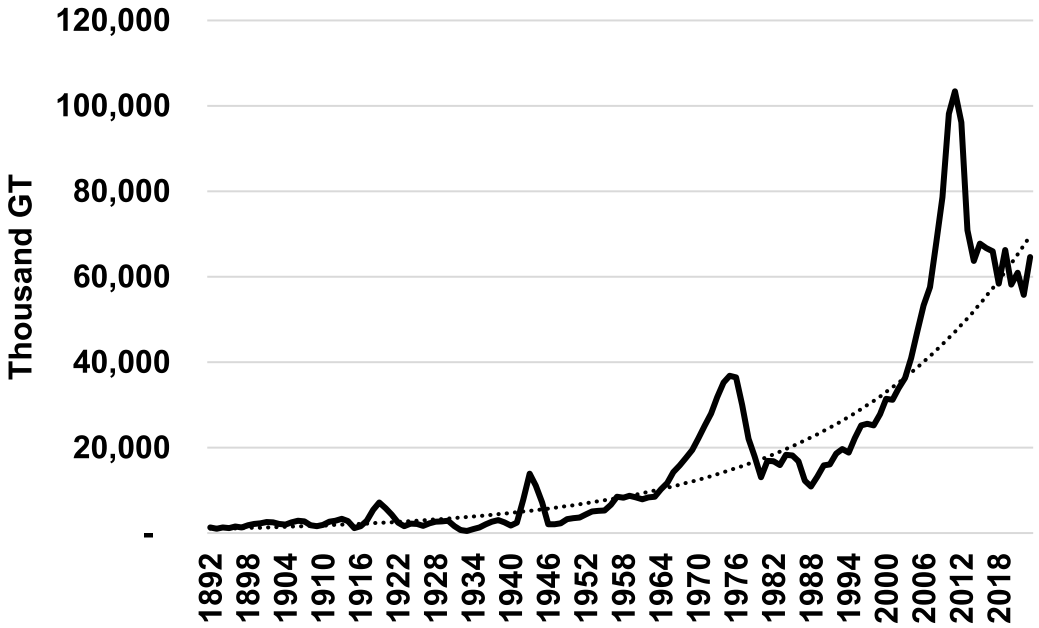
The result is that backlog has increased significantly and, as a result, price has also increased (inflation can only explain about 20% of the increase in price since 2022).

Increased price will have a significant effect on the supply and demand economics.

Flaw 2 – Labour shortage

Labour shortage could become a disruptor in the shipbuilding business, in which case –

1. Price likely to remain higher.
2. Future demand booms will be difficult to achieve.



It is difficult to see at the moment that this pattern of demand can propagate into the future.
With the current production strategy, a shortage of labour could prevent the next peak (however big that peak might be).

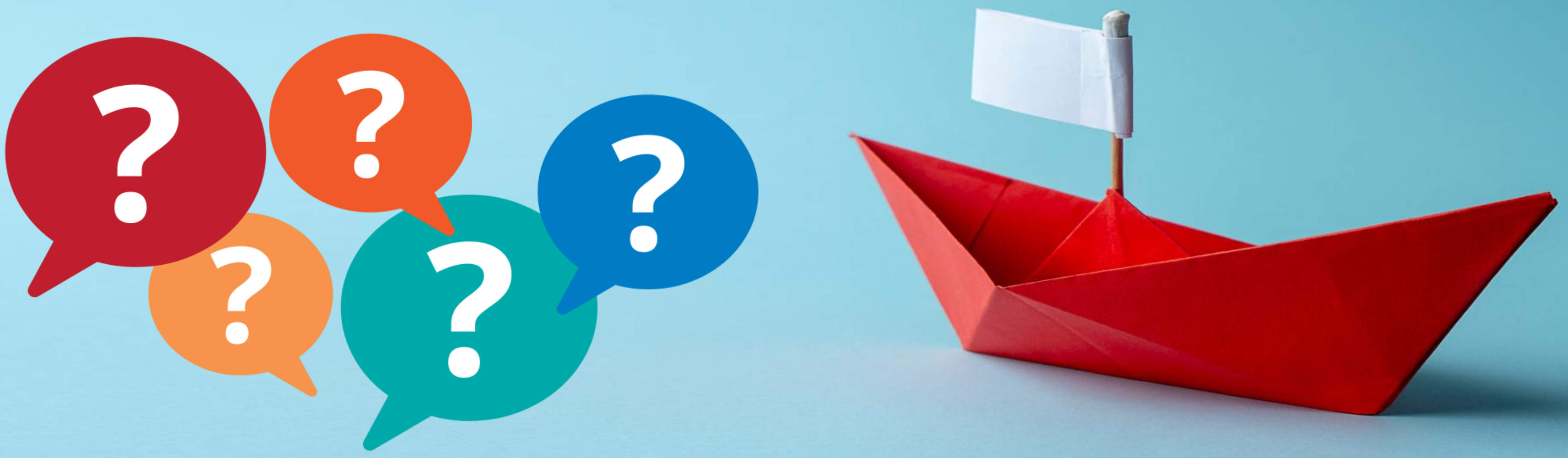
Flaw 2 – Labour shortage

Labour shortage could become a disruptor in the shipbuilding business, in which case –

1. Price likely to remain higher.
2. Future demand booms will be difficult to achieve.
3. Supply (shipyard capacity) shifts should be expected.
4. Capital will increase in competitive importance and productivity will reduce (shift in the relative balance between fixed and human capital – i.e. automation and de-skilling)

This will lead to both opportunities as well as threats.

Third question: can we see a better strategy?



Elements of the better strategy:

Disruption is needed to:

1. Shift the focus away from volume;
2. Improve the response to demand volatility;
3. Shift the balance from human to fixed capital;

Why is disruption so difficult to achieve

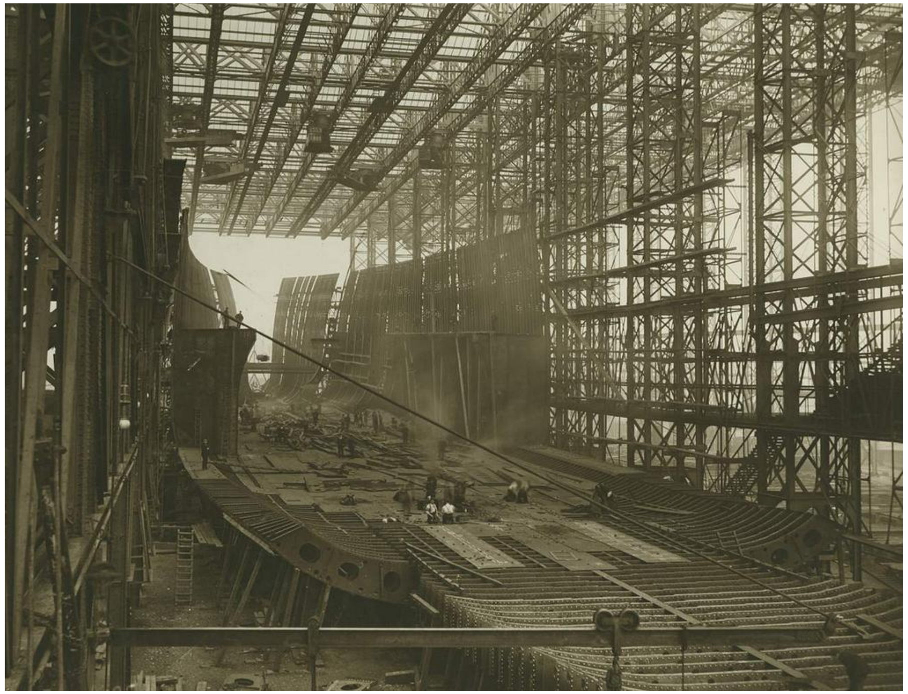
Because it is very difficult to see what doesn't exist.

Henry Ford disrupted transport with his development of the Model T.

"History is more or less bunk"

"If I had asked people what they wanted, they would have said faster horses"

Welding was introduced into US shipyards from civil engineering



The last major disruption in shipbuilding

Japan's post-war strategies were developed using input from aircraft manufacture

Are there any disruptors on the horizon in shipbuilding?

- AI
- Digital Twin and Simulation

These aren't new and much progress has been made, with the second of these in particular.

But they are not yet disruptors – they are currently modifying the status quo.

Barriers to enabling the maximum benefit from these technologies are often non-obvious.

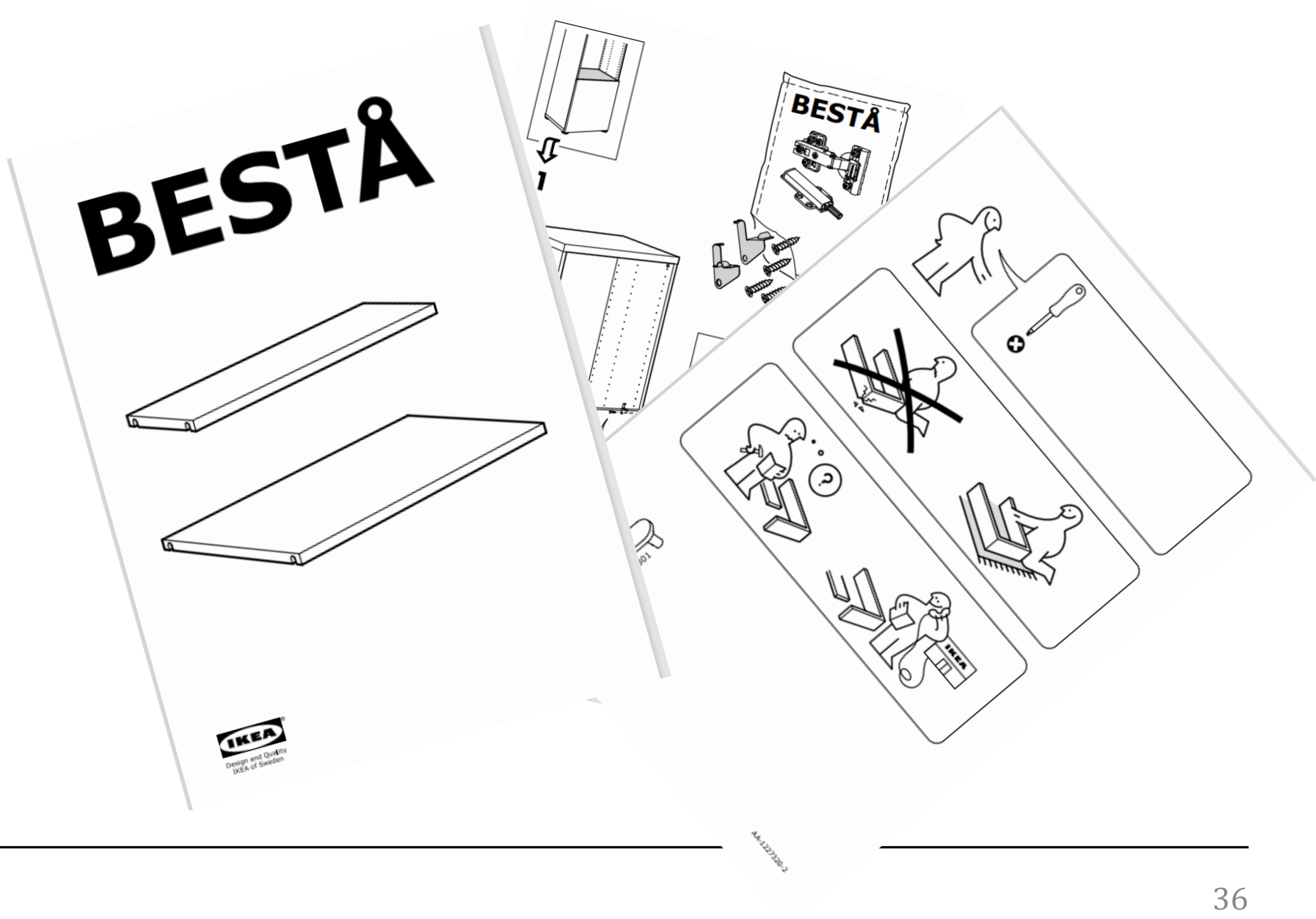
Where to look for inspiration?

Benchmarking against other industries:

- Processes
- Organisation
- Interim product design

Newcastle University

What can we learn from the example of one of the most significant disruptors in recent years:

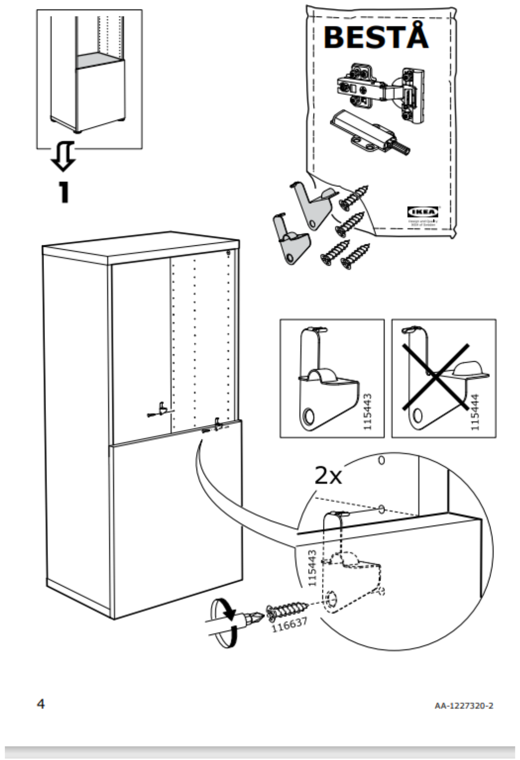


What is it that makes the Ikea model so successful?

1. The work package is always complete – nothing missing.

2. Accuracy of parts – they always fit together without re-work.

3. The parts are self-jigging and self-aligning.



4. No skill is required to interpret the drawings.

5. No skill is required to complete the work package.

6. Clever design of fastenings.

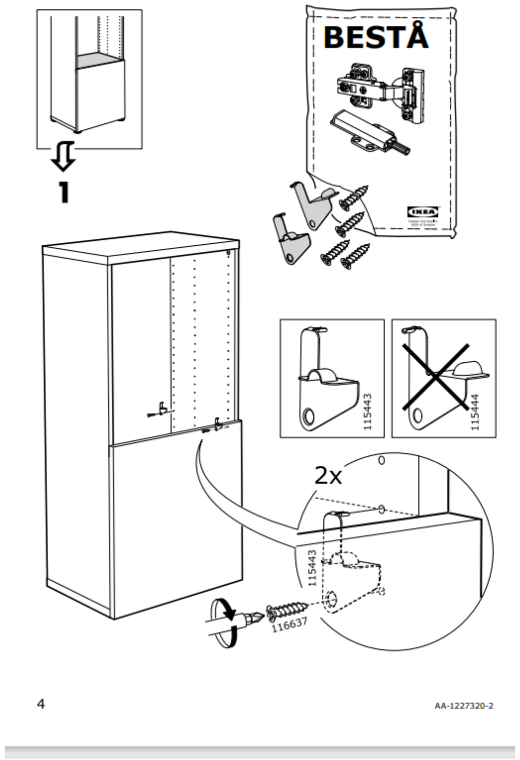
Can these principles be applied in shipbuilding?

What is it that makes the Ikea model so successful?

1. The work package is always complete – nothing missing.

2. Accuracy of parts – they always fit together without re-work.

3. The parts are self-jigging and self-aligning.



4. No skill is required to interpret the drawings.

5. No skill is required to complete the work package.

6. Clever design of fastenings.

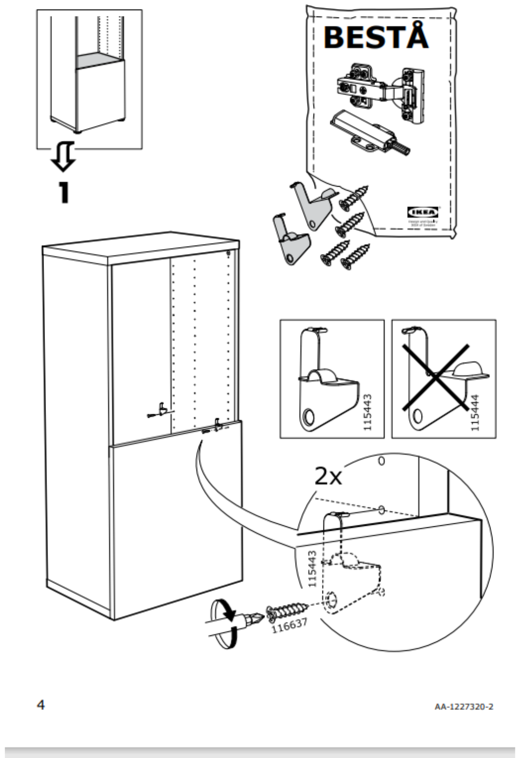
These two are readily achievable.

What is it that makes the Ikea model so successful?

1. The work package is always complete – nothing missing.

2. Accuracy of parts – they always fit together without re-work.

3. The parts are self-jigging and self-aligning.



4. No skill is required to interpret the drawings.

5. No skill is required to complete the work package.

6. Clever design of fastenings.

These 4 are more difficult and will require investment

1: Work packaging

Aim: precisely ½ shift of information, parts, fastenings and consumables delivered to the workstation every 4 hours.

- This is achievable using the digital twin and simulation but…
- Proviso that the design is complete and sufficient pre-production time is available

Pre-production time is often scarce, and production often starts before the design is finalised.

- It is conceivable that AI might help to shorten detailed design.

But there are imperatives that generally force production to start too early.

What imperatives force production to start too early?

1. Standard contracts normally link payment to physical progress
2. The need to keep a core workforce busy in the face of a volatile workload

We need to find ways around these – using a re-designed contract and automation.

We also need better confidence from the finance industry for working capital – improved forecasting will be the key to achieving this.

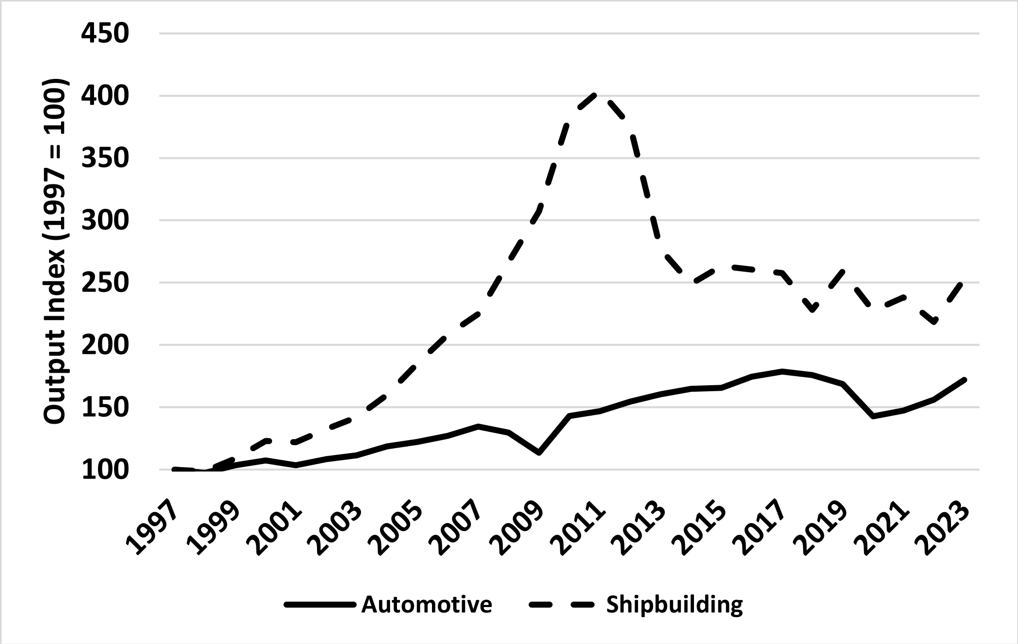
The evils of volatility

Volatility of demand is at the core of what makes everything difficult in shipbuilding.

1. Fluctuating workload leads to an unpredictable business risk.
2. Investment decisions are difficult.
3. Operational decisions are difficult.
4. Commercial finance is wary of the industry because of this.

Volatility of demand

The result is a difficult investment climate.



Shipbuilding demand is more volatile than any other industry sector outside agriculture.

Index of GT delivered for small ships and number of vehicles delivered for automotive (1997 = 100)

2: Accuracy of parts

- Two sources of inaccuracy:
  1. Shrinkage — Predominates above 8.5mm
  2. Distortion — Predominates below 8.5mm

1. Is relatively easy to fix
2. Is difficult and expensive to fix – but **can** be fixed

2: Accuracy of parts

Aim: perfect fit-up without distortion.

- A new approach to steel fabrication is needed to achieve this
- Stress relieve plates after blasting / cutting (and possibly re-roll)
- Automation of joining with minimum heat processes (ultimately adhesives in place of welding)
- Dimensional adjustment following panel fabrication
- Design for parts handling and automation

This will require investment, which in shipbuilding is difficult to achieve.

Pooled investment

Given the difficult investment environment, it may be difficult for all shipyards to separately make the investment needed.

This may require re-definition of what a shipbuilder is, separating fabrication from assembly.

This is not completely new - suppliers of kits of steel already cut have existed for a long time – but what is suggested is more than a kit supplier.

The assembler would no longer take in steel for fabrication but highly accurate fabrications for assembly.

3: Jigging and alignment

Aim: simple and accurate alignment for assembly.

- Automation of fit-up using manipulators
- Automation of assembly welding

This will require investment at the assembler (the shipyard)

Only possible with zero distortion and perfect accuracy (requiring investment in the fabricator)

5: Elimination of skill

Aim: maximum automation of the ship assembly process

- Elimination of steelwork inaccuracy
- Clever design of fastenings to eliminate the need for outfitting skill
- Automation
- Design for assembly

Use of AI in detailed design may help and simulation will definitely help – requiring sufficient pre-production time

Pre-requisites for the change

1. Change to contract to eliminate the link between physical progress and payment, to enable pre-production time to be maximised.
2. Investment in automation to reduce the imperative to start production too early.
3. Improvements to the shipyard investment climate.

Why is investment difficult in shipbuilding

1. The business is inherently high risk and low return.
2. Commercial finance is wary of the industry because of volatility, high capital dependency and poor forecasting.
3. We need a better forecast. The current widely-used market model (replacement demand plus fleet growth) is incorrect.
4. Better forecasting will reduce the risk in investment – volatile markets always return upwards – eventually. But when?

Recommendations

1. Research (with input/lead from outside the sector)

Processes & automation

Interim Product Design (use of AI)

Assembly design and automation

What to invest in

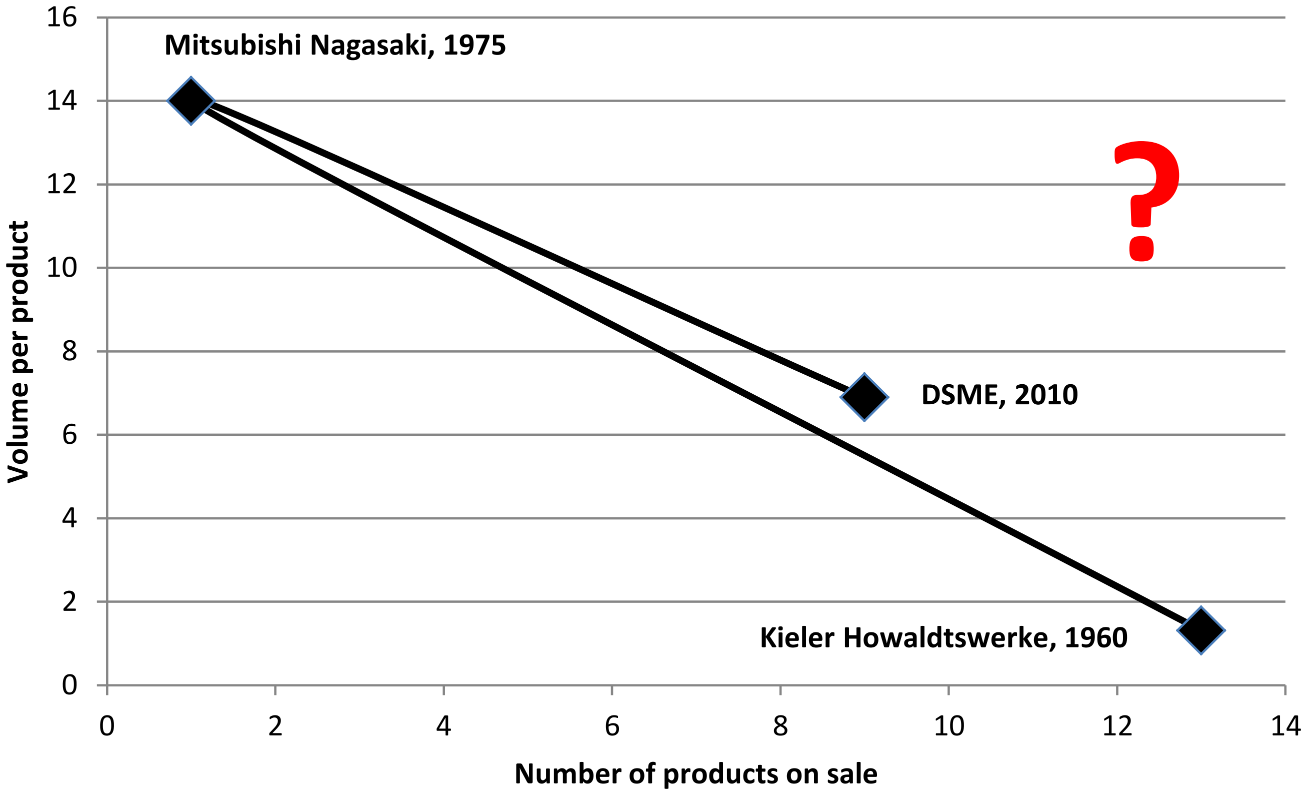
Industry Strategy

How to organise that investment to optimise the risk

Market forecasting:
- Yachts
- Workboats
- Small Ships
- Others

To improve the investment climate

Where does this go next?



Because what I am suggesting probably means the separation of steelwork from assembly, I am not sure what the answer to this is?

But, thinking about this will probably yield dividends and any suggestions gratefully received.