SIZING THE BOX

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Sizing the box

Adopting a platform-based approach to design for manufacture and assembly (P-DfMA), is hoped by many to transform the construction industry. The Infrastructure Projects Authority has signalled their commitment, mirrored by UKRI's investment in the 'Platform Design Programme' - a collaboration between the Construction Innovation Hub and leading industry players.

> **Methods of Construction as a key vehicle for change. Platform Design for Manufacture and Assembly (PDfMA) remains a route to deliver on our vision for the industry as described in our Transforming Infrastructure Performance publication.**
>
> **Will Varah, Infrastructure Projects Authority (IPA)**

Bryden Wood, leaders in new open systems architecture, have championed platform-based solutions, hoping that it will do for our industry "what the shipping container did for transportation".

Exactly 50 years on from publication of the ISO standard for the intermodal container, we reflect upon the history of how the shipping container was developed – learning lessons from others as the construction industry seeks to define a new standard of interoperability in catalysing a new market.

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Consistent themes

The shipping container is referenced as potentially the biggest enabler of globalisation. To understand its impact, it is important to consider how a trade journey typically looked prior to its invention. In 1954, an unremarkable cargo ship, the S.S. Warrior carried merchandise from Brooklyn, New York to Bremerhaven, Germany. With a cargo of over 194,582 separate items in 1,156 different shipments from 151 cities, record keeping alone of all the consignments was a nightmare.

The real challenge however was physically loading and offloading. Whilst cranes and forklifts were available, the adoption of automated techniques was limited - the majority of activities remaining manual, via lift and shift. Researchers, from the Nation Research Council, studying the SS Warrior's trip concluded that it had taken ten days to load and unload, as much time as it had taken the ship to cross the Atlantic.

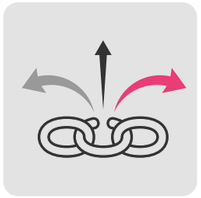
In the late 1950's, labour productivity on the dockside had been flat for almost two decades. Innovation was limited, investment lacking. Shipping goods internationally was expensive, dangerous and immensely inefficient. Surely there was a better way. Indeed there was: placing the cargo into big standard boxes and moving the boxes.

SHIPPING INDUSTRY IN THE 1950s

Flat productivity for two decades

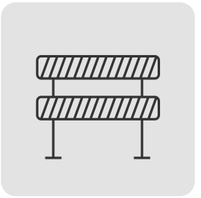
Limited automation and innovation

Fragmented approach with multiple standards



Multi-stakeholder industry

Social obstacles to modern methods



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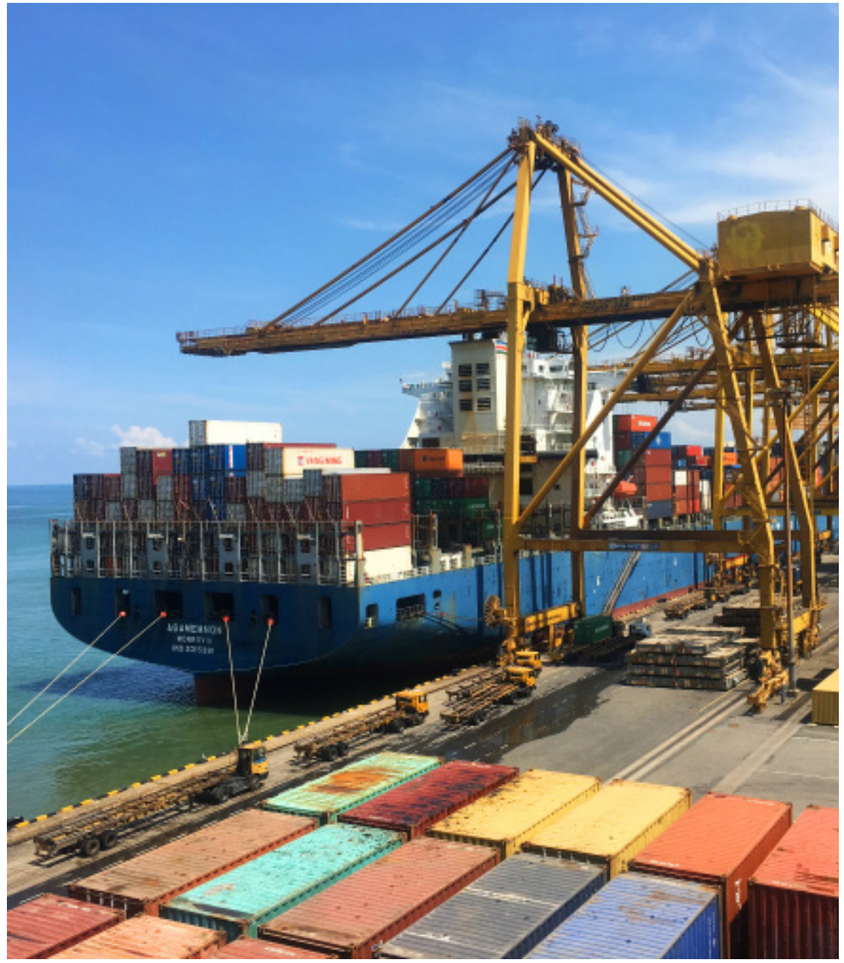


Social hurdles

In retrospect, inventing the box was easy, in fact, the modern method of a shipping container had been already tried in various forms for decades without catching on. Overcoming the social and behavioural obstacles was the key challenge:

- The ports and trucking companies couldn't agree on a standard size – the term container' meant very different things to different people - diversity threatened to nip the opportunity in the bud.
- The powerful dock-workers unions resisted the idea. Whilst the container made work safer, it equally represented a threat to jobs and therefore they refused to unload them.
- US regulators also preferred the status quo.
- There was no market imperative to change; bound by red tape and with separate sets of regulations determining how much shipping and trucking companies could charge, supplier costs were simply managed at a level the market could bear.

Navigating the maze of hazards – generally accepted as the inventor of the modern shipping container – was Malcolm McLean. Originally an American truck driver, McLean wasn't the first person to propose an approach of standardisation, however he had vision, an entrepreneurial style that combined political savvy and focus to relentlessly drive change.

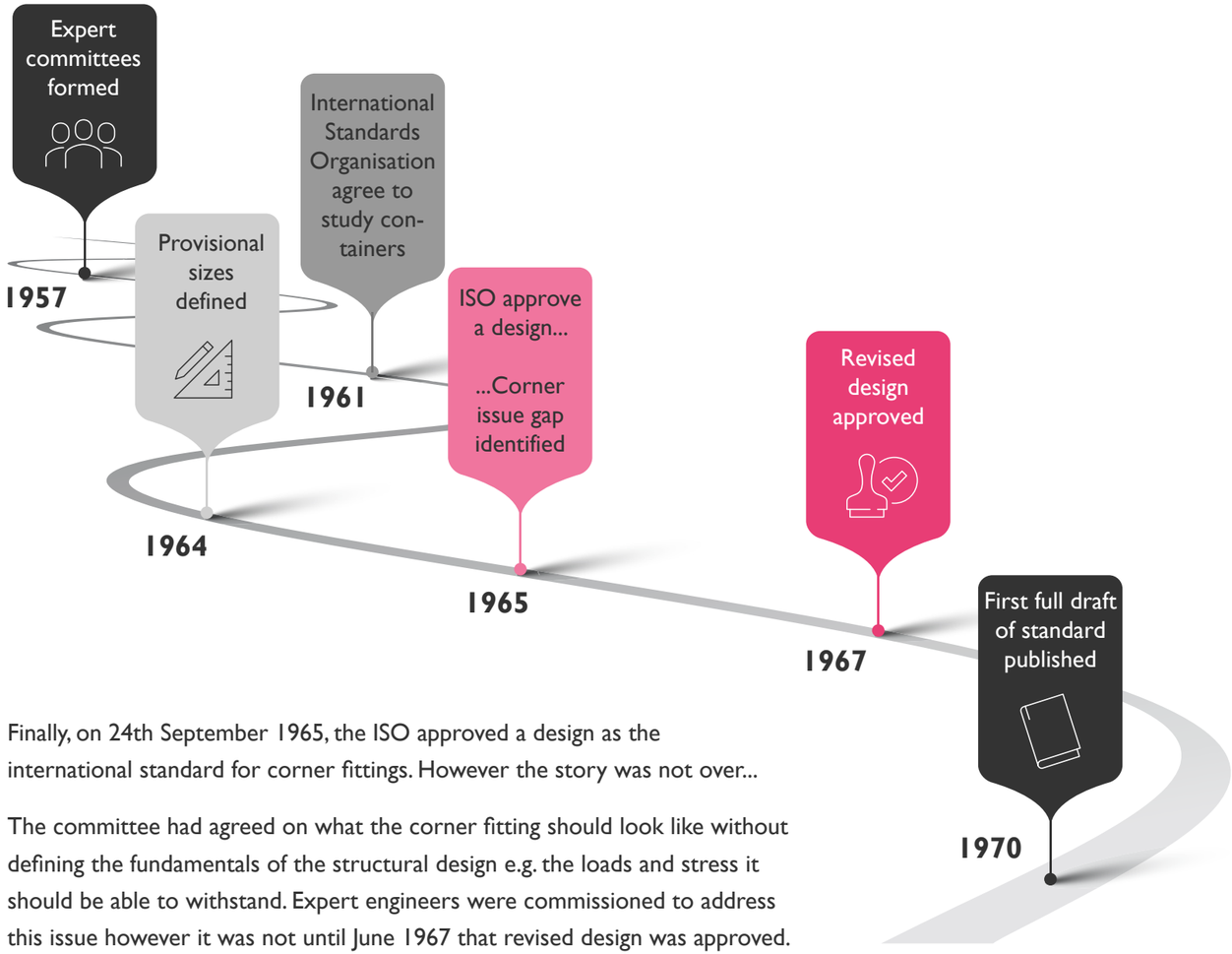
The principle of standardising standards wasn't entirely novel. The railway industry for example, has gone through a standardisation process – to standardise the gauge (the distance between the inside faces of a pair of rails) in creating railway interconnectivity. This example implied that the ship lines may have eventually make their systems compatible without a government dictate however the analogy was quickly found to be misleading. The gauge that become 'standard' on railways had no particular technical superiority nor economic implications. In the shipping world however individual companies had strong reason to prefer one system to another. Furthermore, the width of a rail track only influences rail; the design for containers had a much broader set of vested parties, affecting ship lines, rail, truck lines and shipper's equipment.

Standards war

Seeking to address these diverging market forces, two expert committees were formed by US government in 1958; one to recommend standards for container sizes and the other to study container construction. These organisations were not alone however – the American Standards Association, supported by private industry, also held itself responsible for setting standards. With another body, the National Defence Transportation Association, joining the fray a 'standards war' swiftly began.

In 1961 the International Standards Organisation (ISO) agreed to study containers, with intention to establish worldwide guidelines, prior to firms making large financial commitments. The wrangling over container sizes that had consumed three years in the United States was now repeated at an international level, with debate continuing for the same period again until, in 1964, a number of sizes were adopted as ISO standards.

Whilst one set of ISO sub committees and task forces were hashing out dimensions, other groups of experts were seeking common ground regarding strength requirements and lifting standards. Market forces again conspired with best intent - agreement on a single design for lifting and locking devices in corner fittings proved elusive with various manufacturers continuing to push their own products.



Finally, on 24th September 1965, the ISO approved a design as the international standard for corner fittings. However the story was not over...

The committee had agreed on what the corner fitting should look like without defining the fundamentals of the structural design e.g. the loads and stress it should be able to withstand. Expert engineers were commissioned to address this issue however it was not until June 1967 that revised design was approved.

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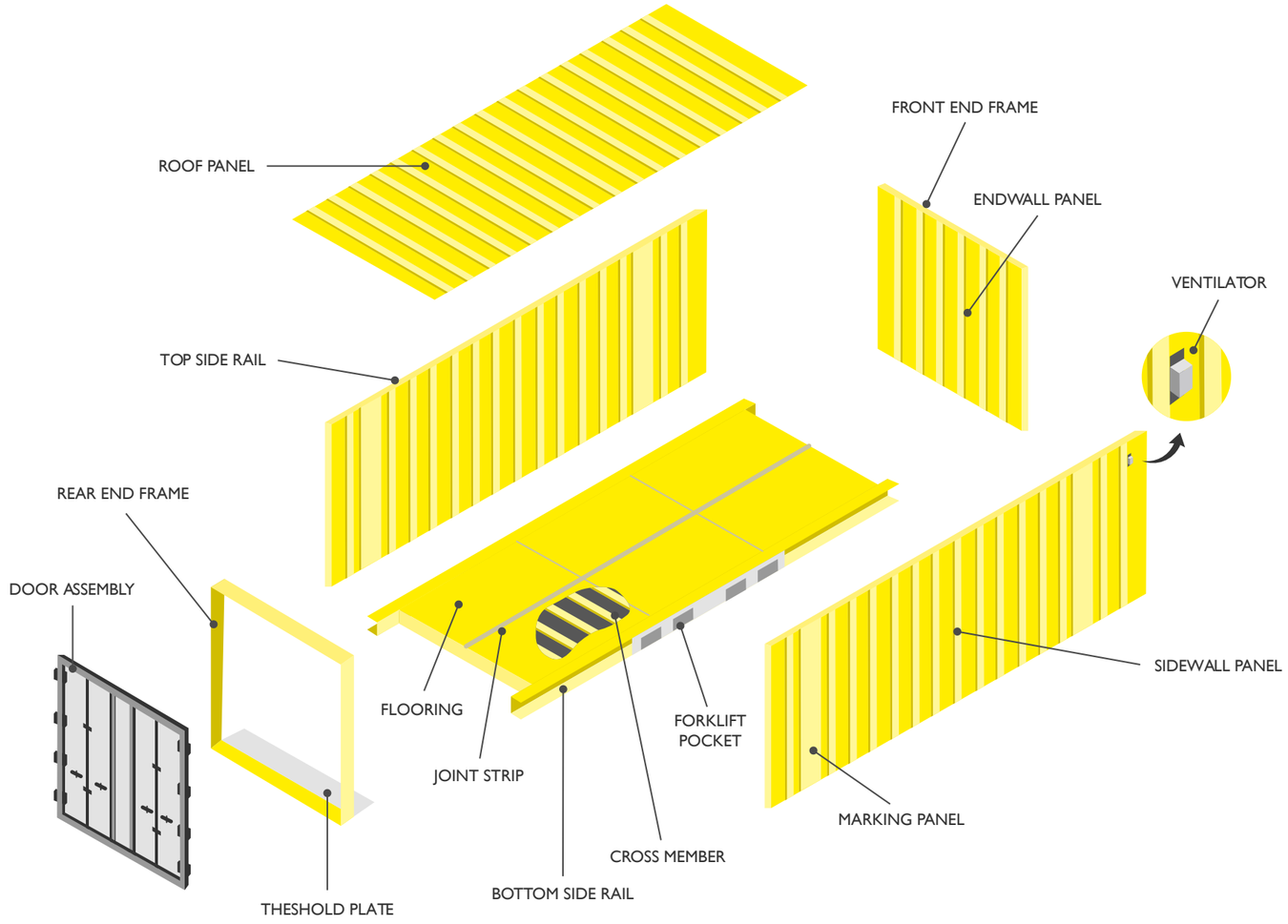
Still not quite done just yet…

Whilst the process of standardisation had evolved, the economic benefits were still not clear. Despite the US government's pressure to use 'standard' sizes, non-standard containers continued to dominate. Only 16% of containers in service complied with the standards for length – standard containers were far from taking the industry by storm. Large ones were perceived as too hard to fill – small ones required too much handling.

Key players in the market also threatened to unpick the solution. As the government sought to stimulate the market by subsidising the use of standard solutions, lobbyists working on behalf of the incumbent leaders (including Malcolm McLean) raised challenge in Congress. Concerned that the designed solution was inefficient to their needs, McLean argued:

> **I don't care what size is adopted as a standard. If the marketplace can find one that moves cheaper, that is the way the marketplace will dictate it and we want to be flexible enough to follow the marketplace.**

After protracted and vigorous debate a compromise was finally agreed – government was directed not to discriminate against companies using non-standard solutions, with concessions made around sizing. In 1970, twelve years after the initial committee formations, the International Standards Organisation prepared to publish the first full draft of painstakingly negotiated standards.



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Market impact

In 1965, nine years after launching the initial concept of containerisation, the impact was tepid. Container tonnage hit a plateau and the International Longshoremen's' Associated remained vociferously opposed to its growth. The way most manufacturers, wholesalers and retailed moved their goods had hardly changed. A market catalyst lay in waiting however…

A game-changing moment took place in the late 1960's when McLean sold the idea to possibly the worlds most powerful customer - the US military. Despite wrestling with the logistical nightmare of trying to ship equipment to Vietnam, McLean initially encountered predictable resistance. After constructing a port, at risk, he sold the principle of containerisation to offer the military an integrated logistical system. Initially hesitant to adopt container technology, the US army swiftly became its greatest advocate.

Opportunistic, McLean serviced the military's need and spotted the opportunity to divert empty container ships on their way back from Vietnam to collect payloads from the worlds fastest growing economy, Japan, accelerating trans-Pacific trading.

Containerisation had became a tool for reform; the circumstances of its adoption coincided with a burgeoning demand.

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What are the Implications for the Construction Industry?

The parallels between the shipping industry and status quo within construction are stark.

- The industry challenges: Flatlined productivity, low levels of investment and innovation.
- The social obstacles and behavioural issues: Fragmented industry, with multiple players driven by commercial independence.
- The tepid adoption of industry standardisation or modern methods.
- The paradox of competing 'best-practice' initiatives, with multiple different approaches to standardisation.

To create sustainable impact took:

- **Vision** – of systematic change. McLean didn't see just a shipping container but took a step back and saw a global system for moving cargo.
- **Concerted and continued effort,** to address social and cultural issues as much as technological solutions.
- **Continual drive** from both Government and industry.
- **Collaboration,** competitive persuasion and the occasional moment of coercion.
- Healthy dose of **circumstantial luck** (namely the timing of the Vietnam War).
- **Time** - it look almost 12 years for real traction.

The introduction of standardised containers provided a foundation for an efficient method of transport. McLean looked beyond the truck, ship or container – he saw a system and in establishing a framework he enabled the overall network to flourish.

> **The invention of the ISO shipping container changed the world economy. However, the benefits of this standardised box have been hugely amplified by the digital systems that match customers with carriers, optimise and track container placement on ships and in docks, drive automated cranes (and, in the near future, vessels), track shipments etc, and the physical transportation and storage networks that span the globe.**
>
> **Jaimie Johnston, Bryden Wood**

Platform systems... a new dawn

The Construction Innovation Hub is currently leading the Platform Design project, with a mission to "lead change across industry by developing, prototyping, testing and demonstrating platform solutions for social infrastructure, using common kits of parts from a diverse UK supply chain."

A digital, platform-based approach to designing and manufacturing buildings is expected support construction in assembling a product to a much higher and consistent quality.

Akerlof are proud to be part of this project, working in support of the Hub and in collaboration with other industry partners to develop platform solutions that apply principles of mass customisation.

We equally recognise that with a broad client base, dynamic market forces and multiple stakeholders the enormity of the challenge ahead. The Platform Design project is structured around a two year timeline, not 12 years.

The ambition of the Hub and industry partners to realise change is more than just admirable though; the shift from construction to production through standardising process is planned to unlock untapped value.

> **Innovation combines components in a new way.**
>
> **Joseph Schumpeter, 1939**

COVID-19 has exposed the vulnerabilities of the UK's construction delivery model. The government's programme to 'Build, Build Build' intertwined with the Construction Leadership Council's recovery plan offers a stated opportunity to reset and reinvent.

50 Years on from the standardisation of the shipping container, we are left to question whether the pandemic could provide a serendipitous moment for innovation to flouish.

As Bill Gates said:

> **We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction.**

Adapted from "The Box – How the Shipping Container Made the World Smaller and the World Economy Bigger" by Marc Levinson

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