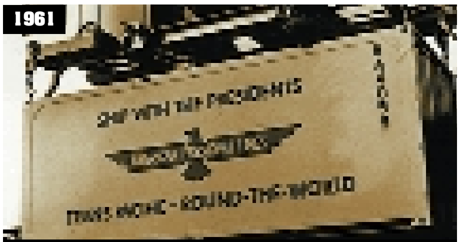
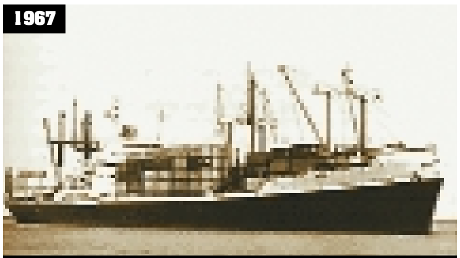
April 1956: containers being loaded on to the Ideal X, Sea-Land's first container ship



An APL container from 1961



The APL Harrison in 1967

Source: www.btinternet.com/~philipbparker

1969, United States Lines Container Ship "American Lark" Working at Liverpool's Gladstone Graving Dock

50 years in the making

To mark its 20th Anniversary year, **Container Management** asked two senior container engineers to review the history of container manufacturing. In the first of two articles, **David Tingle** and **John Holmes-Walker** consider how box-building became a global industry – and then centred on China

JOINING THE INDUSTRY IN THE LATE 1960S, early 1970s, the authors have accumulated 65 man years of indirect and direct manufacturing experience world wide. During this period, many changes have taken place involving container design, materials used, production methods, global centres of production and production volume per factory.

This article concerns box design and production and box derivatives. It does not embrace specials such as flat racks, reefers or tank containers.

How it started

According to common belief, the container was invented in the USA in the mid-to-late 1950s – in April 1956, Malcolm McLean converted an old tanker, the Ideal X, and strengthened her decks to handle 58 containers. She left Port Newark and headed down the East Coast of the US, and around Florida to Houston. At about the same time, on the West Coast, Matson Line was shipping goods to Hawaii in boxes of their own design with strange dimensions (such as lengths of 27ft).

Mclean, who established Sea-Land, invented the forerunner of today's corner casting. He patented his ideas but later, generously, gave his patents to the world. Clearly, the advent of the corner casting was the key to a whole new industry because of the common methods of transportation and handling which followed. Sea-Land's containers were also of strange dimensions, mainly 35ft in length; both these and the Matson dimensions were developed to suit the maximum lengths allowed under road regulations at that time.

However, some people argue that the principle of container transportation was not invented in the USA but by a small Irish shipping line in the 1930s which was involved in the Irish sea trade to UK and vice-versa. This line saw no sense in shipping lorries or tractors with trailers as well as their vans and so positioned the vehicles in both countries and just shipped the vans. Also, prior to World War 2, railway companies throughout the UK developed a system based on a large wooden box with steel reinforcings and lifting points and handled by a simple 5 ton jib crane erected at virtually all UK railway sidings. The boxes were transferred from rail wagons to small articulated vehicles consisting of a three-wheel tractor and trailer for local delivery.

In any case, by the mid 60s the container, very much as we know it today, had truly arrived on the world scene.

Box production

Container manufacturing started in earnest in the USA; but for economic and logistic reasons soon transferred - mainly to Europe, later to Asia and more recently, to China in particular.

Early container designs often incorporated a large variety of bought-out sections; sheet materials, including aluminium, GRP and steel were, for a time, all popular with various buyers. For reasons to be described later, steel construction now dominates the industry but with container manufacturing being viewed by many as a golden opportunity to make good profits, dozens of companies joined the industry. However, in the rush to achieve a competitive advantage, many costly mistakes were made (see Box Story: "Learning from Experience").

Just as there was a wide range of design and materials employed, production methods were quite diverse in the 1960s and 70s. But the box has always been designed - and generally constructed - as a unit made from six major sub-assemblies consisting of: base, one door end-frame and one closed-end frame; two side walls; and a roof.

One of the main areas where production diversity was evident relates to the treatment process of steel. Today, abrasive blasting is universal, but in the early years many manufacturers were persuaded that chemical processes - as used in the automobile and white furniture industries - were suitable for container treatment. They failed to recognise that a container would suffer impacts and abrasions in service that would not immediately, or indeed, ever be repaired and serious corrosion was common.

Overall, now that the industry is in its 5th decade, it has failed to use automated techniques as much as could have been expected. Perhaps the main reason for this is that there was no single factory in Europe which had a customer demand, or capacity, exceeding 20,000 TEU/year; production cycle times of, say, 20 to 30 minutes per TEU were considered satisfactory. Today's factories - and even those in Japan in the 1970s - achieved more than 100,000TEU per factory with cycle times as low as 6 minutes per TEU.

Manufacturing locations

In the early 1960s in the USA, companies such as Fruehauf, Trailmobile and others had established container production lines based on similar construction methods to the already common aluminium trailer van. Such "vans" were constructed of steel frames (for containers) and flat aluminium panels reinforced by extruded aluminium sections attached with rivets and blind fasteners.

In parallel, the Strick company, also in the USA, had other ideas and developed an all-steel container which was potentially cheaper to produce than the aluminium type and had greater strength possibilities. Strick set about licensing its design in other countries, but particularly in Europe and Japan, and the popularity of the steel container started to expand quite rapidly. Some manufacturers of containers who did not obtain a Strick license designed and developed their own models. A number of law suits followed although many manufacturers were successful, at least for the time being, in marketing their own product.

The ever-increasing popularity of the steel container was due to cost and the fact that repairers of damaged aluminium containers worldwide had to maintain stocks of the special extrusions and panel repairs which were often an unsightly riveted patch. Welding of aluminium was not viable. Also, bear in mind at this point that the handling of containers - even in the late 1970s - was nothing like the controlled sophistication seen today in ports, railheads and depots and in-service damage was a major and costly problem. Steel containers withstood the damage generally better than the aluminium models and the ease with which they could be repaired without the need for large stocks of special spare parts brought about the death knell of the aluminium box as a viable alternative to steel in the longer term. Even the pioneer Sea-Land, which had been a strong advocate of the aluminium box for several decades, started to change to all steel construction.

A Matson 27ft aluminium container built in 1970 - a good example of flat aluminium sidewall with riveted aluminium extrusion reinforcings and steel frame construction.

'In the USA, container production was based on similar construction methods to the aluminium trailer van'

European boom

From about 1968 to around 1973 (it is difficult to be precise), the steel container business in Europe was booming but there were still some significant manufacturers of aluminium models and a few GRP plants. However, Japan had seen the manufacturing opportunities with containers and was planning factories on a much larger scale than Europe, where, as stated earlier, 20,000TEU/year was considered to be big but most were less than 10,000TEU/year.

In the UK, there was Adamsons, Cravens, York, Fruehauf, YMCL etc. In Ireland: Ulcon and McArdle; in France: SIC Trailor, SNAV, Luchaire and Fruehauf; in Germany: IWT and Mannesman; in Italy: Morteo Soprefin, CMB and Cobra; in Spain: Inta Eimar and CAF; in Belgium: Brugeoise et Nivelles; and in Hungary; HSCF.

Of these, only IWT and SIC Trailor reached the 20,000TEU/year production volume and very few of the above companies even exist today as suppliers of containers. So, the industry was on the move again - and to Japan in particular, where demand was high due to Japan's export volume of consumer goods and the efficient high capacity of their new factories leading to competitive pricing as well as attractive financing. Nevertheless, the industry did not entirely collapse in Europe since many factories had become established suppliers of special containers not suitable for high volume production on the box assembly lines elsewhere. This trend has continued to date and in some cases we have seen factories expand to accommodate the new demand for swap bodies but that is another story.

Not all box production had transferred to Japan in the mid-70s because during that period Henred Fruehauf, later to become Trencor in South Africa became a popular source of steel containers. Also, various countries in South America tried to establish container plants but they all failed for various reasons. There were other pockets of container production as well, notably Russia and Sweden - but while the latter did not stay the course Russia has continued.

Move to Asia

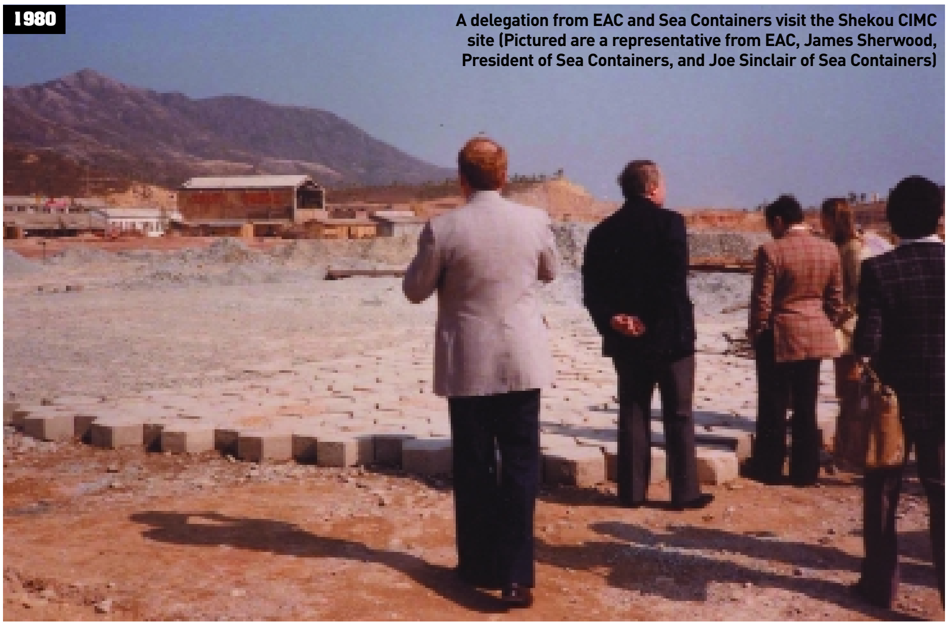
From about 1973 onwards, Japan had established several new suppliers of containers, notably Tokyu Car with 100,000TEU/year plants in both Yokohama and Osaka.

Other companies in Japan including Nippon Strick (Fuji Heavy Industries), Nippon Fruehauf, Nippon Trailmobile, Alna Koki and Kanto Auto came on stream with steel container production but all with very much less capacity than Tokyu Car. Tokyu pushed the boundaries of product design and volume production harder than had ever been seen in the industry previously. And while they do not exist as a container supplier any more, they should be recognised as having pioneered many of today's principles of volume production as well as some very valuable design features which have become an industry standard.

Japan's success was relatively short lived because, well before 1980, other Asian countries with lower production costs had seen the commercial opportunities thought to be possible with container manufacture. In addition, they also had high volumes of consumer goods for export. The main suppliers that sprang up in the region were: Jindo, Hyundai and Hung Myung in South Korea; AIC, Neptune, Evergreen and Union in Taiwan; ICL in almost central Hong Kong! and later, medium volume factories were established in Thailand, Indonesia and Singapore. In addition, India started to enter the container manufacturing business through Nathani in 1974 and later factories were built by HIM, Balmer Lawrie (2 plants), Trans Freight, Sea Lord, Bajaj, Hyundai and Bridge & Roof. Few, if any of these plants have survived - and the reasons are not entirely clear: competition from China has been claimed by some, and pricing and logistics by others.

In the late 70s and early 80s South Korea and Taiwan had become the major two countries supplying most of the world's demand for all steel containers, since Japan's production costs were no longer competitive. ▶

1980: The Shekou site of CIMC's first container factory



A delegation from EAC and Sea Containers visit the Shekou CIMC site (Pictured are a representative from EAC, James Sherwood, President of Sea Containers, and Joe Sinclair of Sea Containers)

The South Korean companies in particular were very aggressive with their sales and marketing. Some accused them of taking major orders at prices thought to be below cost - but China was on the horizon now and by the end of the 1980 decade, many of the Korean companies were out of business or had transferred their container production interests to China where labour and energy costs were considerably cheaper.

China entry

In 1979, the major leasing company CTI - now defunct - had surprised the industry by announcing a large container order they had placed in China with Canton Shipyard who were not known as a container manufacturer. The technology came from USA.

In the same year, Sea Containers joined with EAC of Denmark to form a joint venture with China Merchants of Hong Kong (which was a division of COSCO), to establish a very modest 5,000 TEU/year capacity factory. This factory was to be built at Shekou on the Yellow river estuary South of Canton (Guangzhou) and started production in 1980/81. This apparently minor event has been explained in some detail, because the Shekou factory became the very first CIMC plant and - as most readers will know - CIMC has become the largest manufacturer of containers in the world through the build of new plants and acquisitions.

The CTI and Sea Containers' activity in Southern China had encouraged others to become part of the industry and two more factories were soon established in the Canton region. They were not successful. However, in the meantime, Tectrans of Germany and UK were invited, together with leasing company Contrans of Germany, to create a new factory with Shanghai Shipyard on the basis of compensation trade (foreign companies supply the technology, equipment and materials and place firm orders for the product, the home company provides the labour and energy etc – a system rarely used today). The factory was completed in 1982 to produce steel frame/GRP panel containers but the demise of this type of product soon became evident when the Shanghai factory was modified to produce an all-steel container.

Building the quay wall at CIMC's first container factory in Shekou

Following the events around Canton, there was a steady expansion of the industry in China with almost every Eastern seaboard province wanting to have its own container factory(s) - and the central government did little to rationalise the industry. It became very much a "free-for-all" despite representations by foreign investors. However, CIMC was expanding rapidly over the Eastern side of this vast country and Singamas established themselves very firmly in Shanghai with real volume production.

The production at Singamas was very unusual in that the press shop activity and assembly of some major sub-assemblies were carried out at factories remote from the main assembly lines causing an interesting transportation problem; but the system seemed to work and large orders were won. Tectrans received invitations to form joint ventures in both Tianjin and Qingdao and these plants both came on stream in 1992 but typically, like many other independent container factories, were later absorbed by CIMC. Singamas have remained independent and expanded their activities with new factories and with CIMC are now known as the "duopoly".

Certainly, the world has never previously seen such rapid economic expansion as has taken place in China over the past quarter of a century on such a vast scale and the container industry is just one small part of the overall industrial activity and development. Without doubt, China could, given the opportunity produce the whole of the world's container requirements including steadily taking over most of the special container manufacturing industry in the future.

Before container production was established in China, a few other countries had set up new plants but they failed eventually to attract orders because there was little cargo available for the delivery voyage. This is, of course, quite the opposite in China where the creation of a huge container industry has been in parallel with the development of many other industries producing consumer goods for

Learning from experience

There were many mistakes in the early years of containerisation but it is clear that the industry steadily learnt from bad experiences, particularly the feedback from the operational experiences of container owners.

Here are some as recalled by the authors:

- Large, flat, steel data plates for the owner's name logo and data - attached to painted steel containers with aluminium rivets. Result: rivets corroded due to electrolytic action and plates fell off in less than one year in the field in some cases.
- Owners/buyers of containers insisting on larger and larger flat side wall areas for owner's name, logo, and data display. Result: created high stress areas, difficulty in passing side-wall test and sometimes side-wall creasing leading to failure.
- GRP panel containers manufactured with aluminium frames, including corner posts with aluminium castings. Result: catastrophic casting failure since aluminium has poor resistance to impact loads and inadequate stacking strength. Several hundred units withdrawn from service and sold as static storage units.
- Containers fabricated from untreated hot rolled steel, advised by a major chemical company to prepare for painting using a manually applied phosphoric acid treatment. Result: heavy premature corrosion and a large warranty claim by the buyer.
- Arc welding as opposed to MIG or TIG used for joining all steel components including panels thus impossible to prepare such welds satisfactorily for painting. Result: serious premature corrosion.
- Several hundred containers manufactured with door gear attached by undersize blind fasteners before end wall test performed. Result: failed end wall test and all container door assemblies had to be rebuilt.
- Very extensive use made of very cheap bitumastic underseal for underfloor treatment over inadequate steel preparation and priming affecting tens of thousands of containers. Result: premature corrosion and very expensive rebuilds of container base frames.
- Interior sealants applied which continued to give off solvent vapour over a long period. Result: cargo contaminated (cigarettes) and containers rejected for further use until modified.
- Lightweight "mini" door gear specified for container side doors to gain maximum cubic capacity. Result: doors difficult to close – and, in one case, a partially closed door broke loose when a goods train met a passenger train and one passenger was killed. Containers withdrawn from service.
- Several thousand aluminium/steel frame containers constructed without non-metallic bushes in the door hinges. Result: impossible to open frozen doors manually. Also, expensive field modifications.
- Open top containers produced by several different suppliers suffered serious fatigue failure of the top-side and end-rail structure on one UK-Australia voyage. Result; complete design re-think and modifications made to the containers in repair depots. (Note: ISO does not call for fatigue testing, yet it is a mode of failure that can and does occur from time to time)
- In two high volume factories, assembly operators found it quicker and easier to position and hold down the corrugated roof panel prior to periphery welding externally by tack welding the panel to top side rails internally. Such welds were not part of the design or production schedule. Result; In service stresses caused the tack welds to fail and roofs to leak leading to expensive repairs and warranty claims.
- A factory installed a dimensions board where the inspection department was required to record the external dimensions of every container manufactured. Some dimensions stated were found by visiting customer inspectors to be outside the ISO requirements. Result: extensive re-working of a batch of containers before they could be delivered.
- A paint thickness-measuring instrument being used to measure the abrasive blasted profile! Result: profiles were incorrect and the paint thickness had to be significantly increased to ensure proper paint coverage of the abrasive blasted peaks.
- A factory changed its paint supplier, but was left with primer from one source and top coat from another so they applied the material as if it came from one supplier. Result: customer and factory were offered a paint warranty for primer only from one supplier and another paint warranty for top coat only from the other supplier. Luckily, there were no paint warranty claims on this batch of containers.
- A batch of 40ft steel containers appeared to comply with all ISO dimensions when inspected at the factory before delivery but when viewed end to end the side wall on one side only was substantially outside the ISO profile. The problem was found to be distortion caused by the complete welding of all underfloor cross members in a rotating jig on one side only before welding the opposite side. Result: many containers rejected.

export. In addition to this, similar to South Korea before, China has also established the production of many container ancillaries, such as door gear and corner castings plus raw materials and with an abundant availability of low cost but efficient labour, it is hard to imagine the industry leaving or diminishing in China for the foreseeable future.

It is the view of one of the authors of this article that in retrospect, the lack of central government intervention in the 1980s to control the expansion of the container industry in China may have been a long term plan. The result of this has been that many foreign companies provided modern technology and machinery through which the learning curves were much less steep and now they own this technology, and continue to develop it such they are on a par with those that supplied the technology and machinery in the first instance. Even if this was not planned, it has certainly worked out as described. Just one example. Tectrans supplied machinery with advanced inverter AC drive motors in 1991. In the next year we attended a machinery exhibition in Beijing. Inverter drives of local manufacture were on display and we had been convinced by our partners that inverters were not known in China!

Volume in Denmark

Before concluding this section, one outstanding container factory development, which was not in Asia or China, has to be mentioned.

The production of box containers had well and truly left Europe but in the mid-1990s Maersk of Denmark decided to manufacture their own containers in their homeland. They embarked upon a plan to fully automate the production as much as - and wherever – possible; and to this end, they totally surrendered their demanding specifications given to outside suppliers in order for the design to facilitate automation while maintaining structural integrity.

Labour costs in Denmark were high, even by average European standards but through advanced automation, they had calculated that they could compete with Asian production. A very interesting plan but some saw the very much reduced man hours/TEU labour content as a way of using labour which had been unemployed and on social security. Very few people in the container industry ever visited the Tinglev plant and your authors were also disappointed. Nevertheless, the plant was successful for a few years and some of the process was leaked to the container world in general. Unfortunately, this brave endeavour did not succeed in the longer term.

Automation in China?

As stated, a duopoly of successful manufacturing now exists in China and the rest of the world's dry freight production is so low as to be of little consequence in terms of competition. In addition to this, China is steadily taking over much of the industry's special container manufacturing and the country's other industries generally provide the vital exports for containers to be delivered with cargo as opposed to costly dead heading. China has also developed a significant container ancillaries manufacturing industry.

Nevertheless, some of the existing Chinese factories are now quite old and it is quite possible to project that some new plants could be created and if and when that happens, we should expect to see more automation. Those who may become involved in new facilities could well benefit by involving Maersk in order to learn from the leaders of container automation up to the present time.

Previous countries to China such as Japan, South Korea and Taiwan that developed major volume producing factories, all succumbed to a lack of competitiveness through labour, energy and raw material costs. China may not be so affected in the years to come because firstly, it is reported that some 800 million Chinese are currently involved, mainly in agriculture, in the areas generally west of the now industrial Eastern coastal and river regions.

As both authors are well aware, labour rates in China have increased very significantly over the past 15 years or more and do continue upwards but it is very doubtful that they will increase sufficiently to make other countries again competitive in container manufacturing in the next two decades at least. Secondly, China is making great strides to provide sufficient energy for its needs, witness the major but controversial hydro electric schemes; and thirdly, it also has very large coal reserves and it is producing oil from the Yellow Sea.

Our conclusion on China is that it going to be very hard to beat for a very long time to come.

Future predictions

Generally, no region - other than China or group of countries such as Europe – has succeeded in maintaining a strong foothold in the container industry for much more than a decade and a half. At times we thought that some countries were in for the long haul, but China's rapid development and growth was not foreseen to the extent we know now.

India always comes to mind as the world's second – just - most populous nation and they have already proven that they could, given the support of buyers, produce containers competitively. They have much lower and relatively stable labour costs compared to China and this labour can also be efficient when given the opportunity and training. English is widely spoken and this is an advantage. Unfortunately, they do not have all the raw material resources and were penalised in the past by material transport costs, particularly for steel, from South Korea and Japan.

But, there is the other factor of regular exports available and that is not the case in India which seems to have embarked more on a policy of exporting services rather than consumer goods. Even when India has tried hard to break this mould, as Tata has done recently to design and build a low cost city car for Rover, suitable for the European market, it appears to have already failed due to the non acceptance of potential buyers. We must hope that this is not a precedent, but India will need a greater domestic supply of the necessary raw material ingredients of a steel container and a reliable supply of consumer goods for export if a container industry is to be resurrected.

We cannot see the container manufacturing industry returning to Europe or USA - simply on the grounds of a lack of competitiveness with Asia and China in particular.

Sometime in the future, the potential of South America might be explored once again now that Brazil, for example, has established a strong position in the automobile components export market, but this is not enough to challenge China's dominance.

From there, our crystal ball takes us virtually nowhere else for significant change for many years to come, but there may be others much wiser than us in world economics and finance who have other and interesting forecasts or predictions. CM

ABOUT THE AUTHORS

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From 1968-1980, he was responsible for Sea Container's engineering and technology of containers, special containers, chassis and cranes.During this period started the founding of YMCL and became a director and part of the Sea Containers' management team to create: China International Marine Containers (CIMC), Chicago Marine Containers and Singapore Marine Containers - thus the gravitation to container manufacturing.

From 1980 – 2002, he worked for Tectrans Services Ltd and Tectrans Gmbh - as Managing Director & Engineering Director respectively. He designed the factories and project-managed the creation of HIM Containers in India, TIMCO & QUIC in China and Balmer Lawrie in Madras, India. He also acted as manufacturing consultant to: Xtra, Adamson, Trencor and SeaCold.

John Holmes-Walker - After spending 20 years in the Aircraft industry, focusing on propulsion systems research and development, John Holmes-Walker joined the engineering department of Sea Containers in 1973. He stayed there until 1992, rising to the position of General Manager – Engineering Management Department. During his time at Sea Containers, his responsibilities included Purchasing and M & R for all container and container related equipment produced or purchased by the company. He also established the company-owned factory to build refrigeration equipment designed by the Engineering Department. For his last six years at Sea Containers, he was responsible all new container projects, and had technical responsibility for the establishment of new company owned factories. Since 1993, he has run his own consultancy company, Seagull Technology, providing engineering and management services to the container and related industries worldwide.