

# Modern Container Architecture

Edited by Aidan Hart

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# Creating a New Architectural Future—One Container at a Time

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Shipping containers are the quintessential symbol of commerce and product distribution around the world. They represent global mobility and our capacity to move anything from anywhere. It is ironic, then, that they are increasingly being used for architectural installations, forming more static temporary and permanent structures.

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## The Advent of Containerization

Containerization changed the way the world traded with itself. Before the advent of standardized boxes to transport goods, individual cargo items were manually loaded at the point of production to be transported to ports and other trade destinations. At the other end, the consignment was again manually handled off the ships or wagons into the receiver's hands. This time-consuming, labor-intensive process was exacerbated by transport delays: ships and other carriers would make multiple stops to offload or pick-up goods along the way.

This process, called break bulk cargo, began to change in the late 18th century. In 1766, James Brindley, an English engineer, designed a box boat for transporting coal. The boat, called *Starvationer*, carried 10 wooden containers. This was the first recorded use of containerization as a means to ferry goods from one point to another. Later, in 1795, Benjamin Outram, another English engineer, developed the Little Eaton Gangway, which enabled coal-filled containers to be transferred from horse-drawn wagons and canal barges.

Originally constructed from wood, distributors began to use iron containers during the 1840s. Closed container boxes became more prevalent during the early 1900s, a departure from the original open-top design. Containerization made it far easier to shift a load of cargo from a ship to a train to a vehicle as it moved from one port to another.

## A Simple Idea that Changed the World

The next step in container evolution came in 1955. By then, manufacturers and distributors across the world had begun to see and take advantage of the benefits of containerization to move goods. But it was one simple idea that brought about a step

change in the process. Malcolm P. McLean, a trucking entrepreneur from North Carolina in the United States of America, formulated an idea that would make cargo distribution even more efficient. McLean's idea was to transport fully-loaded truck trailers on steamships. At the end of the journey the trucks would be offloaded with cargo fully intact before travelling on to their final

destination. McLean's simple yet innovative idea minimized interruptions in the distribution cycle by eliminating the need to unload containers when transferring cargo between transport modes. Called intermodalism, the concept revolutionized global trade.

Since then, cargo ships have been criss-crossing the world's oceans, laden with containers destined for distant shores. The success of the idea escalated quickly. To illustrate the trajectory, in 1968, just 13 years after McLean devised the concept, the first container ships with a capacity of 1,000 TEU<sup>1</sup> were built. A year later, 25 were built with a capacity of 2,000 TEU.

Containerization made the world smaller, opening gateways between trading partners that had never existed before, and reinforcing historical trade routes. By 1972, container ships from the United States, Europe, and Asia alone transported goods with a combined capacity of four million TEU. Eleven years later, that capacity had grown to 12 million TEU.

These numbers have continued to grow exponentially over the years, as containerization has become the worldwide cargo transport standard. The *Economist* magazine has described the container as "more of a driver of globalization than all trade agreements in the past 50 years together"<sup>2</sup>.

## Single Use and the Circular Economy

Over time, the cost of the containers themselves has dropped significantly, which has influenced the way containers are used. Today, it is cheaper to use a container just once. Goods are transported from one port and emptied out at another. Once cleared of its cargo, the container is left unused, primarily for economic reasons. The costs of shipping an empty container back to the originating port are far higher than the costs of replacing it

with an entirely new one. For shipping operators, it is more cost-effective to scrap the units than to dismantle them.

The component parts cannot be used individually, and nor is it feasible to melt down the steel. To illustrate, melting down a 40-foot (12-meter) container would require around 8,000 kWh of energy, which equates to the amount of energy required to power the average home for a year. Instead, the containers are left to gather dust, unused, in ports around the world every year.

**Wahaca Southbank** / The restaurant provides a comfortable dining space for the visitors



While container stacks present challenges for city planners and property owners, the single-use practice presents a significant opportunity for the construction industry. The circular economy demands that products are designed for reuse after their original use has been discharged. This book celebrates the advent of container architecture, which offers single-use containers a new lease of life as buildings of every kind.

## Shipping Containers as Accommodation

While there are clear advantages of using containers for shipping cargo, it could be argued that they truly come into their own when used for accommodation purposes. Container architecture is an unintended, yet positive, consequence of an unsustainable practice in the shipping industry.

The concept of converting shipping containers into buildings was first formalized in 1989, when Phillip C. Clark was granted the patent for a “method for converting one or more steel shipping containers into a habitable building at a building site and the product thereof.”<sup>3</sup> Since then, greater creativity and bolder statements have been seen that perfectly encapsulate why containers are the ideal building blocks for almost any project anywhere in the world.

The concept of container architecture has tremendous appeal. The notion of using a structurally secured box that can be customized to suit the user’s needs presents the designer with a unique opportunity to be truly creative, innovative, and inventive. In the same way that a child’s Lego® blocks fit snugly together in countless variations, so too do containers.

Clients come to architects to find and deliver the best design solutions that meet their needs within the context of a site. The solutions depend on the client’s budget and vary from project to project and from site to site, with the site being arguably the most important starting point for the project’s ultimate outcome. The architect’s role is to deliver the best possible architectural product that respects the site’s context. They assess the possibilities and constraints that exist on a site, including topography, orientation, natural features, and so on. The site conditions will influence the end product, dictating the bulk, orientation, materials, and construction methods. But, in some cases, the site’s constraints can impose limitations on the architectural possibilities.

Container architecture allows architects to concentrate on the opportunities on the site, rather than the constraints.

The viewfinder principle focuses on bringing the building to the view, rather than compromising on the site to accommodate the architecture, and taking this approach allows the building's design to celebrate the context and the environment. The potential of modular prefabrication as a construction technique creates immense possibilities for repurposing shipping containers, enabling architects to implement the principle of celebrating the site with flexible, creative architectural ideas, while also taking full advantage of the versatility offered by reusing shipping containers.

## Why Build with Containers?

### Durability, Strength, and Ease of Use

Containers have three primary qualities that make them the ideal choice for contemporary residential, and commercial projects: durability, strength, and ease of use. Built specifically to carry heavy loads and to protect them from damage while in transit, containers are strong and robust. Made from 14-gauge steel, they are built to withstand the forces of pressure when stacked on top of one another. They are also solid in the face of high winds and other extreme environmental conditions, and especially so when they are securely anchored. In addition, their standard shapes and mobility allow designers to create versatile configurations.

Shipping containers are designed for purpose: they are structurally robust and also sufficiently waterproof to prevent water ingress during their passage over the world's oceans. These inherent qualities make container shells entirely appropriate for construction. Waterproofing and structural stability are important factors in creating habitable structures, whether commercial or residential.

Additionally, designed for portability, containers can be easily transported from place to place. Once they reach the site, they can be craned into position. Temporary installations can be removed from sites just as easily. This mobility offers designers much greater flexibility: there is value in impermanence. Further to this, because of their consistent shape, containers can be stacked in columns of multiple units. This allows the structures to be scaled up as the users' needs change.

Aside from the structural capabilities, the industrial aesthetics of containers, with their textured corrugated sides and roof, can bring a unique personality to a building. The structures can

also be clad in creative ways, removing any clue of their original purpose. Designers embrace this versatility as a blank canvas for their imagination.

### Save Time, Money, and Manpower

Traditionally, a building project requires time, money, and manpower even before the first pile is driven into the ground. Bricks-and-mortar construction can be expensive and time-consuming, with many variables in place that could cause a project to be delayed for extended periods or even stopped completely. Those delays or cancellations have a knock-on effect, not only on the contractor's bottom line, but they also have financial and labor implications for the electrical, engineering, sanitation, and other sub-contractors. Container architecture has disrupted that status quo.

The origins of container architecture have been borne out of the practical use of the structure. The size and mobility of containers dramatically speeds up the construction process, minimizes environmental damage, and offers designers and clients much greater control over the entire project.

Prefabrication is not synonymous only with container design. But the essence of container architecture and the reason it is becoming more prevalent as a construction tool is prefabrication. Prefabricated, modular containers can be fitted out in controlled environments, minimizing potential delays and maximizing project efficiencies. They can then be transported and maneuvered on to the site, reducing construction times and enhancing productivity on each project.

Containers can be stacked or laid out side by side in endless configurations to create inventive, innovative commercial projects for a fraction of the costs that a traditional building would require.

## Applications of Container Architecture

### Creativity in Commercial Design

As this book reveals, the versatility of container architecture can be demonstrated by the many ways containers have been used for diverse projects around the world. They have been widely used for plush office spaces, student accommodation, market kiosk outlets, school campuses, libraries, museums, and more. Other notable projects, not documented here, include Google's barge-based education centers;<sup>4</sup> Container City's accommodation and science

labs installed in sub-zero conditions in Antarctica for Sir Ranulph Fiennes' expedition: The Coldest Journey;<sup>5</sup> and Citiq's student accommodation made up of 375 containers stacked above 11-story unused grain silos in Johannesburg, South Africa.<sup>6</sup>

As understanding of containers as a building medium grows, even more ambitious projects will be realized. Consider CRG Architects' striking proposal for a 400-meter high skyscraper to provide affordable housing alternatives to slum conditions in Mumbai;<sup>7</sup> and OVA Studio's Tetris-like Hive-Inn™ City Farm that allows containers to be moved in and out of the structure,<sup>8</sup> which is a perfect example of plug-in architecture (referred to later in this introduction).

An excellent container-architecture project that further demonstrates this versatility is the illy Coffee Shop push-button shipping container installed at the Venice Biennale, created by artist and architect Adam Kalkin.<sup>9</sup> This small coffee shop folds outwards at the touch of a button and can be packed up and moved to another location when needed. It embodies the temporary nature of pop-up architecture and demonstrates the maximum use of a single container.

The drive-through Starbucks outlet in Tukwila, Washington State in the United States,<sup>10</sup> is another example of how containers can be used to produce the structure and enclosure for a retail outlet.

The New Jerusalem Children's Home project in Gauteng, South Africa,<sup>11</sup> created by 4d and A Architects, uses 28 containers in a playful, stacked formation to house 40 children in a dignified environment. This ambitious project shows the full design flexibility of containers as building blocks.

Sebastián Irarrázaval's Caterpillar House in Santiago, Chile,<sup>12</sup> constructed from five 40-foot (12-meter) and six 20-foot (6-meter) standard containers and one 40-foot (12-meter) open-topped container, undulates with the landscape's topography. It is a modern home that includes a swimming pool built into the open-top container, and a state-of-the-art passive cooling system. This project is an exemplar of how containers can be used to create beautiful living spaces, even in harsh terrain.

While there are many examples of outstanding container architecture around the world, these examples showcase a collective representation of the flexibility and versatility that can be gained from building with shipping containers. This book presents many other compelling and architecturally beautiful exemplars of this growing trend.

## Affordable Housing Alternatives

Designers and developers have used containers to create beautifully designed luxury homes around the world, but

**Room Mate Container Hotel** / The main body of the hotel is made of a container, which is colorful and full of creativity



**Trump Cadde** / The containers used in this building are special due to the graffiti art, which gives, the whole building a sense of creativity



containers also have a profound potential for bringing dignity to millions of people living in informal housing.

Urbanization is becoming a critical factor in the way that cities around the world are designed. More people are moving into urban areas to seek employment opportunities. Today, the global urban population is estimated to be 3.5 billion people. The World Bank estimates that this number will reach five billion by 2030, and six billion by 2045.<sup>13</sup> This places significant pressure on urban infrastructure. National governments will be faced with growing demands to provide sufficient housing that can accommodate their rapidly expanding urban populations.

One country that this issue is particularly acute in is South Africa. Increasing urbanization is placing additional strain on cities that are, in parallel, also seeking to address the structural inadequacies and geographical segregation created by historical apartheid urban planning.

In 1994, the country held its first democratic elections that succeeded in breaking the chokehold of the apartheid regime. In that year, the government reported that around 1.5 million homes were required to address the demand for housing. But, even then, this number was growing by around 178,000 units per year.<sup>14</sup> Today, a large proportion of the South African population still lives in informal housing in unsanitary and cramped conditions. The country's 2011 census counted 1.9 million shacks or informal dwellings across the country.

A 2014 report by Africa Check,<sup>15</sup> a non-partisan organization that promotes accuracy in public debate and the media (Twitter@AfricaCheck and www.africacheck.org) stated that, while the numbers have fluctuated in the years since 1994, around 140,000 houses are being added to the housing stock each year under the government's Reconstruction and Development Programme (RDP). While the RDP houses are intended to produce a low-cost housing solution, building a house from the ground up using bricks and mortar can be time-consuming and expensive. The strain on resources leads to a housing backlog.

This is where container architecture has an important role to play. With greater mobility, greater project control, prefabrication, and shorter construction periods, shipping containers present a significant opportunity to provide cost-effective housing for lower-income families.



**Nomad Living** / Container housing has been gradually accepted by the public, creating comfortable living spaces for people

Providing housing for all in South Africa's complex socio-economic landscape is a far-off vision—a far more detailed problem than can be presented in the introduction to a book. But, in principle, the concept of container housing presents an opportunity to think differently about the way houses are built. Reusing shipping containers and converting them into low-cost houses certainly presents an exciting opportunity to address inequality and meet basic human needs.

The Low Cost House in Jangheung, South Korea (on page 226) ( is a good example of how containers can be reused and adapted to provide affordable housing. Designed for the Korea Child Fund, an organization that improves living environments for low-income families, the 1,085-square-foot house was constructed from three containers, replacing a derelict, rat-infested house that was occupied by a family of seven. The result was a dignified “house within a house” protected with three layers of insulation materials and featuring large sliding doors and circulation spaces. The design allows the entire family to live in vastly improved, healthier conditions.

## Designing Innovative Spaces

Typically available in 20-foot (6-meter) or 40-foot (12-meter) options, shipping containers are structurally sound and ideally formed to create temporary pop-ups or more permanent accommodation options, whether for commercial, residential, or leisure uses. With size and shape as known quantities, designers



are able to apply more creativity in the way they plan their spaces. The results can be surprising and memorable.

Inhouse Brand Architects was commissioned to build a new office space for an up-and-coming advertising agency in Cape Town, South Africa. The goal was to create a new space to clearly reflect the agency's growing reputation for producing world-class creative advertising campaigns. The agency, called 99c, ships their ideas around the globe and, as such, Inhouse Brand Architects was inspired to use a shipping container to represent their global reach. Shipping goods is a container's *raison d'être*.

The office occupies three levels of a new commercial development on the edge of the city's harbor district. Using containers was a natural option for the design, given the location of the building overlooking the busy Cape Town port. The overall scheme<sup>16</sup> forms a hybrid of traditional construction and container architecture, and results in a contemporary environment that reflects its context and use perfectly.

This is just one example of how innovative design can uplift and showcase the inherent qualities of containers. Other designers around the world have chosen to reuse and upcycle containers in various innovative ways for commercial applications. This book features many outstanding examples of how containers have been used to shape museums, coffee shops, offices, shared workspaces, pop-up and temporary retail outlets, schools, student housing, art galleries, and exhibition spaces.

**99c Office** / The orange container is used in 99c Office to fill the entire office space with vitality



A superb example is the SEED Library. This project in particular highlights how a bland, industrial utilitarian container can be transformed into a stimulating place that encourages learning and discovery. The library, located at the MC Weiler Library in Alexandra Township in Johannesburg, South Africa, cast aside the vision of a staid "prison for books," and transformed into a space that is filled with both light and imaginative places for children to learn and play. This approach makes a profound statement about how dignity and pride can be brought to an area more frequently associated with poverty and deprivation. This was all achieved with just two shipping containers and an imaginative commitment to creating positive learning spaces.

## Temporary, Emergency, and Disaster Accommodation

Container-based accommodation does not have to be limited to permanent residential or commercial applications. Governments, aid agencies, and designers around the world have been opting the use of containers to create accommodation alternatives in the wake of natural disasters, such as the 2010 earthquake that devastated Haiti, as well as Hurricane Sandy, which battered the United States in 2012. When disaster strikes, pre-fitted containers can be moved into disaster areas as temporary hospitals, clinics, warehousing, mortuaries, and accommodation for people displaced by the catastrophic events.

They also offer opportunities to deliver critical services in areas with inadequate or failed infrastructure. Containers can be fitted with medical equipment and moved into remote locations relatively easily. This is particularly important in developing countries where medical services are sparse or lacking completely. Clinic in a Can<sup>17</sup> is just one organization that specializes in doing so. Their fully fitted container clinics can be found in Haiti, Sierra Leone, South Sudan, and other areas, enabling people there to access basic medical services that otherwise don't exist.

Shipping containers have also served in the military for many years, primarily as supplies storage facilities, but also for barracks accommodation in military zones. In the same way, scientific expeditions around the world have taken advantage of the temporary and portable nature to provide shelter and storage, even in areas as remote as Antarctica.

One such example is the Indian Research Base (on page 156), located in the Antarctic. The structure uses 134 shipping

containers all designed to accommodate over 70 researchers in a double-story configuration comprising 24 rooms. The extreme weather conditions required particular innovation to ensure the structure's occupants are protected while working and living there. The façade was reduced to minimize the effect of wind loads. The entire building was clad in an insulated, aerodynamic skin of metal panels, and the elevated structure was designed to prevent a build-up of snow drifts around the building. But the functionality does not detract from the design effects. Glazing at each end provides spectacular views of the surrounding landscape. The result is a striking design that represents the unique possibilities of building with shipping containers.

## The Pop-up Trend

Pop-up architecture is a contemporary diversion from more formal, static structures. Pop-up allows designers to create temporary structures that are often in place only for a short while, such as during an event, for example. Over the years it has become a well-entrenched way of making a statement in public spaces like parks and town squares for short periods of time.

Shipping containers are ideal for pop-up installations. They are easy to move and install. They can also be well secured when they are not in use, which helps event owners and businesses to minimize losses, maintain greater control, and reduce costs.

The temporary nature of pop-up structures challenges architects and designer to innovate with maximum impact. This requires a particular approach to the different elements designed to be built into the pop-up structure, including how to secure the unit, as well as insulation and services, if necessary.

For the ZX FLUX Adidas Gallery (on page 88)—a temporary exhibition installation for sportswear brand Adidas, in Santiago, Chile—the designers used four 20-foot (6-meter) containers to create four linked modules that each contained different parts of the temporary exhibition. The installation was erected in front of the beautiful classical Museo de Arte Contemporáneo of Santiago (MAC) for a limited time. Because of its location directly in front of, and obscuring the MAC, the designers configured the containers to ensure that passers-by and visitors could still catch glimpses of the MAC behind it.

Three days later, it had moved on, leaving little trace of its physical existence. It did, however, leave a lingering conversation

about how contemporary and classical can co-exist—even if only for a short while. This project has been highlighted to reflect how container architecture allows temporary or pop-up architecture to have a presence without having a permanent place.

## Plug-in Architecture

As an extension of pop-up architecture, plug-in is the next evolution of container architecture. Shipping containers are synonymous with mobility. They were designed to be moved and stacked. As such, they are ideal for buildings. Their use as permanent structures has been well documented. That said, the trend towards plug-and-play architecture is rapidly gaining more prominence.

The notion of plugging in prefabricated modules into a central structure is not new. In 1947 to 1952, Le Corbusier envisaged his high-rise *Unite d'Habitation* apartment block as being constructed from pre-fabricated apartments hoisted into place around a central core.<sup>18</sup> The UK-based architectural practice Archigram also proposed a similar scheme in the 1960s, in the design for their *Plug-in City*. Other designers have put forward their own proposals since then, some more radical than others. But many of these schemes have remained just that: ideas that have not been realized. Until now.

Today's construction and transport technology have advanced sufficiently to allow plug-in architecture to come of age, and shipping containers are at the center of that opportunity. The principle behind contemporary plug-in architecture is that modular units can be added or subtracted from designs as the users see fit.

HUB 01, Student Housing of the Future (on page 182), begins to hint at what that concept could look like in reality. The project was designed by dmvA and A3 onwerpburo, for Katho, a Catholic educational academy, located in Courtrai, Belgium. It features a central hub with customized modules that can be plugged into the hub. The hub houses the common areas—kitchen, living room, and a bathroom, and is linked to each module. The modules, which are made using shipping containers, are individually designed to suit the tastes of the students who use them. One is covered in plants; another has solar panels on its walls; and another has a skate park on the roof. They can be moved away from the hub when the student moves on. This creates an ever-changing, dynamic, and organic scheme design.

OVA's Hive-Inn™ City Farm (mentioned earlier) is conceived from the same principle. In that design, containers are craned into place in a staggered form to create an urban farm. Food is grown in the containers. Brands can buy or rent the containers to form restaurants or retail outlets. The designers have also extended the idea to a hotel. In the Hive-Inn™ Hotel scheme, the shipping-container units can be plugged in, taken out, or shifted around—like a game of Jenga.

Plug-in architecture presents a dramatic shift in our accepted views on housing and neighborhoods. It suggests a future in which we take our homes with us, rather than moving into a new one each time our circumstances or lives change. This is a radical departure from the current model and has potentially far-reaching, disruptive implications for the way our cities are built.

## Technical and Structural Considerations

### Space Planning

Shipping-container dimensions do carry limitations. They are built to ISO standards, and come in 20-foot (6-meter), 40-foot (12-meter), 45-foot (13.5-meter), 48-foot (14.5-meter), and 53-foot (16-meter) sizes. The most popular choice for buildings are the 20-foot (6-meter) and 40-foot (12-meter) versions. Their capacity is expressed in TEU (Twenty Foot Equivalent Units). A TEU is the equivalent of one standard container measuring 20-feet (6-meter) long x 8-feet (2.5-meter) wide. The standard height of the container is 8 feet and 6 inches (2.5-meter).

With these numbers in mind, using a container for accommodation requires creative design thinking to ensure its occupants can live comfortably within a constrained space. Many of the projects featured in this book show how it is possible to expand the living areas by creating additional spaces between multiple containers, or extending upwards.

### Mitigating Environmental Impacts

The environmental benefits of container architecture are not only limited to the principle of upcycling used containers—architectural designers are constantly seeking ways to mitigate the effect that the work has on the environment.

Despite best efforts, the entire construction process, from site preparation to final completion, can cause extensive damage to the environment. Construction vehicles and earth-moving

equipment are responsible for high carbon emissions, especially for projects that have protracted construction programs. The vehicles can also destroy vegetation in and around the construction areas. This vegetation can take months, if not years, to recover, particularly in areas with delicate ecologies.

Unless design teams take deliberate steps to minimize the carbon footprint, traditional building projects can consume significant amounts of energy. The manufacturing processes for standard building materials such as bricks, cement, and others can be highly energy inefficient. Those materials are then often

**Container Park /** The landscape planning inside Container Park is in harmony with the whole building



transported over long distances in vehicles that also produce high carbon emissions. The combined effects of producing and transporting the materials can negate any energy-reducing initiatives.

By contrast, containers are ready-made shells that only need to be transported to a site once before being placed permanently in situ. This can dramatically reduce the energy requirements and increase the energy efficiency of the project in question.

However, there are some environmental considerations that designers must be aware of as they are planning their first or next container project. Given their original purpose, shipping containers are designed to survive long periods while exposed to the wind and saltwater on their journey from port to port. To protect them from the harsh elements, the containers are treated with a cocktail of chemicals, including chromate and phosphorus, as well as paint. The wooden floors at the base of the container are also treated with pesticides and chemicals, including arsenic and chromium, to prevent invasion from pests. The containers need to be well-prepared in advance to eliminate the toxic elements and to reduce health risks and ensure they are fit for occupation once complete.

Preparing the container can also be energy-intensive, considering the carbon emissions from, for example, cutting apertures into the sides and roof for doors and windows; and welding and sandblasting in the containers. That said, it is possible to mitigate the effects of this work by incorporating energy-efficient features into the design. Solar power, passive heating and cooling, rainwater collection systems, living roofs, gray-water recycling, green walls, composting toilets, LED lighting, wind turbines, cross-ventilation, and efforts to maximize natural light, among others, can all be used to minimize energy demands and enhance the environmental benefits. It is possible to design a container building to operate entirely off-grid.

Design specifications can also help to reduce the carbon footprint of container-design projects. This could include using sustainable materials such as bamboo or recycled timber, among others.

## Building Strong Foundations

While the containers are strong enough to withstand high winds, more permanent structures do need to be anchored to the ground, with a sound foundation. When laid side by side, containers

can be hooked and welded together in the designer's preferred configuration. The way the foundations are constructed depends entirely on the building's design. However, for smaller residential projects, foundations are created either by laying a concrete slab, which is the more popular option, or a crawl space that creates additional storage. A third option is to build an entire basement into the ground, which has the added advantage of increasing the available storage or living space.

## Protection Against the Elements

Built from corrugated CorTen steel, shipping containers are treated to prevent damage from the wet and salty ocean conditions. CorTen develops a natural rust patina to prevent corrosion. The containers are also watertight, to protect the cargo inside. While this means that preparing a container is relatively straightforward, designers should be aware of the steps that should be taken to, for example, decontaminate the containers from the toxic elements mentioned earlier.

Once the containers have been adequately prepared for the design to be implemented, they can be painted to show off their original aesthetic, or clad with other materials. Given their original purpose, containers are made of sheet metal. It is therefore critical to insulate the containers to ensure that occupants are comfortable and temperatures inside the containers are moderated. Regardless of what the repurposed unit will be used for, without adequate insulation, containers can be stifling hot during warm seasons and extremely cold during the winter. The preferred method of insulation will be influenced by the nature of the project, and the design itself.

Insulation materials can be installed on both the internal and external surfaces. Closed-cell insulation foam is very effective. It is sprayed directly onto the walls and roof of the container, covering any gaps and protecting the surfaces against corrosion and mould. The foam can be sprayed on to both internal and external surfaces; and then painted over during the final finishing phase.

Insulation panels can also be fixed to the internal and external walls and roof. These have the added advantage of being able to conceal the pipes and cables installed to deliver electrical, water, and sewerage utilities.

Blanket insulation is the third and most cost-effective option. However, since the blanket is generally made from fiberglass, it

does require specialist knowledge and skill at installation. At the very least, it is important that installers use adequate personal protective equipment to prevent injury during installation. The insulation is installed between the container wall and stud walls.

Other, more environmentally friendly, insulation options include wool, mud, and cotton. Some designs have even incorporated living roofs as an added measure of insulation. These can offer the additional benefit of creating a green space for the occupants, which can either be used as a leisure area, or to grow food.

A final option is to build natural heating and cooling methods into the design itself. These measures include installing sun shades; using reflective paint to reflect heat away from the building; or placing windows strategically to increase air flow.

### **Fit-out and Utilities**

Once the container has been sufficiently insulated, and the space has been effectively planned, the full design can be implemented. For smaller projects, space is a consideration, and this will impact on the configuration of bathrooms and kitchens. Regardless of the size of the project, however, the electrical, sewerage, gas, and water services can be installed in the same way as in a traditional structure.

As with any construction project, it is important to engage experienced teams and contractors to ensure that all services, particularly gas and electrical, are installed safely and correctly.

### **Containers and the Future**

This book brings together an impressive collection of container-architecture projects. Despite their functional shape, containers bring flexibility, versatility, and opportunity to architectural projects of all sizes. The projects seen in this book and elsewhere highlight the magic that can emerge when truly creative ideas are applied to a seemingly mundane, utilitarian structure.

The projects featured here are just a small snapshot. As globalized trade releases more containers into ports, even more creative designs will emerge in the future, which certainly indicates there will be many new creative uses of the simple container in the years to come.

Regardless of their uses, these schemes have the potential to change the way we use existing resources. The need to do this is having a profound impact on the way that architects approach

projects. There is an urgent need to begin working with what we already have, rather than returning to what we have always done, which is to create something new each time.

On a more profound level, architects and designers have a responsibility to think differently about their work, and the impact it has on communities, the environment, and society at large. They also have a responsibility to themselves to uphold their creative integrity by seeking alternatives to energy-hungry, environmentally damaging construction practices.

The fourth industrial revolution is surfacing new technologies and processes that will allow architects to do just that, as there is a greater understanding about the world around us than ever before. Building materials and construction methods are also evolving as our awareness increases. This knowledge offers a unique opportunity to step away from harmful practices and to embrace new ways of thinking. With that comes a growing momentum that will help to address the profound challenges faced in the world today.

It is hoped that this book will inspire readers to embrace the enormous potential offered by the humble steel shipping container. Standing on the threshold of a bright future, designers hold the keys to fundamentally change the way neighborhoods and cities are built.

## Notes

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