Offsite
design meets
manufacture

OFFSITE
DESIGN MEETS MANUFACTURE

We are passionate about the opportunities presented by offsite, particularly in the production of our future homes. Occupying the intersection of architecture and industry, the technology has real potential to bridge the growing gap between supply and demand to provide high quality, affordable and sustainable homes at scale.

As part of Green Sky Thinking in 2017, we hosted an event exploring the emergence, challenges and opportunities posed by offsite. This was centred around a striking conceptual pod, whilst an exhibition charted the role of offsite in relation to the current housing market – looking at how projects and events of the past have informed the design and manufacture of homes today. A panel of speakers also discussed the role this technology could play in solving London's housing crisis.

This document summarises our research; incorporating information about the pod, the full exhibition and some of our current offsite projects. If you are considering offsite for your next project, or would like to learn more, please get in touch with Tony Hall, Technical Design Director: tony.hall@levittbernstein.co.uk.

THE POD

Images courtesy of: Levitt Bernstein.

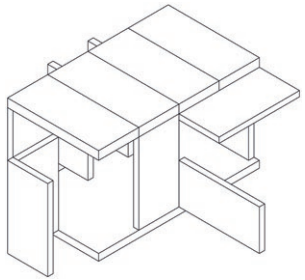
Levitt Bernstein and Innovaré have collaborated to create a 1:1 pod constructed with structural insulated panels (SIPs), using two identical components to represent the two parties involved in its creation: designer and manufacturer. These combine to form a porch and chimney, the former representing the initial stages of the manufacturing process with the raw materials revealed, whilst the latter is finished with render to illustrate the construction process. The design process is revealed through the form.

SKETCHBOOK

This sketchbook charts the journey of our pod, from pencil drawing to oblique 3D structure.

Levitt Bernstein and Innovaré are the respective designers and manufacturers behind the pod, which is constructed using structural insulated panels (SIPs). By creating this faceted, bespoke structure together, we hope to demonstrate the advantages of designers and manufacturers closely collaborating throughout the design process. We believe the success of projects utilising offsite technology is dependent on this close working relationship, which we hope will be exemplified by this exhibition, and the pod itself.

The pod is a visual representation of the offsite process, with the two elements representing the two key parties involved: designer and manufacturer. These combine to form a porch and chimney, the former representing the initial stages of the manufacturing process with the raw materials revealed, whilst the latter is finished using a render system to illustrate the construction process.

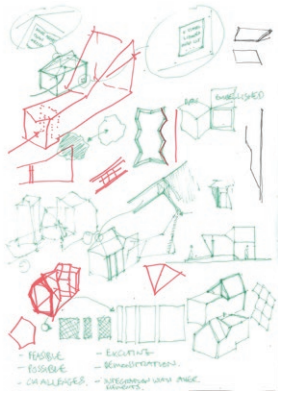


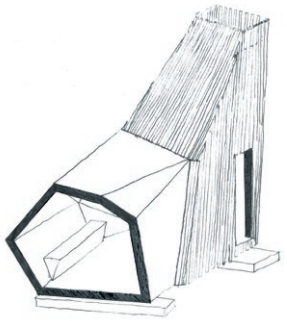
BEGINNINGS

In October 2016, Levitt Bernstein's Detail studio visited the Innovaré factory in Coventry to get a better understanding of SIPs technology and how panels are made. Their initial pod concept used standard size OSB panels assembled volumetrically.

IRREGULARITY

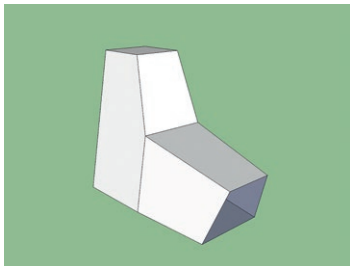
Following further research and conversations with Innovaré, Levitt Bernstein developed a more bold and less regular form, using faceted panels to create a bespoke shape and demonstrate the flexibility of the SIPs system. The key section then emerged with two distinct elements: 'porch' and 'chimney'.





DEVELOPMENT

The concept of the chimney and porch was explored further to represent the design and manufacture processes respectively, with different finishes applied to illustrate each stage. Focusing on the visitor's experience of the space, Levitt Bernstein developed its form and shape; and worked out how it could be detailed, clad and delivered.

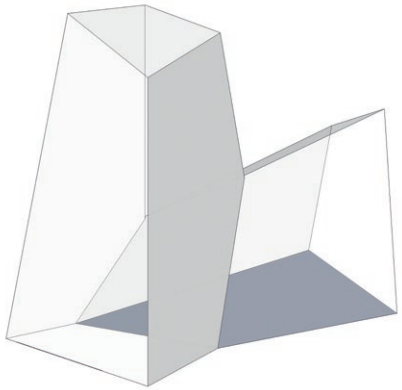


SKI BOOT

A key moment in the design process was Innovaré feeding back that five panels could not be joined to one point in the factory. They provided a simplified version of the proposals with parallel sides and only four panels meeting at each point.

DESIGN REVIEW

Levitt Bernstein invited another of their studios to review the pod. They were struck by the concept of the two elements representing the two stages of the offsite process, and suggested the equal nature of these two sides could be represented in the form – with the elements being duplicates of one another.

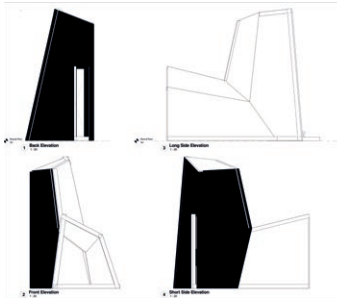


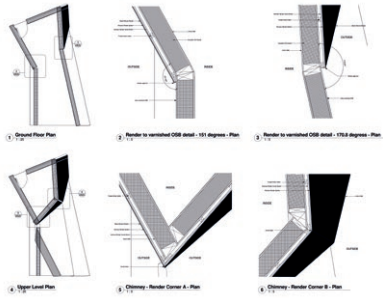
TESTING

The ski boot model was then tested in three dimensions, and the form and the practicalities of getting it from Coventry to Dalston unpicked.

PANELISATION

Whilst Innovaré produced fabrication drawings, Levitt Bernstein prepared general arrangement drawings and began conversations with Alumasc and Eden Facades about the rendering process, Total Glass about the door, and to Strong Tie about the supporting feet.





FINAL DESIGN

Levitt Bernstein and Innovaré then finalised the form with the two equal components, creating a similar geometry and facilitating simpler manufacture.

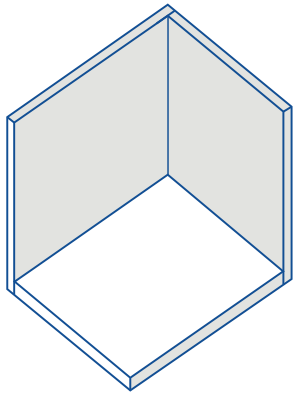
ASSEMBLY

Levitt Bernstein then developed these details in collaboration with the manufacturers and created a 3D printed model of the final pod.

DELIVERY

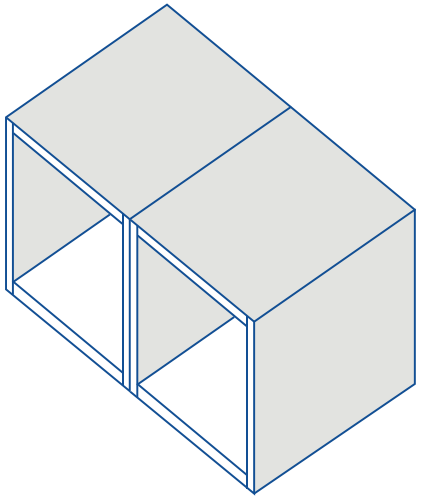
Innovaré set to work on constructing the pod, and just days later, it was loaded onto a lorry and driven down to London. Once in place, visitors were able to experience the space and see the flexibility of the technology first hand.

SYSTEMS



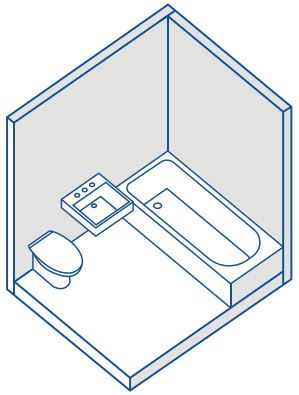
PANELISED

These can be either ‘closed’ or ‘open’, with plasterboard linings fixed or unfixed in the factory. They can use timber, steel framing or structural systems such as structural insulated panels (SIPs) and cross-laminated timber (CLT). As these systems allow for bespoke solutions to individual sites, they are the most commonly used in the UK.



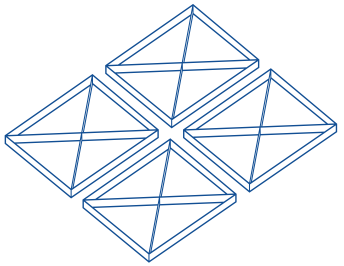
VOLUMETRIC

These can include panelised systems such as SIPs and CLT, with panels assembled volumetrically in the factory and delivered to site ready for installation. They facilitate quick construction and can help to overcome labour or material shortages, as well as drive up quality or build volumes.



HYBRID

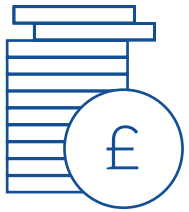
These are part panelised, part volumetric; for instance, bathroom or kitchen pods. Fixtures and fittings can be installed in the factory and arrive on site ready to be craned into place. This minimises the number of trades on site and can reduce programme length and cost too.



STANDARDISED

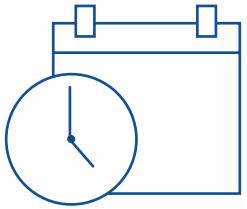
Rationalising a design and creating a series of identical components for building fabrication allows factories to mass produce elements that are easy to transport and quick to assemble, saving time and waste during construction.

BENEFITS



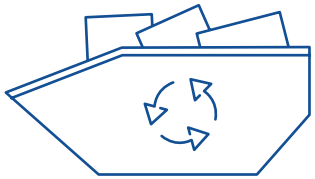
COST SAVING

Cost savings are generally made during construction thanks to the use of standardised materials and components. Building users can also benefit from reduced energy bills thanks to high performance building fabrics.



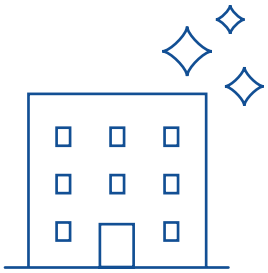
TIME SAVING

Buildings constructed using offsite systems are generally much quicker to complete due to their often repetitive, modular nature. Much of the work can be completed in factories before being delivered to site for final assembly.



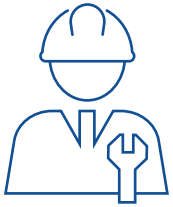
WASTE SAVING

Traditional building sites generally over order materials by up to 20%. By planning and cutting materials according to their standard sizes, this waste can be drastically reduced.



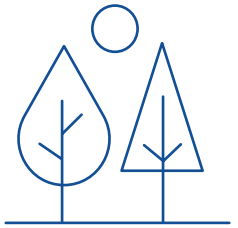
ENHANCES DESIGN

Technological advances and improved collaboration between designers and manufacturers mean offsite systems can now offer much improved design quality and performance.



LABOUR SAVING

Prefabricating building elements in a factory means there is less need for labour on site, which also reduces health and safety concerns and dependence on good weather for work to be completed.



SUSTAINABLE

As well as producing less waste, offsite systems can result in a much improved building performance with increased airtightness and better U-values. Using carbon sequestering materials can also add to the environmental benefits.

EXHIBITION

The story of offsite construction is one of persistent re-emergence. This way of building is nothing new – even Vikings transported prefabricated homes on longboats – but, looking back over history, many offsite projects were not realised as they were intended, for a myriad of reasons. In fact, offsite often bore the brunt of public backlash and commercial failure, and yet, in spite of this, we continually return to it. It is only recently that we have seen consistency in high quality projects built using offsite systems.

Occupying the intersection of architecture and industry, offsite construction relies on factory capability, policy, cultural context, available labour and, perhaps above all, the market. It can be used in the delivery of any building type and has historically been used extensively for housing during periods of extreme shortage, most notably after the two world wars. Since the dawn of the digital era, we have seen a renewed enthusiasm for offsite production, and it seems technology may have finally caught up with our homebuilding aspirations.

Curated by Levitt Bernstein, this exhibition focused on the role of offsite in relation to the current housing market, looking at how projects and events of the past have informed the design and manufacture of homes today. With the government announcing its commitment to offsite in the recent housing white paper, and the housing crisis ever increasing, this method of construction could play a significant role in bridging the gap between supply and demand today.

Images courtesy of: Levitt Bernstein.

1

PRAGMATIC APPROACH

1833 – 1918

The global colonisation effort, particularly for Britain and France, created a dilemma for these nations of how to build in faraway lands. Unfamiliarity with local materials, a deficiency of skilled labour and lack of existing building infrastructure in the colonies meant traditional construction methods were impractical, if not altogether impossible. Soldiers in distant, often mobile, field operations at this time experienced similar difficulties for both medical centres and accommodation, whilst the developing United States had settlements rapidly expanding westward, amplified during the California Gold Rush.

At the close of the Industrial Revolution, with labour increasingly shifting into factories across a variety of sectors, industrialised production seemed to address many of these problems. With the ability to 'import' buildings, or at least their components, structures could be erected more easily and quickly.

As such, this period saw a change from ad hoc construction to strategic multiple production, and determined the fundamental principles which have stayed with prefabrication and serial production ever since: dimensional coordination (adhering to whole multiples of a dimensional unit) and standardisation of components.

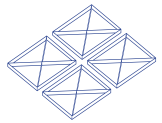
1833

MANNING PORTABLE COTTAGE

H. John Manning set about designing what was to become the first advertised prefabricated house – the Manning Portable Colonial Cottage for Emigrants – when his son decided to move to Australia and needed somewhere to live.

The cottage's components were built entirely in London and shipped to Australia, where it could be assembled with no more than a bed-wrench. This was a key element to the cottage's success thanks the lack of raw materials and skilled labour in the area.

Although design options were limited due to the simple timber frame structure, the cottage provided an easily transported, simply assembled and economically viable place to live. Manning later developed several models of varying size and cost, which proved a commercial success across Australia.



STANDARDISED

SYSTEM DETAILS
Timber frame structure clad in wood panels

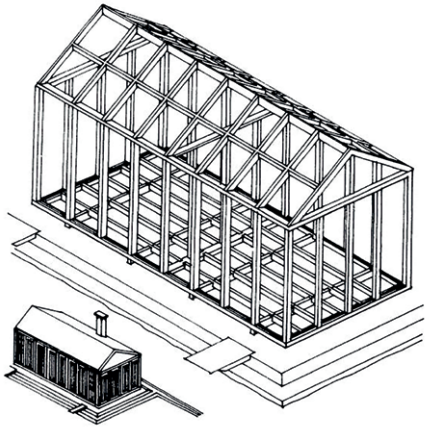
DATE
1833-1840

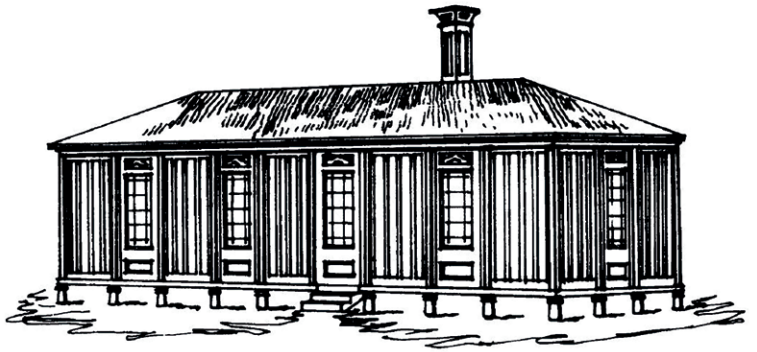
TEAM
Designer was H. John Manning

LOCATION
Across Australia

NUMBER OF STOREYS
1

NUMBER OF HOMES
Dozens





Images courtesy of: Gerizim Inmobiliaria and Quonset Hut blog.

1849

CALIFORNIA GOLD RUSH HOUSING

The Gold Rush started at Sutter's Mill in 1848 with the discovery of gold pieces in the American River. The subsequent race for gold led to the population of San Francisco exploding from 1,000 to 25,000 by 1850, straining the city's infrastructure. People lived in tents, wood shanties or deck cabins removed from abandoned ships. There was a market for inexpensive and quick to assemble housing – settlers were short on shelter, but rich with gold.

Houses were fabricated in England, China and eastern United States. Ease of transportation was as important as quick assembly. Houses of 20' x 15' were shipped in two 12' boxes. In 1849, one storey portable 'Naylor' houses with wood or iron roofs that cost $345 in New York, could be sold in California for $500.

STANDARDISED

SYSTEM DETAILS
Corrugated iron panels and timber frame

DATE
1849-1855

TEAM
Designer was Peter Naylor and others

LOCATION
California, United States

NUMBER OF STOREYS
1 (occasionally 2)

NUMBER OF HOMES
More than 5,000

FIG. 3. — Corrugated iron, Liverpool, 1849. — Warehouse prefabricated for the California Gold Rush. From: "London Illustrated News," XIV (1849), p. 109.

Images courtesy of: Instant House blog and The California Gold Rush blog.

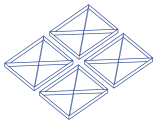
1851

CRYSTAL PALACE

The Crystal Palace was a cast iron and plate glass structure built to house the Great Exhibition of 1851 and demonstrate Britain's industrial prowess.

The building was prefabricated, with one size of glass used to determine the size of the repetitive units. The production of large sheets of cheap but strong glass was made possible thanks to the invention of the cast plate glass process in 1848. It had the greatest area of glass ever seen in a building – astonishing visitors with clear walls and ceilings that did not require interior lights.

After the exhibition, the Palace was disassembled and rebuilt on Penge Common. This second iteration was even larger and used twice as much glass. It stood from 1854 until it was destroyed by fire in 1936.



STANDARDISED

SYSTEM DETAILS
Cast iron and plate glass structure

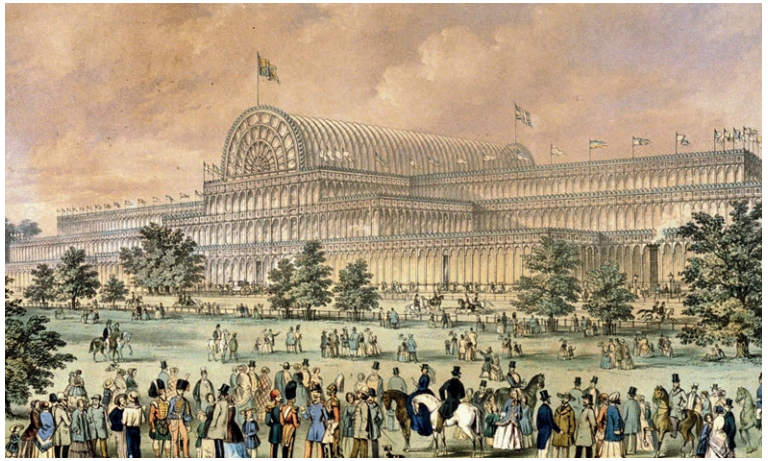
DATE
1851

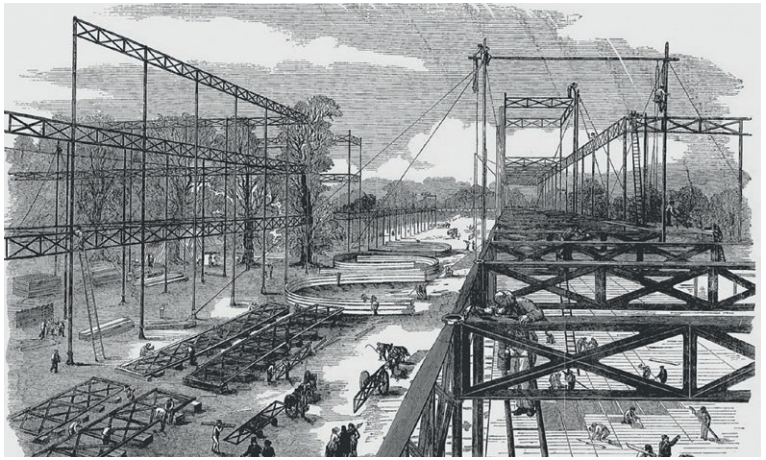
TEAM
Designer was Joseph Paxton

LOCATION
London, United Kingdom

NUMBER OF STOREYS
2

NUMBER OF HOMES
N/A (exhibition space)





Images courtesy of: Archexpo and National Diet Library, Japan.

1854

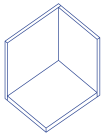
CORIO VILLA

Corio Villa is a very ornate prefabricated iron house that was created in Scotland and shipped to Australia.

The prefabricated pieces included 12mm-thick cast iron plates measuring 450mm x 300mm, which were bolted together to create flat wall sections. The window sashes, too, were made of iron and designed to slide into wall cavities.

The National Trust describes the Corio Villa as a unique example of a changing attitude to iron buildings. In the early 1850s, utilitarian iron buildings were regarded as daring and innovative, and industrial structures were later overlaid and enriched with architectural ornamentation.

Corio Villa exemplifies the emergent relationship between design and engineering, but sadly, shortly after it was shipped, the factory burnt down and all moulds were destroyed.



PANELISED

SYSTEM DETAILS
Prefabricated cast iron plates

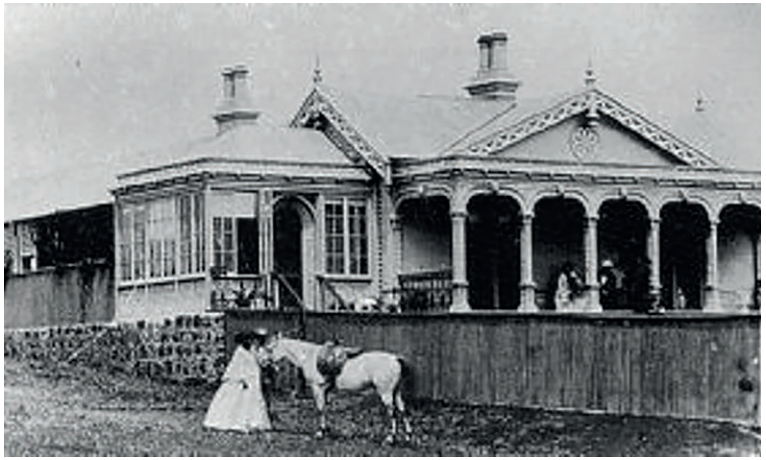
DATE
1854

TEAM
Designed by Bell & Miller and fabricated by Charles D. Young & Co.

LOCATION
Geelong, Australia

NUMBER OF STOREYS
1

NUMBER OF HOMES
1



Images courtesy of: Geelong Visual Diary blog.

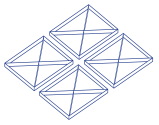
1885

RENKOI HOSPITAL

When Britain joined the Crimean War, medical staff were horrified by the poor hygienic conditions they found. Isambard Kingdom Brunel was invited by the government to design a prefabricated hospital that could be made quickly in Gloucester, England and then shipped to the front in Turkey.

Brunel designed a unit to house 50 patients, 27m x 12m, divided into two wards. The design incorporated hygiene essentials: access to sanitation, ventilation, drainage and rudimentary temperature controls. These were then integrated within a 1,000 patient hospital layout, using 60 of the units. It was designed and fabricated in just six days.

The layout had a huge impact on the health of the patients, with mortality rates dropping by 90%, and it was used by Florence Nightingale to inform her recommendations for hospital ward design standards.



STANDARDISED

SYSTEM DETAILS
Timber framed trusses and tin sheathing

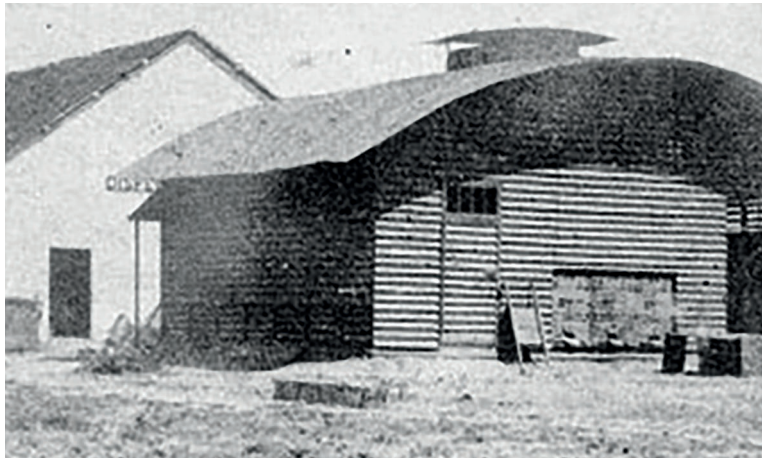
DATE
1885

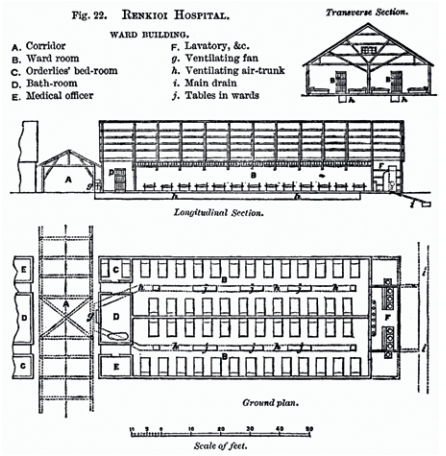
TEAM
Designed by Isambard Kingdom Brunel and fabricated by Price & Company

LOCATION
Renkioi, Turkey

NUMBER OF STOREYS
1

NUMBER OF HOMES
N/A (1,000 bed civilian hospital)





Images courtesy of: Inmobiliaria and Modularize.

1908

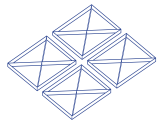
SEARS CATALOGUE HOMES

In 1908, department store Sears published its 'Book of Modern Homes and Building Plans', featuring 44 house styles with a numbered kit of parts for the entire house. They ranged in price from $360-2,890.

As sales grew, Sears expanded into production and purchased lumber mills across the US. Pre-cut and fitted lumber was first offered in 1916. Prior to this, home builders had to cut their lumber to appropriate lengths.

Construction of a kit house with pre-cut lumber reduced construction time by up to 40%. This system also used standard sizes for framing and only required one carpenter.

The kits were sent by train before being driven to site, comprising an average of 30,000 parts.



STANDARDISED

SYSTEM DETAILS
Timber frame, lath (and later, plasterboard) walls and asphalt shingles

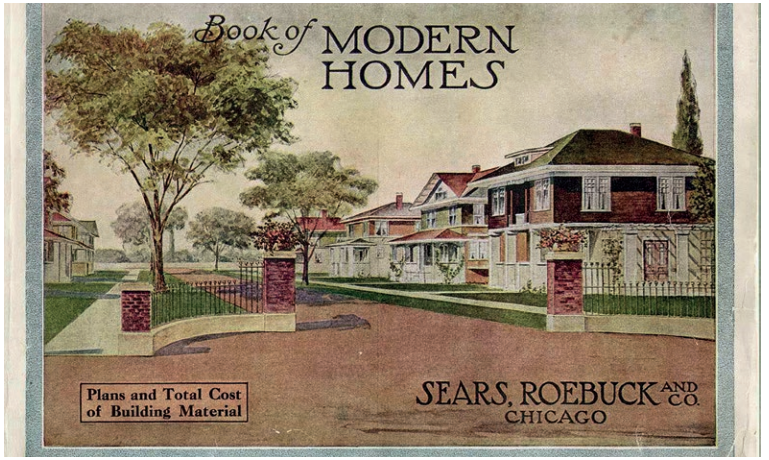
DATE
1908-1940

TEAM
Sears, Roebuck & Company

LOCATION
Across the United States

NUMBER OF STOREYS
1-2

NUMBER OF HOMES
70,000+



Images courtesy of: Sears Archives and Digital Research Library of Illinois.

2

INVENTION

1919 – 1936

The turn of the 20th century was met with great optimism and a sense of societal 'progress' – fuelled by innovations such as the automobile and air travel; new building materials such as iron and reinforced concrete; and greater awareness as to the benefits of industrialised manufacturing (Taylorism and Fordism were extremely influential at this time).

However, this sanguinity and confidence in the future did not survive the traumas and physical destruction of the First World War. A housing and skilled labour shortage followed the conflict and – at least among Modernists – architecture was lifted to a heroic status. Historicism was largely rejected in favour of 'the new'; it was felt modern ways of living could (and should) be enabled by the spaces with which we surround ourselves. Architecture became the solution for a slew of problems with a consensus that design could change the current reality – and perhaps even trajectory.

Numerous prefabricated systems at this time were openly intended for mass replication, however, none managed to do this on any sort of meaningful scale. There was no great move into the factory as so many imagined, but instead, further rationalisation of design systems and standardisation of components.

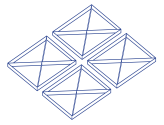
1920

MAISON CITROHAN

Le Corbusier believed industrialism and technology were the tools to enlighten society and improve people's everyday lives.

With Maison Citrohan, the design was meant to be affordable and as efficient as an automobile (the name is a nod to Citroën). Intended to be built only with materials that could be mass produced, it was a demonstration of the standardisation of all the elements of a house, from the walls to the stairs.

In the years following, Le Corbusier would create several subsequent prototypes, ranging from two to three storeys tall; only the last few versions were actually built. Although intended to be produced on an assembly line, the homes were actually hand-crafted. Le Corbusier would never achieve his dream of a factory-made home.



STANDARDISED

SYSTEM DETAILS
In situ concrete frame with 3" membrane walls (cement on sheet iron)

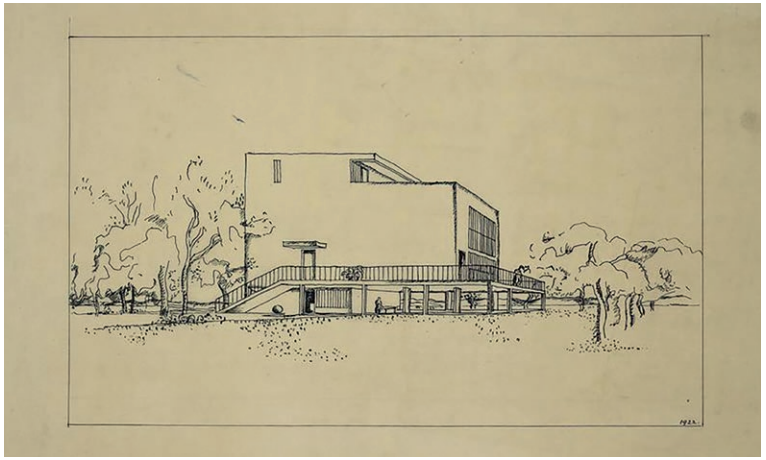
DATE
1920-1927

TEAM
Le Corbusier (Charles-Édouard Jeanneret)

LOCATION
First versions unbuilt; later iterations in Stuttgart, Germany and Pessac, France

NUMBER OF STOREYS
2-3

NUMBER OF HOMES
Unknown



Images courtesy of: University of Maryland and Fondation Le Corbusier.

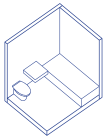
1926

TÖRTEN ESTATE

The Törten Estate, commissioned by the municipality of Dessau, was a means for the Bauhaus to find a practical solution to the problem of building affordable housing for the masses. Gropius' design featured 314 terraced houses, each with a floor space of 57-75m² and a kitchen garden.

The estate was built in three phases and the site organised so that several houses could always be built simultaneously using specialised labour brigades. Structural components were prefabricated on site, such as the Rapidbalken (precast concrete joists), which were then transported via a small rail wagon and moved by crane.

Shortly after completion, defects in design and construction became evident and residents began to make numerous alterations themselves.



HYBRID

SYSTEM DETAILS
Haus-bau-fabrik ("home-building-factory") combined several systems including precast concrete joists

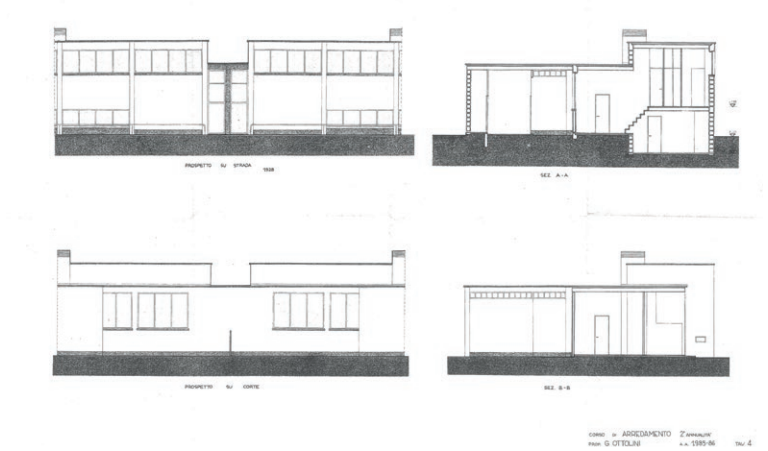
DATE
1926-1928

DESIGNER
Walter Gropius

LOCATION
Dessau, Germany

NUMBER OF STOREYS
2

NUMBER OF HOMES
314



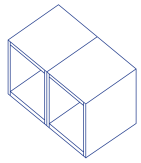
Images courtesy of: Shelter Press.

1927

DYMAXION HOUSE

The Dymaxion House was a prefabricated single family home designed by inventor and architect Buckminster Fuller in 1927. Meant to be earthquake and storm resistant, the concept was for it to be a mass produced unit that could be easily flat-packed and shipped around the world.

Although never realised, the house was to be constructed from aluminium due to its superior strength, low weight and minimal maintenance. The structure would be supported by a central stainless steel mast on a single foundation. From this, central structure cables would be suspended to support the roof, while beams radiating out would support the floor. A hexagonal, flexible plan grouped all utilities in the centre and the unique dome roof ventilated the interior. Fuller would return to this design nearly two decades later for the Wichita House.



VOLUMETRIC

SYSTEM DETAILS
Stainless steel mast, steel tension cables and aluminium skin

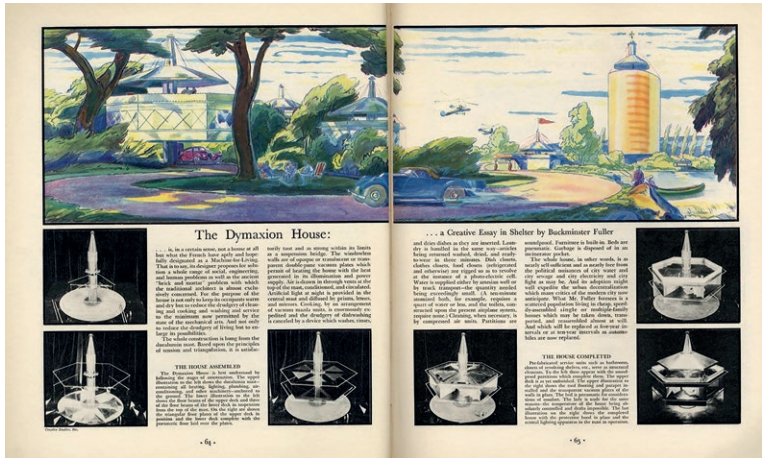
DATE
1927

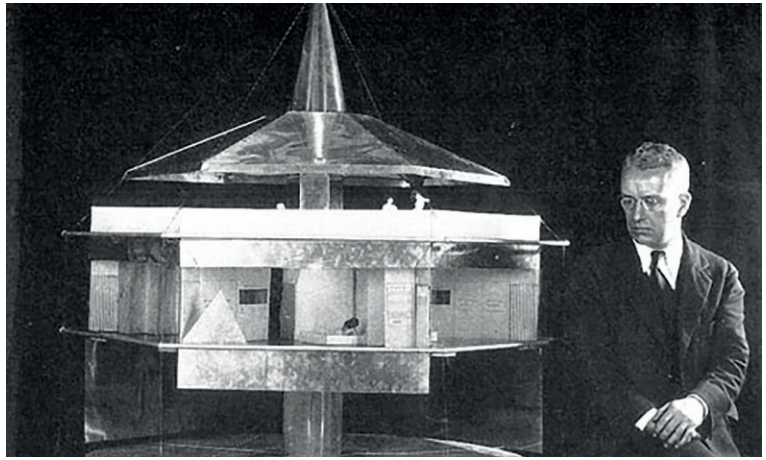
DESIGNER
R. Buckminster Fuller

LOCATION
Unbuilt

NUMBER OF STOREYS
1

NUMBER OF HOMES
Unbuilt





Images courtesy of: ArchDaily and Shelter Press.

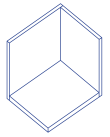
1931

ALUMINAIRE HOUSE

Albert Frey (a former student of Le Corbusier) moved to the US in the 1930s where he teamed up with A. Lawrence Kocher to design the Aluminaire House for the Architectural and Allied Arts Exhibition.

The three storey house was made of donated materials and built in ten days, and was the first all-metal clad house in the US. It demonstrated many principles of functional Modernist architecture, including the use of inexpensive, off-the-peg materials and a simple construction methodology.

The cubic home was 111m² and contained five rooms. It was made of steel and aluminium, and sat partly atop six columns. The exterior walls were clad in corrugated aluminium panels.



PANELISED

SYSTEM DETAILS
Aluminium and glass panels; timber and steel frame

DATE
1931

DESIGNERS
Albert Frey and A. Lawrence Kocher

LOCATION
New York, United States

NUMBER OF STOREYS
3

NUMBER OF HOMES
1

Image courtesy of: Instant House blog.

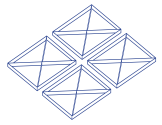
1933

CRYSTAL HOUSE

Crystal House was entered in the 1933 Century of Progress Exposition in Chicago as an example of what might be achieved with mass production in housing.

The lightweight box, three bays by two, measured 10.8m x 7.2m x 8.7m. It was framed externally by vertical steel lattice beams and floor-to-ceiling glazing. The steel was shop-welded and painted, and then assembled on site, utilising mullions and glass panels of standardised sizes. Internally, the space was open and flexible, with prefabricated wall units serving as movable space-dividers.

It was not a financial success and never replicated, as there was only one mortgage company at the time willing to fund Modernist homes in the US.



STANDARDISED

SYSTEM DETAILS
Glass panels, shop-welded steel truss frame and prefabricated walls

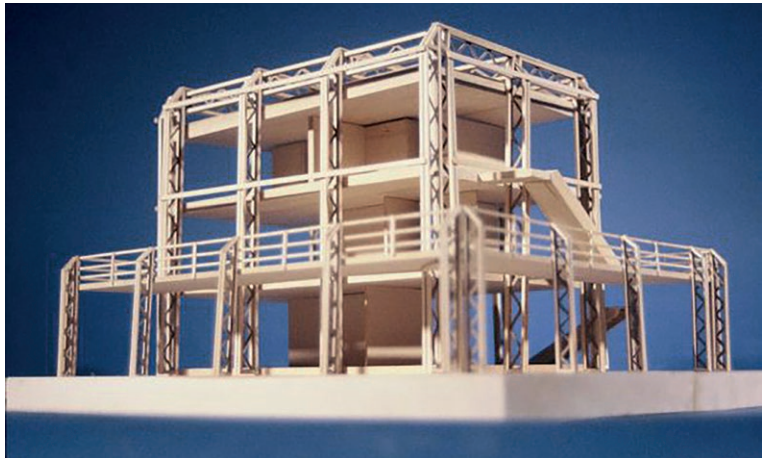
DATE
1933-1934

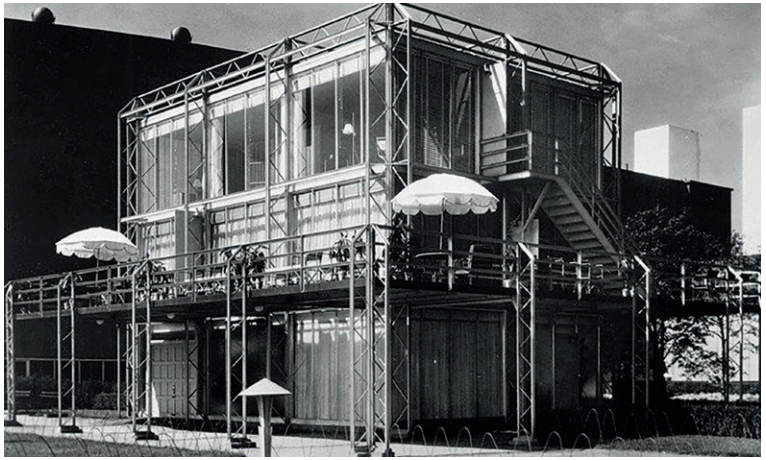
DESIGNERS
George Fred Keck and Leland Atwood

LOCATION
Chicago, United States

NUMBER OF STOREYS
3

NUMBER OF HOMES
1





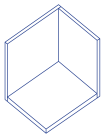
Images courtesy of: Shelter Press.

1936

JACOBS HOUSE (USONIA 1)

These homes were designed for a client looking for a family home on a very tight budget. Wright's answer was to devise a plan based on a strict 2' x 4' grid, utilising his standard details and typical timber and masonry sizes. To speed up construction, he also developed a panel composed of plywood sandwiched between horizontal cypress cladding boards – a precursor to modern SIPs and CLT.

Wright went on to design around 50 family houses based on this system ('Usonian') and construction details. Its flexibility meant that the houses could be adapted to the requirements of the client or site, with the possibility to achieve a strong architectural character internally and externally for minimal cost.



PANELISED

SYSTEM DETAILS
Plywood sandwiched between horizontal cypress cladding boards

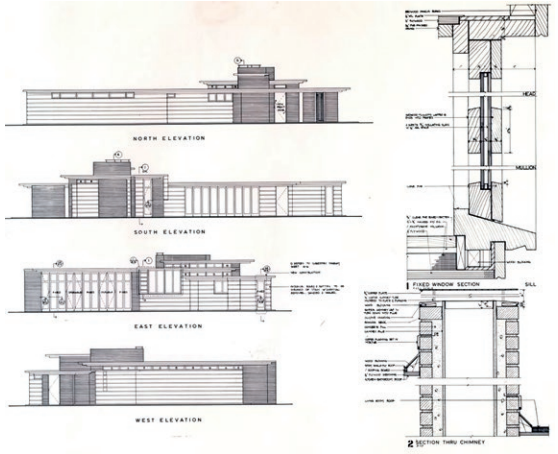
DATE
1936

DESIGNER
Frank Lloyd Wright

LOCATION
Wisconsin, United States; later versions are found across the United States

NUMBER OF STOREYS
1

NUMBER OF HOMES
50



Images courtesy of: 99% Invisible and ArchDaily.

3

NECESSITY

1936 - 1952

In the years following World War II, there was a great sense of urgency to provide shelter in large numbers. Throughout the war, quick and inexpensive mass accommodation was needed for deployed soldiers across several countries. Back at home though, housebuilding had come to a screeching halt. This, in combination with the start of the post-war baby boom and the fact that Britain had lost over one million homes during the Blitz, meant homes needed to be built on a scale never seen before, and fast.

Prefabrication returned to the fore as a way to remedy this shortage of housing and skilled labour. At the same time, many wartime factories now needed to diversify their output to survive, and countries were grappling with either a post-war surplus or shortage of steel and aluminium.

Government-sponsored homebuilding initiatives were introduced at this time across nearly all nations involved in the war, although much of what was built was meant to be temporary (some as short term as ten years). However, many of these buildings have lasted long past their expiry date, shaping our opinion of prefabricated homes today.

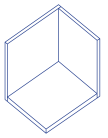
1936

BELLMAN HANGAR

In 1936, the Air Ministry organised a competition for the design of a temporary wartime hangar, suited to accommodating aircraft that could be easily erected, dismantled and transported.

Bellman's solution was constructed in 14 bays based on a unit system of rolled steel sections: both walls and roof used the same standard units joined at the junction of wall and roof by a standard corner unit.

In 1937, the design was modified to include steel-framed and steel-clad doors after some hangars were damaged during heavy snow fall. Over 400 Bellman hangars were built in the UK up to 1940, with hundreds more manufactured across the Commonwealth, proving themselves to be invaluable during World War II.



PANELISED

SYSTEM DETAILS
Steel section frame and corrugated steel sheets

DATE
1936

TEAM
Designed by N.S. Bellman and manufactured by Teesdale Iron Works

LOCATION
Across the United Kingdom

NUMBER OF STOREYS
1

NUMBER OF HOMES
N/A (aircraft hangars)

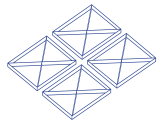
Image courtesy of: Wikipedia Commons.

1939

NISSEN HUTS

Major Nissen designed the first of these huts to accommodate troops during World War I, however, they were revisited and primarily used during World War II. Their use varied from accommodation and community space to bomb storage and church halls. They had to be cheap and portable, and could be easily packed in a wagon and erected in just four hours. Although successfully mass produced, these structures had not considered the comfort (particularly thermal) for those who would inhabit them.

Some of the huts were later recycled and turned into civilian housing or commercial space, some of which were modified with an additional storey. However, despite being extremely economical, their association with wartime accommodation meant that their use as long term family housing was not widely adopted.



STANDARDISED

SYSTEM DETAILS
Semi-circular steel section frame and corrugated steel sheets

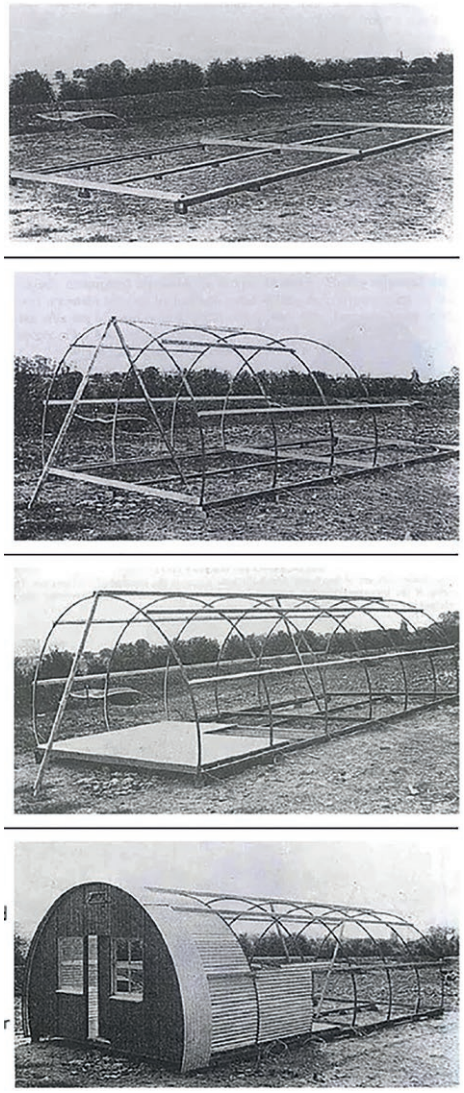
DATE
Originally 1916, revisited in 1939

DESIGNER
Major Peter Norman Nissen

LOCATION
Across the WWII fronts

NUMBER OF STOREYS
1

NUMBER OF HOMES
200,000+



Images courtesy of: Wikiwand.

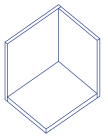
1943

PACKAGED HOUSE

The Packaged House is one of the few architect-inspired attempts to manufacture and market a prefabricated home.

Based on years of research, the system was technically impeccable. It was an open, adaptable system of ten types of 40″ x 120″ panels on a 40″ module. Wachsmann's 'universal joint' was key; it provided great structural stability to the joining of prefabricated panels and allowed two, three and four-way connections. Consequently, the system was extremely flexible.

Great lengths were taken to publicise the system, and despite the opportunities presented by WWII and its aftermath, it never reached production. This was arguably due to the obsession of the designers – the time it took to perfect the system meant funding was lost.



PANELISED

SYSTEM DETAILS
Timber composite panels fabricated offsite

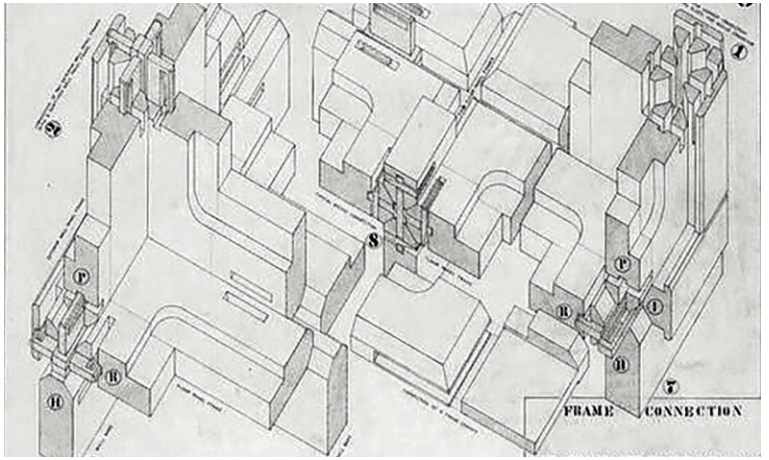
DATE
1943

DESIGNER
Walter Gropius and Konrad Wachsmann

LOCATION
Massachusetts, United States

NUMBER OF STOREYS
1

NUMBER OF HOMES
200



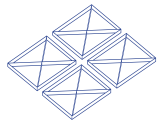
Images courtesy of: North Carolina State University and Shelter Press.

1943

PLYMOUTH NEW SUBURBS

Following WWII, when Plymouth's housing shortage had been exacerbated by the Blitz, Sir Patrick Abercrombie set out a plan for the city. The need for large volumes of housing in a short time, combined with shortages of labour and of materials, led to the use of prefabricated systems that could deliver buildings quickly and cheaply.

Three systems were used to deliver the majority of new houses. Laing's 'Easiform' system used in situ concrete cast into standard forms. Next, Selleck Nichols' 'Cornish Unit' houses were formed of precast concrete posts and planks using the waste from the local clay mines. The upper floors and roofs were timber framed. Finally, the British Iron and Steel Federation's BISF Type A house used a steel frame clad at ground floor with brick or render, and corrugated steel upper walls and roof.



STANDARDISED

SYSTEM DETAILS
A variety of systems – precast concrete, timber and steel frames

DATE
1943-1955

DESIGNER
Various

LOCATION
Plymouth, United Kingdom

NUMBER OF STOREYS
2

NUMBER OF HOMES
32,705

Images courtesy of: Britain from Above and The Architects' Journal.

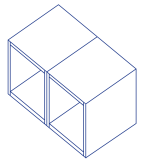
1945

B2 ALIMINIUM BUNGALOW

Churchill's Temporary Housing Programme was set up in 1944 to build 160,000 prefab homes for those who had lost theirs during the Blitz.

There were four standard designs which utilised different building materials. The B2 Aluminium Bungalow was built in aircraft factories from damaged planes and consisted of four parts, which were prefabricated before being transported to site on a lorry. They could then be assembled in about 24 hours, and bolted together on a brick base. All fittings and finishes were added in the factory, including aluminium window frames, pine floors and wooden doors.

The bungalows were always seen as a short term solution, built to last only ten to fifteen years. The final one was demolished in the 1970s.



VOLUMETRIC

SYSTEM DETAILS
Factory built aluminium alloy bungalows from recycled aircrafts

DATE
1945-1948

DESIGNER
Various

LOCATION
Across England and Wales

NUMBER OF STOREYS
1

NUMBER OF HOMES
54,000

Images courtesy of: The Architects' Journal.

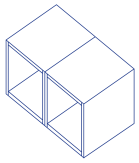
1946

WICHITA HOUSE

The Wichita House was an iteration of Fuller's 1927 Dymaxion House. The Beech Aircraft company had a post-war surplus of aluminium and turned over their factory to him for two years.

Fuller refined his original concept by incorporating a round floor plan instead of a hexagonal one, and reducing the height of suspension. The home was delivered on site as a modular system of prefabricated pieces, including a drop-in bathroom.

Despite being generally well received, it was never produced industrially as Fuller relentlessly felt the design could be improved, whilst Beech Aircraft felt the public was not ready for a "machinelike" home. Fuller and his team moved on from the former aircraft factory in 1947.



VOLUMETRIC

SYSTEM DETAILS
Stainless steel mast, steel tension cables and aluminium skin

DATE
1946

DESIGNER
R. Buckminster Fuller

LOCATION
Kansas, United States

NUMBER OF STOREYS
1

NUMBER OF HOMES
1

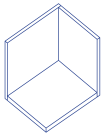
Images courtesy of: The Architects' Journal.

1949

CASE STUDY HOUSE #8

Case Study House #8, a home and studio for and by Charles and Ray Eames, was designed in response to the Case Study House Program in Arts & Architecture magazine which sought experimental designs to address the housing shortage.

The structure of the house consists entirely of off-the-shelf parts from steel fabricator catalogues: 4″ H-columns formed the walls, while 12″ web joists were used for the roof. The steel elements were arranged in regular bays to suit standard panel and window sizes. The walls were then infilled with solid and transparent coloured panels of varying materials: glass, stucco, wood and metal. The house illustrated how prefabricated materials were easy to build with, without sacrificing style and personalisation.



PANELISED

SYSTEM DETAILS
Semi-prefabricated, light steel frame with infill panels, using off-the-shelf steel parts

DATE
1949

DESIGNERS
Charles and Ray Eames

LOCATION
Los Angeles, United States

NUMBER OF STOREYS
2

NUMBER OF HOMES
1

Images courtesy of: ArchDaily.

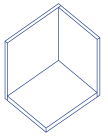
1951

PANELÁKS

Paneláks were factory-produced concrete panels craned into place to form immense apartment buildings in response to the post-war housing shortage in the former Czechoslovakia. Here, more than one million apartments were created using this system.

Nearly identical systems were used elsewhere in the Eastern Bloc and it became ideological; allowing Communist leaders to provide affordable housing whilst putting low skilled labourers on site. However, this sometimes led to poor workmanship and even demolition.

The standardised appearance was seen by the West to be drab and de-individualised. There are exceptions, however, with some buildings remaining popular as they are spacious and incorporate a mix of social classes. Soviet-aligned countries continued to build primarily using this system until the mid-1990s.



PANELISED

SYSTEM DETAILS
Prefabricated concrete panels

DATE
1951-1995

DESIGNER
Unattributed

LOCATION
Across former Czechoslovakia

NUMBER OF STOREYS
3-20

NUMBER OF HOMES
More than one million

Images courtesy of: Read Tiger, Idnes and Pontiacsolstice.

4

EXPERIMENTATION

1953 – 1981

Architecture in the post-war period mirrored the newfound interest in technology and progress. The 1950s and 60s saw an explosion of new building materials coming to market, including plastics and fibreglass, which offered an unprecedented lightness, at times taking inspiration directly from the space travel of the era. Whilst many of these building systems were designed specifically for factory production, architects no longer seriously sought mass production; instead of direct involvement, they tried to shape the world by demonstration and so this period saw many one-off prototypes.

At the same time, precast and pre-stressed concrete panels increased in popularity for built projects all over the world. Whilst persistently pursued in Soviet-aligned territories, the West began to see prefabricated concrete panels as representative of high-density developments as a whole. In the UK, these quickly fell out of favour after being widely built in response to the baby boom. Prefabricated high-rises were viewed as generic, repetitive and of poor quality, and the public's pessimism seemed validated with the collapse of Ronan Point. Following this disaster, government building regulations changed.

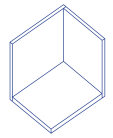
Due to both the ecology movement and slow economic growth of the 1970s, the frenzy of experimentation in modern methods of construction all but ceased in the West.

1953

TECHBUILT HOUSE

Techbuilt, a modular system of structure and skin, used standardised panels to facilitate the mass production of houses. The panels, all at 1.2m wide but of varying lengths, allowed for design innovation throughout the home. Most notably, it could be easily modified, adapted or dismantled and reassembled on a different site.

Every aspect was scrutinised to minimise materials, assembly time, labour and cost – resulting in a sleek, modern looking house that could be erected for only $8 per square foot. By 1963, over 3,000 packages with varying sizes and floor plans had been shipped across the US. Following his success with Techbuilt, Koch expanded the idea to include Techcrete, a modular system of pre-stressed concrete components.



PANELISED

SYSTEM DETAILS
Standardised panel wall, roof and floor components fabricated offsite

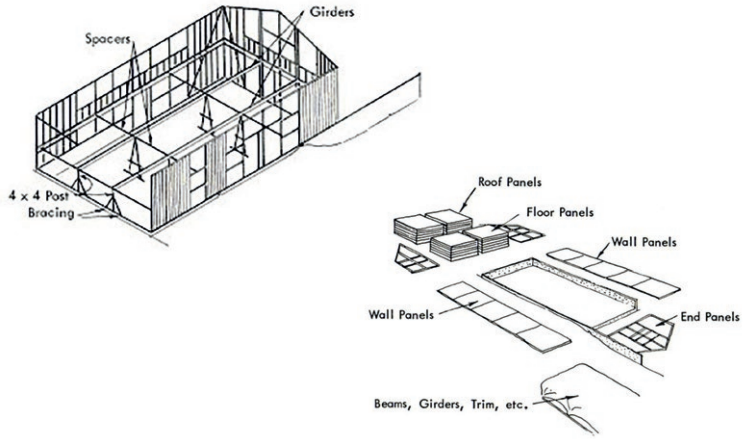
DATE
1953-1963

DESIGNER
Albert Carl Koch

LOCATION
Across the United States

NUMBER OF STOREYS
1-2

NUMBER OF HOMES
Over 3,000



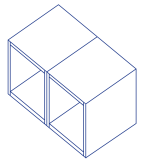
Images courtesy of: Fffound and Curbed.

1956

HOUSE OF THE FUTURE

The House of the Future was designed and installed at the Daily Mail Ideal Home Exhibition in London in 1956. It was a full scale mock-up of a home for a childless couple, set 25 years in the future, which was reliant on technology to interact with the outside world.

The premise was that this mass produced, low cost, prefabricated mode of living would become increasingly popular. The structural basis of the house was a double plastic shell, which would be manufactured in a single piece. However, only the prototype was ever realised; it was built using plywood and covered in plaster and emulsion to give the appearance of smooth plastic.



VOLUMETRIC

SYSTEM DETAILS
Double plastic shell skin

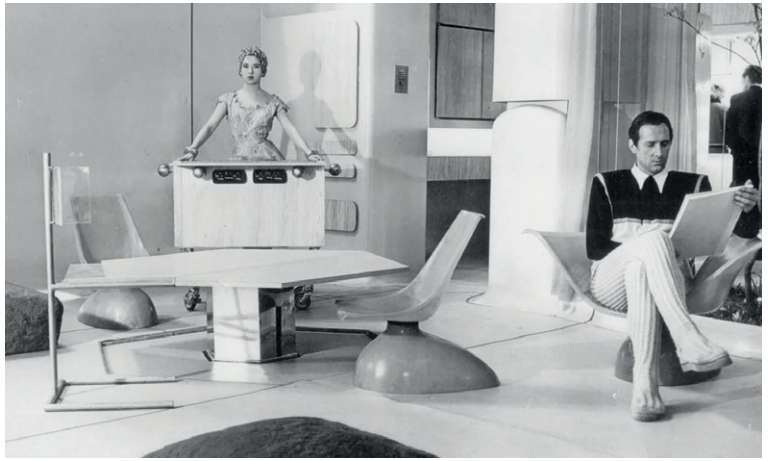
DATE
1956

DESIGNERS
Alison and Peter Smithson

LOCATION
London, United Kingdom

NUMBER OF STOREYS
1

NUMBER OF HOMES
1



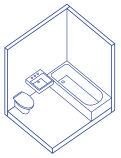
Images courtesy of: Information Society.

1961

KHRUSHCHYOVAKS

In 1954, Soviet leader Khrushchev railed against monolithic concrete buildings (a dig at Stalinist architecture) and advocated 'progressive' prefabricated panels. As both industry and land were under government control, he oversaw experimentation with industrialised housebuilding systems for several years. The result was the Khrushchyovka, an inexpensive prefabricated concrete panel system. This system even became part of Soviet propaganda, which included imagery of panels dangling off cranes.

The objective was to address the severe housing shortage and employ low skilled workers. Uniform design, specialised factories and cheap materials meant homes could be built rapidly and extremely cheaply. However, they were small and overcrowded, and aesthetics were not a priority.



HYBRID

SYSTEM DETAILS
Prefabricated concrete panel

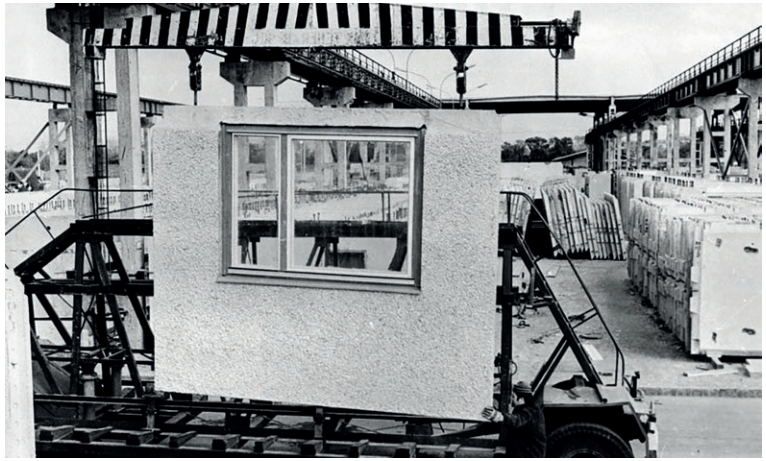
DATE
1961-1990

DESIGNER
Unattributed

LOCATION
Across the former Soviet Union

NUMBER OF STOREYS
3-12

NUMBER OF HOMES
Millions



Images courtesy of: Dom Publishers and Rferl.

1967

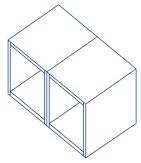
HABITAT '67

Designed for the 1967 World Exposition in Montreal, Habitat '67 is recognised for pioneering the design and implementation of three-dimensional prefabricated homes. The project began as Safdie's master's thesis in 1961 and combines two major housing typologies – the urban garden residence and the modular high-rise apartment building.

The scheme is composed of 354 stacked modules to create 158 homes with 15 different housing types. These vary between 60-160m², each accommodating between one and four bedrooms.

Projections and recesses are organised so that each apartment has a balcony on the roof of the apartment immediately below.

To facilitate prefabrication, a factory was built next to the site to produce the concrete modules. However, construction costs escalated and latter phases were never realised.



VOLUMETRIC

SYSTEM DETAILS
Precast concrete volumes fabricated offsite, connected by steel cables

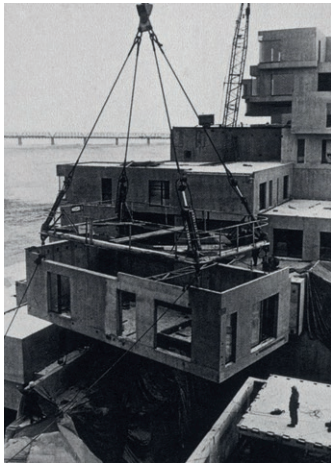
DATE
1967

TEAM
Architect was Moshe Safdie and contractor was Anglin Norcross Quebec

LOCATION
Montreal, Canada

NUMBER OF STOREYS
12

NUMBER OF HOMES
158



Images courtesy of: Architectural Record.

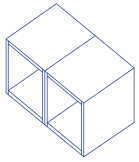
1968

RONAN POINT

Ronan Point, one of many towers erected during the 1960s, was built using a large panel system, which involves casting large concrete prefabricated sections offsite and bolting them together to construct the building.

Just three months after completion, a small gas explosion on the 18th floor blew out the load bearing flank walls. The weakness was identified in the joints connecting the vertical walls to the floor slabs – causing the flank walls to fall away and the south-east corner to progressively collapse. The disaster killed four people, injured 17 and ruined the reputation of the high rise building.

Having been built to regulations, changes were subsequently made to those governing window loading, disproportionate collapse, fire compartmentation and construction defects. Ronan Point was finally demolished in 1986.



VOLUMETRIC

SYSTEM DETAILS
Precast concrete panels using the Larsen & Nielsen large panel system

DATE
1968

DESIGNER
Taylor Woodrow Anglian

LOCATION
London, United Kingdom

NUMBER OF STOREYS
22

NUMBER OF HOMES
80

Image courtesy of: The Avery Review.

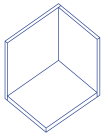
1968

ZIP-UP HOUSE I & HOUSE II

Zip-Up House I, designed for the 1968 'House of Today' competition, was conceived for rapid assembly from mass produced industrial components.

Insulated panels made up the external shell, while automotive windows were sealed with neoprene 'zips'. The internal layout was adaptable with no fixed divisions, made possible by 9m clear structural spans. If extra space was needed, further modules could be added. The house was also designed to be suitable for varied sites, using adjustable legs rather than traditional foundations.

Although Zip-Up House I was never constructed, it was used as the prototype for Zip-Up House II, a less technically advanced version without legs that was built for Richard Rogers' parents in Wimbledon, London.



PANELISED

SYSTEM DETAILS
Factory built, prefabricated components

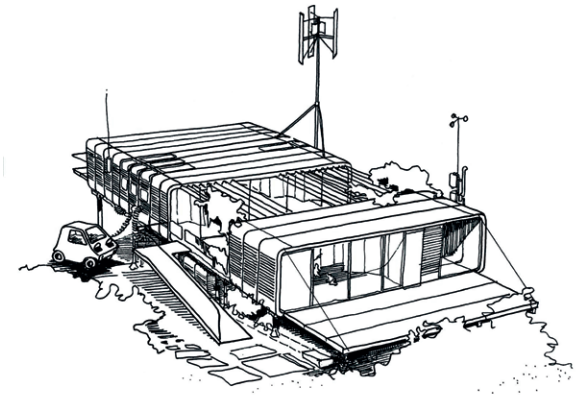
DATE
1968-1990

DESIGNERS
Richard and Su Rogers

LOCATION
London, United Kingdom

NUMBER OF STOREYS
1

NUMBER OF HOMES
1



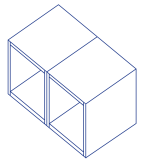
Images courtesy of: Rogers Stirk Harbour + Partners.

1972

NAKAGIN CAPSULE TOWER

This project focused on how to make the most efficient use of space to accommodate everyday essentials. Kisho Kurokawa borrowed the 'capsule' terminology from the aerospace industry and retrofitted a rectangular cabin of 2.4m x 3.6m with a built-in bathroom, double bed, desk, storage spaces, TV, tapedeck, typewriter, calculator, clock radio and two-burner stove. Capsules were cantilevered from permanent precast concrete cores and completely prefabricated offsite, only needing to be hoisted into position and hooked up to services.

Contrary to Kurokawa's original vision, all 140 capsules have now outlived their intended 25 year life span. Whilst many are seeking to preserve the building as a forerunner to the offsite movement, it has become more viable to replace it.



VOLUMETRIC

SYSTEM DETAILS
Steel truss boxes clad in reinforced steel panels insulated with asbestos, coated with rust-preventative paint

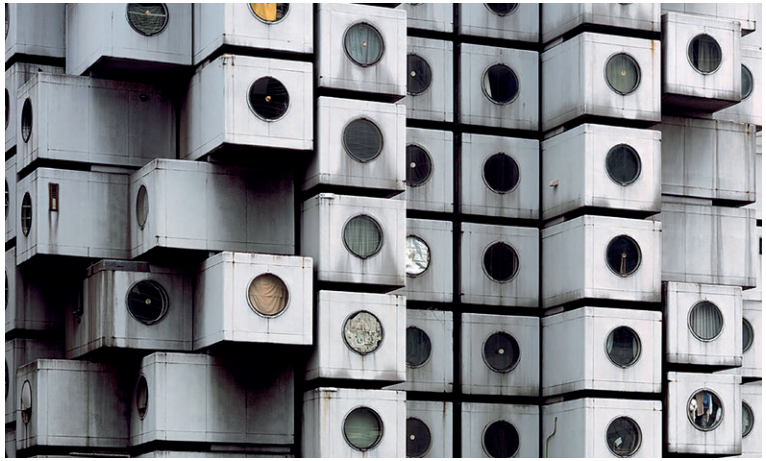
DATE
1972

DESIGNER
Kisho Kurokawa

LOCATION
Tokyo, Japan

NUMBER OF STOREYS
14

NUMBER OF HOMES
140 capsules



Images courtesy of: moreAEdesign and Archaic magazine.

1976

DRESEDEN PROHLIS

This project focused on how to make the most efficient use of space to accommodate everyday essentials. Kisho Kurokawa borrowed the 'capsule' terminology from the aerospace industry and retrofitted a rectangular cabin of 2.4m x 3.6m with a built-in bathroom, double bed, desk, storage spaces, TV, tapedeck, typewriter, calculator, clock radio and two-burner stove. Capsules were cantilevered from permanent precast concrete cores and completely prefabricated offsite, only needing to be hoisted into position and hooked up to services.

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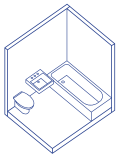


HYBRID

SYSTEM DETAILS
Precast concrete sandwich panel walls with core insulation

DATE
1976-1981

TEAM
Architect was Udo Fehrmann and Gerhard Landgraf and contractor was VEB Wohnungsbaukombinat

LOCATION
Dresden, Germany

NUMBER OF STOREYS
5-17

NUMBER OF HOMES
10,000

Images courtesy of: Wikipedia Commons and Duetches Architektur Forum.

5

RENEWED INTEREST

1982 – 2012

Although Postmodernists were largely uninterested in offsite manufacturing (it was seen as a Modernist fantasy), a resurgence of experimentation rolled in with the digital era. The computer promised solid modelling, 3D printing and laser cutting, changing both the design and production process for buildings.

Political pressure increasingly pushed homes to higher standards of quality, better affordability and greater productivity, and many found tightly controlled factory conditions granted a means of meeting these more onerous requirements. In 1998, Sir John Egan's report, 'Rethinking Construction', suggested prefabrication should be a key part of reforming the UK's construction industry. The Housing Forum was launched in the same year, which included the Offsite Manufacturing Working Group. Several subsequent research initiatives and government reports supported modern methods of construction.

Prefabricated buildings became more appealing to the public as digital technology allowed for mass customisation, shunning the previous association with bland mass produced design. In 2003, Dwell magazine launched a prefabricated housing competition with glossy spreads filling these issues. Two large offsite manufacturing exhibitions were held in the US, at the Walker Art Museum in 2006 and at the Museum of Modern Art in 2008. The ideals of prefabrication, such as affordability and efficiency, had been revived but with much higher expectations.

1983

WORLD IN ACTION DOCUMENTARY

World in Action was a British investigative current affairs programme that frequently had a major impact on events of the day.

One episode in 1983 caused the timber frame housing market in England and Wales to crash – alleging that this construction could not produce houses that would last. It cited rot in the frames of relatively new homes on a Cornwall estate, and pointed to timber frame as a contributing factor to a house fire in the Midlands.

The documentary caused such a furore that, suddenly, no one wanted to buy a timber frame home, even though the claims were widely discredited.

Barratt Developments subsequently complained to the Independent Broadcasting Authority and the Broadcasting Commission that the programme was unjust and unfair; but the damage was done.

Images courtesy of: Barratt Developments and The Guardian.

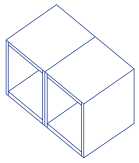
1997

BOKLOK HOUSES

The BoKlok House is a joint venture by IKEA and Skanska, offering affordable homes to the masses. Terraced housing and apartment buildings can be created using the timber framed volumetric system.

The only UK BoKlok project was constructed in Gateshead using Kingspan's Optima closed panel system, which features whole walls, including doors and windows. About 80% of the construction happens in a factory. The floor is constructed using open panel timber cassettes and the roof is a traditional timber trussed construction. Cladding is then installed on site.

Despite being incredibly popular in Sweden, no further BoKlok developments have been built since in the UK, with the recession cited as a reason for the homes failing to sell.



VOLUMETRIC

SYSTEM DETAILS
Volumetric system (Scandinavia); Kingspan's Optima panel system (UK)

DATE
1997 (Scandinavia); 2009 (UK)

TEAM
Designed by IKEA and constructed by Skanska; UK versions were manufactured by Pace Timber

LOCATION
Across Scandinavia; Gateshead, UK

NUMBER OF STOREYS
2

NUMBER OF HOMES
5,000 in Scandinavia; 93 in the UK

Images courtesy of: BoKlok.

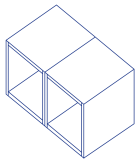
2001

CASPAR

A competition sponsored by the Joseph Rowntree Foundation sought proposals for new housing that kept costs to a minimum whilst providing high standard, affordable accommodation.

Levitt Bernstein's winning solution, CASPAR (City-centre Apartments for Single People at Affordable Rents) centred on the design of prefabricated units that were quickly assembled to fully construct the building just 36 weeks from site possession. 46 unsubsidised one and two bedroom apartments were provided in a striking and sustainable semi-circular building.

However, five years after completion, the building was evacuated following the identification of a small chance of serious structural problems in high winds. The site remains empty to this day, much to the disappointment of residents, who reportedly were very happy with their homes.



VOLUMETRIC

SYSTEM DETAILS
Timber frame with half-modular, half-flat pack component system

DATE
2001

TEAM
Architect was Levitt Bernstein and contractor was Kajima

LOCATION
Leeds, United Kingdom

NUMBER OF STOREYS
5

NUMBER OF HOMES
46

Images courtesy of: Levitt Bernstein.

2003

DWELL PREFAB HOUSING COMPETITON

This project was the brainchild of Allison Arieff, editor of Dwell magazine. In 2003, she challenged 16 architects to design a 2,000ft² factory-built modern home that could be made for $200,000.

The three shortlisted designs featured in the fifth anniversary issue of Dwell. Arieff said, "One of the major obstacles prefab has faced has been effective collaboration among designers, manufacturers and clients. This partnership brings together experienced parties across that spectrum... As a result, we're able to offer the public not one but three beautifully designed, highly functional, and eminently livable homes." The winning design by Resolution: 4 Architecture was built by New Era Building Systems.

Dwell, arguably more than other publications, has brought factory-produced housing increasingly into the mainstream. In addition to the housing competition, Dwell has dedicated entire issues to prefabricated housing since 2001.

Images courtesy of: Dwell.

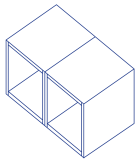
2003

RAINES COURT

This was the first mortgageable volumetric residential scheme in the UK, using a system of prefabricated modules that can be manufactured and delivered to site fully serviced and fitted out. Stacked into position at 30 minute intervals gave the impression of an almost instant building.

The size of each module (12m x 3.8m) was dictated by the limitations of transport on public highways, and the six storeys of the building was the maximum height the light steel module could self-stack.

Despite the rapid construction process and reduction in waste, the modular system at Raines Court required a longer design process, and with the sub-consultants unwilling to install the cladding offsite, the structure spent more time unclad which resulted in damp ingress.



VOLUMETRIC

SYSTEM DETAILS
Light steel room modules

DATE
2003

TEAM
Architect was Allford Hall Monaghan Morris and manufacturer was Yorkon

LOCATION
London, United Kingdom

NUMBER OF STOREYS
6

NUMBER OF HOMES
64

Images courtesy of: Project Journal.

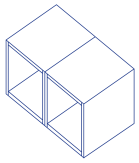
2007

OXLEY WOODS

The 2005 Design for Manufacture competition brief was to design and build high quality homes for just £60,000 each. Following RSHP and Taylor Wimpey's win, they were awarded the Oxley Park site to realise their project.

The concept is based in splitting homes into 'server' and 'serviced' zones. All elements are prefabricated offsite, then transported flat for assembly on site, including timber frame for walls, ceilings, floors, bathrooms, kitchens, utility rooms and staircases. The server spaces (bathrooms, kitchens, staircases and utility rooms) are standardised, allowing for greater flexibility in the habitable spaces.

However, following completion the scheme has suffered a number of defects, particularly related to moisture, and with the contractor since going into liquidation, these have yet to be resolved.



VOLUMETRIC

SYSTEM DETAILS
Timber frame with half-modular, half-flat pack component system

DATE
2007

TEAM
Architect was Rogers Stirk Harbour + Partners, developer was Taylor Wimpey and contractor was Wood Newton

LOCATION
Milton Keynes, United Kingdom

NUMBER OF STOREYS
3

NUMBER OF HOMES
145

Images courtesy of: Urbangrit and Rogers Stirk Harbour + Partners.

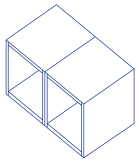
2009

STADTHAUS

Stadthaus, Murray Grove was the first urban housing project to be constructed entirely from prefabricated solid timber. The tower was built from a tight honeycomb of structural panels, with a timber core providing stability, and inset balconies with structural balustrades strengthening the outer structural wall.

Completed within 49 weeks, the project demonstrates that cross-laminated timber is a financially viable, environmentally sustainable and beautiful replacement for concrete and steel.

Compared to conventional construction, embodied energy was reduced by an equivalent of 340 tons of carbon emissions. Approximately 200 tons of carbon are also 'locked into' the wood, equivalent to the energy that will be used to heat, cool and operate the building for 20 years, giving the building a negative carbon footprint until almost 2030.



VOLUMETRIC

SYSTEM DETAILS
KLH cross-laminated timber panel system

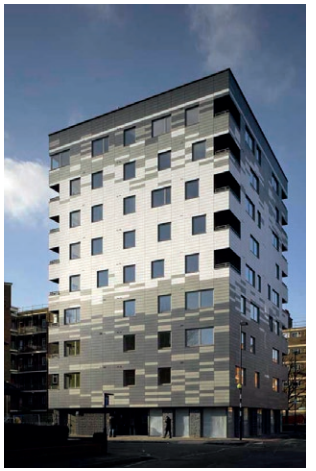
DATE
2009

TEAM
Architect was Waugh Thistleton and contractor was Telford Homes

LOCATION
London, United Kingdom

NUMBER OF STOREYS
9

NUMBER OF HOMES
29



Images courtesy of: Tesseract Design and Plataforma Arquitectura.

6

LOOKING AHEAD

2013 –

In the context of the UK's housing crisis, the promise of offsite technology is now more attractive than ever. The potential to deliver high quality homes on a large scale provides a real opportunity to ease the shortage of homes. Private developers, local authorities and housing associations are increasingly turning to offsite production, using a number of innovative models.

From a sustainability perspective, offsite offers huge advantages. Systems are rigorously tested and verified before arrival, and building materials calculated to reduce waste from the outset. With the majority of construction work taking place in a factory, there is greater safety for workers and reduced disruption on site. Furthermore, build times can be drastically cut without sacrificing design quality. Yet, offsite still faces challenges; due to preferred methods of procurement in the UK, many schemes are designed to planning based on traditional construction and materials, meaning it is less financially viable to switch to an offsite system later.

For now, the future for offsite seems focused on mass customisation; standardising the process but not the product, allowing clients to create unique designs and extend, alter or relocate as desired. However, whatever the approach, the most important element of a successful offsite project is early collaboration between designer and manufacturer. This key dialogue results in a stronger design that works with, not against, the building technology.

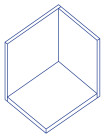
2015

HANHAM HALL

Hanham Hall was the first site in the government's Carbon Challenge initiative and has become one of the first zero-carbon communities in the UK.

Homes were built using the Kingspan TEK SIPs system to create a highly insulated and airtight building fabric, comprising 142mm thick structural insulated panels connected with a jointing system for walls and roofs, and intermediate floors using timber I-beams.

In addition, every home has high performance timber windows and insulated doors, meaning residents can reduce their carbon footprint by 60% without any lifestyle changes. Since completion, the eco village has become a recognised benchmark for energy efficient schemes.



PANELISED

SYSTEM DETAILS
Kingspan TEK structurally insulated panels

DATE
2015

TEAM
Architect was HTA Design LLP and contractor was Barratt Homes

LOCATION
Bristol, United Kingdom

NUMBER OF STOREYS
2-3

NUMBER OF HOMES
187

Image courtesy of: HTA Design.

2015

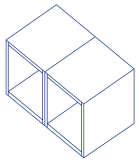
Y CUBE

This scheme responds to research findings that young people leaving homelessness hostels and supported housing schemes couldn't afford to rent in the private market.

The 26m² studios are built as self-contained units in a factory for £30,000 each, before being delivered on site with all the services incorporated. This results in a modular, demountable system of apartments, described as 'plug and play', which can be built on any number of brownfield sites.

Additional units can be added and whole developments taken apart and rebuilt in new locations.

By utilising offsite technologies, the YMCA has been able to pass savings made in the manufacturing process onto residents, with homes rented out at 65% of the local market rate.



VOLUMETRIC

SYSTEM DETAILS
Insulshell panels assembled volumetrically with glue-laminated timber sections

DATE
2015

TEAM
Architect was Rogers Stirk Harbour + Partners and contractor was SIG Build

LOCATION
London, United Kingdom

NUMBER OF STOREYS
3

NUMBER OF HOMES
36

Images courtesy of: Dezeen.

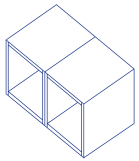
2016

461 DEAN

This residential development is currently the tallest modular high-rise in the world, constructed using 930 volumetric units at the nearby Brooklyn Navy Yard industrial park. Homes were built in 23 different configurations, with countertops, backsplashes and appliances also installed in the factory.

As well as the spacious homes, residents can enjoy a number of shared facilities, including a large lounge, fitness centre, yoga studio and game room. There are also retail units and a concierge on the ground floor. 50% of homes in the build to rent scheme are affordable to low and middle income households.

Although intended to benefit from rapid construction, it greatly slowed due to a dispute between the factory and developer.



VOLUMETRIC

SYSTEM DETAILS
Steel frame with volumetric pods

DATE
2016

TEAM
Architect was SHoP Architects and contractor was Turner Construction Company

LOCATION
New York, United States

NUMBER OF STOREYS
32

NUMBER OF HOMES
363

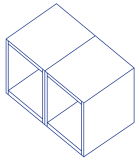
Images courtesy of: SHoP Architects.

2016

hoUSe

Urban Splash's hoUSe aims to combine the cost benefits of offsite construction with the quality offered by architect-designed properties. The modular system allows customers great flexibility in the design of their homes, including the number of storeys and bedrooms and the choice of traditional or open plan layouts.

Each home is prefabricated as a series of timber-framed shells with fixed positions for kitchens and bathrooms. Once the modules have been transported to site, they are craned into position. Partition walls are added later, in accordance with the layouts selected by residents. In total, it takes 16 weeks for the home to be built and delivered, and a further four weeks to finish the interiors.



VOLUMETRIC

SYSTEM DETAILS
Prefabricated timber-framed volumetric shells

DATE
2016

TEAM
Architect was ShedKM, developer was Urban Splash and fabricator was Insulshell

LOCATION
Manchester, United Kingdom

NUMBER OF STOREYS
2-3

NUMBER OF HOMES
43

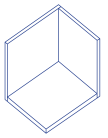
Images courtesy of: Urban Splash and Housebuilder & Developer.

2016

LITTLE KELHAM

This scheme, which puts the environment at the fore of design and construction considerations, consists of a range of one to four bedroom homes in townhouse and apartment buildings, alongside a number of social spaces, shops and cafés.

The main structures have been built using Innovaré's i-SIP system, configured to perform to Passivhaus guidelines without compromising on aesthetics. The system includes both insulated and non-insulated floor cassettes, insulated roof cassettes and i-SIP wall panels. In addition, triple glazing ensures energy efficient temperature regulation and fresh air all year round. The new homes use only 10% of the energy that a standard building would utilise.



PANELISED

SYSTEM DETAILS
Innovaré i-SIP (structurally insulated panels) system

DATE
2016

TEAM
Architects were Bauman Lyons, Hodson Architects and Cal Architects, and fabricator was Innovaré

LOCATION
Sheffield, United Kingdom

NUMBER OF STOREYS
4

NUMBER OF HOMES
153

Images courtesy of: Little Kelham.

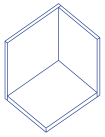
2017

DALSTON LANE

This is the largest cross-laminated timber (CLT) building in the world, utilising the technique for external, party and core walls, floors and stairs.

The CLT panels were made to measure offsite and delivered with cut-outs for doors and windows and preformed holes for soil pipes and other penetrations. They were then craned into position and simply attached to the adjoining structure using off-the-shelf angle brackets, nail plates and self-tapping screws and bolts.

Using timber in this way has significantly reduced the building's carbon footprint in terms of material production, on-site time and energy consumption. Weighing just a fifth of a concrete building of this size, the number of deliveries needed during construction has also been reduced by 80%.



PANELISED

SYSTEM DETAILS
Cross-laminated timber panels fabricated offsite with reinforced concrete frame and brick cladding

DATE
2017

TEAM
Architect is Waugh Thistleton and contractor is Regal Homes

LOCATION
London, United Kingdom

NUMBER OF STOREYS
10

NUMBER OF HOMES
121

Images courtesy of: Waugh Thistleton.

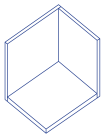
ONGOING

nHOUSE

nHouse is a new product from the commercial arm of Studio RHE: a two storey, three bedroom modular home built using offsite techniques for construction anywhere.

The standard nHouse is 6m x 12m x 7m and available as a detached, terraced or semi-detached unit. Cross-laminated timber panels are prepared offsite and assembled into four volumetric modules, with construction taking just three days using quad-click technology.

The homes cost £190,000 each, but with a minimum order of three homes, are being marketed at private developers, housing associations and local authorities as a means of providing large numbers of high quality, affordable housing. The first nHouse is currently in development and will be available to visit in July 2017.



PANELISED

SYSTEM DETAILS
Cross-laminated timber panels, assembled volumetrically and fully fitted

DATE
Ongoing

TEAM
Architect and developer is nHouse Commercial Ltd (Studio RHE)

LOCATION
Unbuilt

NUMBER OF STOREYS
2

NUMBER OF HOMES
Unbuilt

Image courtesy of: Building Design.

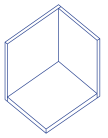
ONGOING

BEECHWOOD WEST

This project forms the final phase of the regeneration of the Craylands Estate. The 251 new homes will be designed to resident's individual specifications and constructed using a modular system before being delivered to site for assembly.

Homes will be built using a cross-laminated timber (CLT) system. This is inherently sustainable as the timber locks away carbon rather than omitting it (as happens during traditional construction processes), plus it is sourced only from managed forests.

Swan's property development arm, NU living, will build the homes in a new factory close to the site. At full capacity, this will be able to deliver over 300 homes a year.



PANELISED

SYSTEM DETAILS
Cross-laminated timber panels

DATE
Ongoing

TEAM
Architect is Pollard Thomas Edwards and developer is Swan Housing Group (NU living)

LOCATION
Basildon, United Kingdom

NUMBER OF STOREYS
2

NUMBER OF HOMES
251

Images courtesy of: Pollard Thomas Edwards.

7

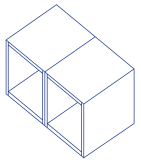
LEVITT BERNSTEIN PROJECTS

Over the following pages we share some of our projects – some realised and some still on the drawing board – which utilise offsite. Our experience spans from volumetric to panelised systems for both new build and extensions, but regardless of the technology, it is always used to facilitate good design and strong placemaking.

JOHN DODGSON HOUSE

This rooftop extension provides an additional 49 new postgraduate study bedrooms to an existing hall of residence for University College London.

An inventive off-site volumetric modular construction was used to keep construction time to a minimum, and works were completed within one academic year. Each bedroom was fitted out in the factory with an en-suite bathroom pod, desk, wardrobe, and light fittings. Once in position, the units were clad with glazed facades, designed to create a layered appearance and use natural and artificial light to animate the built elevations.



VOLUMETRIC

SYSTEM DETAILS
Bedrooms fitted out in the factory with an ensuite bathroom pod, desk, wardrobe and light fittings

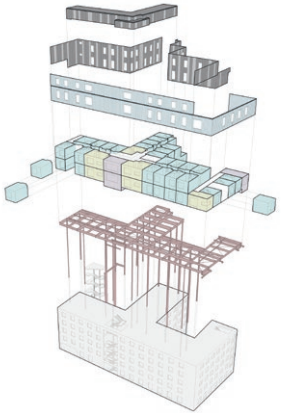
DATE
2013

TEAM
Architect is Levitt Bernstein

LOCATION
Camden, London, United Kingdom

NUMBER OF STOREYS
2 (on an existing 5 storey building)

NUMBER OF BEDROOMS
49

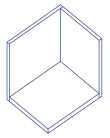


Images courtesy of: Levitt Bernstein.

FORSTER HOUSE

Our plans for Forster House in Bromley received planning consent in February. The scheme for Phoenix Community Housing will deliver 22 new homes, all of which are affordable social rent. The new building infills a vacant site next to an existing housing block, with landscape improvements to the frontage and a new courtyard to the rear.

The homes will be constructed using cross-laminated timber (CLT) panels for the external and internal walls. The CLT will fully form the structure above ground level. Offsite construction technology is being embraced on this project to reduce the programme length, and to minimise disruption to existing residents with restricted access conditions to site.



PANELISED

SYSTEM DETAILS
Cross-laminated timber panels

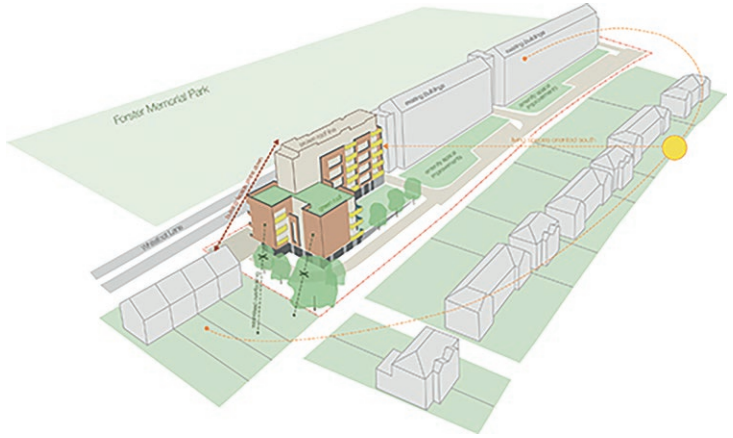
DATE
Ongoing

TEAM
Architect is Levitt Bernstein and contractor is Saltash

LOCATION
Bromley, London, United Kingdom

NUMBER OF STOREYS
2

NUMBER OF HOMES
22



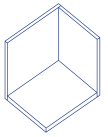
Images courtesy of: Levitt Bernstein.

REDBRICK COMMUNITY CENTRE

The redevelopment of the Redbrick Estate in Old Street will provide 55 homes, new community facilities and retail space, and significant improvements to the communal outdoor spaces and parking areas as part of Islington's council home building programme.

The new community centre is a single storey zinc clad building. Its asymmetric saw-tooth roof will be a unique and beautiful feature of the estate prominently located on Old Street.

We are working with Innovaré to create a SIPs building that will rest lightly over an existing basement. This simple structural solution will shorten the programme by weeks and reduce the build cost.



PANELISED

SYSTEM DETAILS
Structurally insulated panels

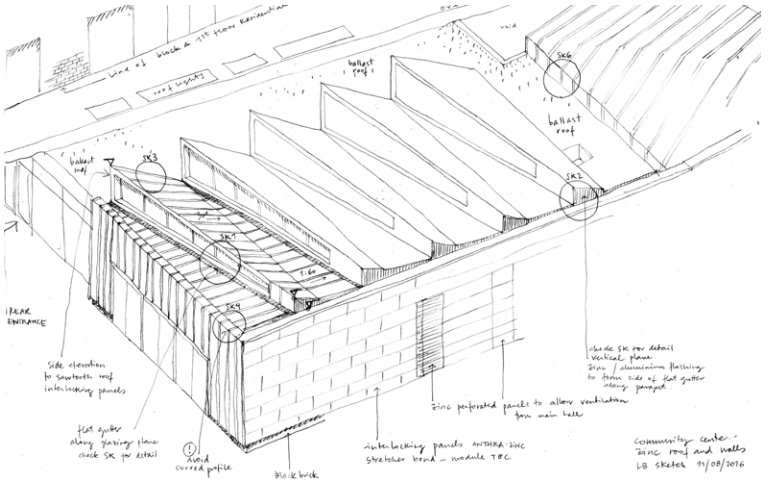
DATE
Ongoing

TEAM
Architect is Levitt Bernstein and contractor is Osborne

LOCATION
Islington, London, United Kingdom

NUMBER OF STOREYS
1

NUMBER OF HOMES
N/A



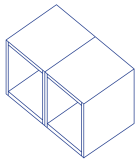
Images courtesy of: Levitt Bernstein.

DEVONSHIRE PARK PLAYERS' VILLAGE

Dating from 1873, Devonshire Park has long been an attraction within Eastbourne and for the wider south coast. As well as being home to three theatres, it hosts major tennis tournaments including the women's warm-up contest for Wimbledon.

We were invited to participate in a design competition and subsequently appointed to enhance the tennis facilities; carefully restore three listed theatres and provide a new conference building and public plaza.

The Players' Village building provides changing facilities for the players, and was constructed using a volumetric steel frame offsite system, which was then clad in timber on site. The building needed to be fully complete ahead of the 2017 tennis tournament; utilising offsite technology meant construction of the entire building only took 100 days, from drawing board to completion.



VOLUMETRIC

SYSTEM DETAILS
Volumetric steel frame

DATE
2017

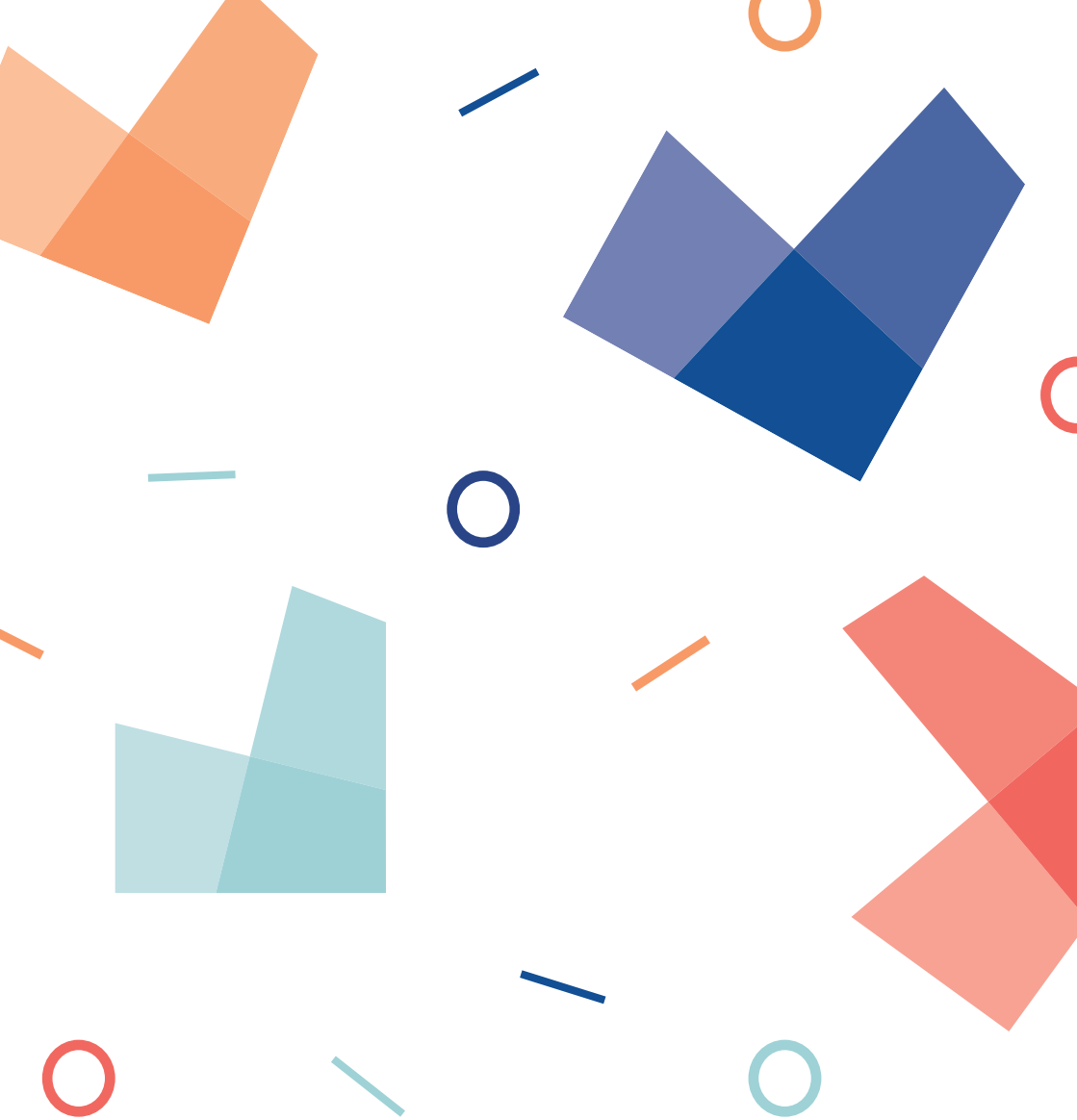
TEAM
Architect is Levitt Bernstein and contractor is Kier

LOCATION
Eastbourne, United Kingdom

NUMBER OF STOREYS
2

NUMBER OF HOMES
N/A

Images courtesy of: Levitt Bernstein.



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