A solution for London?
FACTORY-MADE HOUSING – A SOLUTION FOR LONDON?

This NLA Research was published by New London Architecture (NLA) in October 2018. It accompanies the NLA exhibition and events programme Factory-made Housing: a solution for London? taking place from October 2018 to January 2019, forming part of NLA’s year-round Housing programme, which investigates the future of housing design, delivery and construction.
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**IMAGE**


©Tide Construction Limited & Vision Modular Systems
Richard Crossman was Labour Minister for Housing and Local Government between 1964 and 1966 in the government of Harold Wilson who had promised to forge a new Britain in the ‘white heat of technology’. Crossman’s role was to harness technology to build houses, lots of them. “It does of course mean factory-built housing” he said at the time “but factory-built housing can be just as good as production-line cars. And I think we are going to move to this. The only thing is to make sure they are done by good architects and well-landscaped, that will get over any danger of monotony; the main thing is you standardise the production.”

It didn’t quite work out like that. Yes, they produced the numbers, but the products were shoddily made and erected, the landscaping barely existed and they were monotonous to a degree. The word ‘prefabricated’ has never recovered its reputation.

This time we have to do better. Building technology is much improved, new supply chains can lead to better quality of outcomes and, unlike the 60s when concrete was the only material available, we have a greater variety of structure, cladding and methodology at our fingertips. We also have the benefits of digital technologies which can deliver many benefits of quality, design efficiency, sustainability, flexibility and variety. Nevertheless the same issues of mass production apply – make a mistake once and you make it many times.

The failures of the 1960s were a huge setback for the concept of factory-made housing, although its benefits were realised by the commercial and hotel sectors with prefabricated cladding systems and volumetric pods. Today, attitudes have changed as a result of the Farmer Review, the shortage of on-site labour and the huge numbers of homes that have to be delivered.

This report looks at the current state of play and how the design and construction industry is responding to the challenges of delivering numbers and quality. Done well, offsite construction can deliver both, but we must remind ourselves of Crossman’s hubris and be vigilant of great political pressure without the support and funding to go with it.
The lack of housing to accommodate a growing population is one of the most challenging issues that London is facing. To reach the Mayor’s target of delivering more than 60,000 new homes in London each year – and indeed the UK Government’s overall target of 300,000 nationally per year – radical new approaches in housebuilding are being sought to accelerate the pace of delivery, at a time when local authorities have been set demanding targets for completion.

‘Factory-made’ homes are now being explored and advocated by national and Mayoral policy as one of the key potential solutions to meeting acute housing demand, not only in London but across the UK. The UK Government’s Housing White Paper (2017) notes that industry reports suggest homes constructed offsite can be built up to 30 per cent more quickly than traditional methods and with a potential 25 per cent reduction in costs. Furthermore, using a high proportion of precision-manufactured components, materials and systems is reported to bring other significant advantages over traditional construction, including superior quality control through prefabrication, better energy performance and reduced site deliveries, noise and pollution – and thus less disruption to existing communities.

However, factory-made housing still accounts for a very small proportion of the homes built in London each year – less than 10 per cent of total construction output. Concerns about the robustness of supply chains, safety, and product standards, and a lack of detailed guidance for those who wish to explore these methods are among the factors that are currently inhibiting the wider take-up of innovative or new manufacturing processes in the construction and delivery of housing.

Similarly, the failure of many of the postwar ‘prefab’ and system-built blocks built on a large scale has resulted in widespread negative perceptions about ‘prefabrication’ that endure today.

Perhaps more significantly, housebuilding in London is severely hampered by a lack of skills and workers. As Mark Farmer’s hard-hitting recent review of the construction industry has shown, ingrained outlooks and procedures need to be challenged, and indeed overturned, if we are ever to achieve a major stepchange towards meeting housing targets. Many others in the industry agree that along with expanded capacity, a more diverse market, and safeguarding quality and standards, we need a new ‘modular mindset’ to revolutionise the ways in which housing should be planned, procured, designed and built.

Critical to the emphasis has to be on process as well as product – the use of manufactured elements is not new. It is just an alternative way of delivering the same outcome. The sophistication and range of manufactured systems and components available today – and the opportunities that digital techniques and processes offer – mean that factory-made construction has enormous potential to make a positive contribution to London’s housing needs. However, the same level of consideration needs to be given to design, placemaking, amenity, infrastructure and the public realm, as it would for any project built using traditional construction methods, to ensure that quality remains at the core of delivering new factory-made homes that will support and sustain London’s communities for the long term.

What makes the ‘modular mindset’?

Informed by interviews with leading built environment professionals at the forefront of delivering factory-made housing, this research paper examines how factory-made housing has evolved in the UK and internationally, presents the case for a new paradigm of housebuilding, and highlights a wide range of perspectives and projects to demonstrate how high-quality and successful prefabricated homes can transform a place. Factory-made housing will never be a complete solution for every London home, and its take up in contemporary projects is still in relative infancy, but it offers unique opportunities to accelerate the delivery of high-quality, affordable and sustainable homes for London’s citizens now and in the future.

A new approach or ‘mindset’ is required if we are to unlock the potential of factory-made methods of construction to improve the delivery, sustainability and quality of London’s housing. This demands:

Sustained collaboration and cooperation

A manufacturing-led mindset requires early, open and detailed engagement between the client, designer, manufacturer and contractor to achieve the right outcome. Detailed project frameworks and agreements are essential as specifications and detailed designs have to be confirmed ahead of fabrication; factory-made buildings are not ‘add ons’ to existing processes but require a different starting point.

Transparency and knowledge sharing

Maximising the benefits of manufacturing to deliver housing ‘not only faster but better’ means using rapidly advancing digital applications. Employing these effectively to make building more efficient demands transparency in relation to data sharing. Open communication is also required for understanding the limitations as well as the opportunities provided by different factory-made materials and systems, as not all are appropriate for all sites.

Bold leadership, commitment and ambition

As this publication shows, factory-made housing in a variety of options can be appropriate for a range of different sites in London, but it has yet to be become mainstream. There is an understandable concern to avoid repeating the mistakes of the past, but one of the main challenges faced is embedded attitudes of caution. Using a manufacturing-led approach involves challenging existing conventions and responsibilities and a willingness to embrace innovation.

Flexibility and agility

Factory-made buildings are the ‘disruptor’ of the conventional construction industry, in the same way that co-working spaces, for example, have altered the form and scope of London’s workplaces. Using modern manufacturing methods presents an opportunity to explore new and flexible building typologies adapted to living and working in the 21st century, and to take full advantage of innovations such as digital planning to make decision-making quicker and more agile.
As a starting point for those seeking explanations, this glossary includes terms used synonymously (or nearly so) with ‘factory-made housing’, as well as commonly used categories, materials, components, processes and techniques. Some terms are relatively interchangeable but it is important to note that some are not and can be easily confused: a ‘modular’ building is usually factory-made but not all factory-made buildings are modular, for example.

This is not by any means intended to be a comprehensive list, but an introduction to some of the terminology used.

**GENERAL TERMS AND SYNONYMS**

**Industrialised building system (IBS)**
A term used especially in Asia to describe all aspects of industrialised prefabrication and construction.

**Modular construction**
Often used synonymously with ‘factory-made’, but strictly speaking this term refers to pre-engineered building units that are delivered and assembled as large or volumetric components or as substantial parts of a building. These can include whole rooms, parts of rooms, or separate highly serviced units such as toilets or lifts.

**Modern methods of construction (MMC)**
A term used broadly to describe contemporary innovations in housebuilding, many of which are new technologies or involve partial or complete production in a factory. It is the term generally used by the UK Government. It has been described as ‘a wide range of processes that aim to produce more sustainable social housing of better quality, to cost and in less time’. This process will involve the use of efficient management processes and may involve elements of offsite manufacture’.

**Offsite construction**
A term used to describe buildings, structures or parts manufactured (and wholly or partially assembled) away from the site before installation in their final position. This term is widely used in the UK, US and Australia.

**Precision manufactured homes/housing**
Homes built using a high proportion of components which are produced using modern and technologically driven methods of manufacture, with this production often taking place offsite and the components then assembled onsite. This is the preferred term and definition used by the Mayor of London and GLA.

**Prefab**
Made from a set of parts produced in a factory. A prefabricated building is not always a modular building, as the latter refers to structures in which larger components or rooms are factory-made.

**Open panel system**
Pods, which are typically formed from concrete floor slabs, structural columns and beams. They can be used in single units or in multiples. Fixtures and fittings are usually added and finished in the factory to reduce installation time and work on site. Some volumetric units can be joined together on site to form the whole building without the need for any extra structural support.

**Pod**
A substantial building element or volumetric unit that is generally non-loadbearing and is fitted with fixtures and finishes in the factory. Typically these are complete shower rooms, kitchens, utility cupboards, bathrooms and office washrooms. Pods are commonly steel frame, composite or – especially for smaller units – made from glass reinforced plastic (GRP).

**Subassembly**
Large elements of the building that can be factory-made but do not form the primary structure. These include foundation systems and cassette panels.

**Volumetric (assembly)**
Three-dimensional units built in factory conditions that enclose usable space and are then delivered and installed in or on a building or structure. Each unit can be described as a module or – especially for kitchen, bedroom and bathroom units – a pod. They can be used in single units or in multiples. Fixtures and fittings are usually added and finished in the factory to reduce installation time and work on site. Some volumetric units can be joined together on site to form the whole building without the need for any extra structural support.

**Categories and Processes**

**Closed panel system**
Similar to open panel systems (see below) in that the structural elements of the building are delivered to the site in flat panels. However, they generally include more elements made and added in the factory such as lining materials and insulation and sometimes cladding, internal finishes, services, doors and windows.

**Component assembly**
Building components such as windows, doors and light fittings manufactured offsite but requiring delivery, storage and assembly using traditional skills onsite.

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**Kit house**
A type of self-build home made from a series of prefabricated components bought from a supplier (who may design and manufacture them) and then assembled on site to create a completed house. ‘Suppliers of kit houses may offer a range of components that can be selected and assembled in a number of ways so that the client is able to tailor the design to their personal preferences.’

**Non-volumetric assembly**
Larger elements preassembled in factory-controlled conditions such as complete door sets with frame, lining and glazing, and hardware which require fewer onsite trades to fit and finish on site.

**Open panel system**
The construction of a structural frame using panels made and assembled on site. Services, insulation, cladding and internal finishes are installed on site.

‘**Plug and play’**
A term describing a prefabricated and assembled unit with mechanical, electrical and plumbing services installed (in the ceiling, under the floor or in service-risers) in the factory. On site the services are then connected directly into the mains.

**Hybrid system**
A system of construction in which complete rooms such as kitchens and bathrooms are typically formed from volumetric units (sometimes referred to as pods), with the rest of the structure made from framing and panelised systems.

**Design for Manufacture and Assembly (DFMA)**
An approach to design that focuses on ease of manufacture and efficiency of assembly, with the aim of reducing time and cost without compromising quality. Originally found in the automotive and consumer product industries, it is now being used for building components such as floor slabs, structural columns and beams.
MATERIALS AND COMPONENTS

Cross-laminated timber (CLT)
Layers of solid wood bonded together with a structural adhesive, with each laid at right angles to the next, providing great structural strength.
See Dalston Works by Waugh Thistleton Architects, page 97

Engineered wood
A manufactured composite material comprising layers, strands, fibres or boards of wood glued under pressure.

Industrialised building system (IBS)
A prefabricated structural panel of insulated concrete with a brick outer cladding. They can be manufactured with external windows and doors fitted.

Laminated veneer lumber (LVL)
Used in load-bearing structures, this is a manufactured composite of glued and pressed wood veneers, usually with the grain running in the same direction.

Light (weight or gauge) steel frame
A panelised or volumetric system made from light steel frames and used for primary structures. Light gauge steel framing can be used for a building’s full frame but also for a variety of roofing, modular options and infill walling applications.
See Berkeley Urban House by Berkeley Homes, page 87

Oriented strand board (OSB)
A composite material made from wooden flakes bonded with resin under heat and pressure, and used in building since the 1980s. It is generally used to make SIPs panels.

Pre-cast concrete (also known as ‘factory-engineered concrete’)
Precast and pre-stressed units and formwork include elements such as the structural frame, supporting columns, panels, beams and flat slabs. Concrete elements may be factory-finished internally including services, windows, doors and finishes.
See High Point Tower by AKT II, page 86

Structural Insulated Panel(s) (SIPs)
A type of composite sandwich panel structural system, predominantly used for residential and some commercial buildings. It takes the form of an insulating core between two structural facings, usually oriented strand board (OSB) in the UK.
See Croydon Infill by Stitch

Timber frame panel (system)
A structural panel – for walls and floors – constructed from small section timber studs, clad with board products. Some of these are closed panel systems fitted with insulation, electrical services, etc.
See Marmalade Lane by Elliott Wood, page 56

GLOSSARY

- CROSS-LAMINATED TIMBER (CLT)
- ORIENTED STRAND BOARD (OSB)
- PREFABRICATED STRUCTURAL PANEL OF INSULATED CONCRETE WITH A BRICK OUTER CLADDING
- LAMINATED VENEER LUMBER (LVL)
- LIGHT (WEIGHT OR GAUGE) STEEL FRAME
- INDUSTRIALISED BUILDING SYSTEM (IBS)
- ENGINEERED WOOD
- PRECAST CONCRETE (ALSO KNOWN AS ‘FACTORY-ENGINEERED CONCRETE’)
- STRUCTURAL INSULATED PANEL(S) (SIPs)
- LIGHT (WEIGHT OR GAUGE) STEEL FRAME
- CROSS-LAMINATED TIMBER (CLT)
WHAT IS FACTORY-MADE HOUSING?

SECTION ONE

“What is it generically that we are talking about – large format masonry or innovative use of materials included or just higher levels of offsite processing and manufacturing?” This is the exact question posed in April 2018 by one of the working groups of the Ministry of Housing, Communities and Local Government (MHCLG) tasked with looking at insurance and finance schemes for ‘modern methods of construction’.

A lack of clarity about terminology and definitions – even for the most knowledgeable professionals – is in fact one of the biggest hurdles the industry, decision-makers and wider public have to overcome in relation to factory-made construction.

The multitude of terms used to describe it – offsite, precision-manufactured, modular, and so on – reflects the vast range and scope of different designs, technologies and processes in use today, and to some extent its relative novelty in contemporary terms, as well as a strong reluctance in the UK to use the term ‘prefabricated’ because of negative connotations resulting from postwar ‘prefab’ housing failures (see next section). Internationally, different countries also use different descriptions. On the flipside of this often bewildering complexity and range is a well-embedded misconception that factory-made buildings provide just one single solution of box-like structures, also complicated by the misapprehension that such structures can be a complete panacea for every site. As David Lomax, senior associate at Waugh Thistleton Architects, argued in a May 2018 NLA roundtable: ‘because of the vast number of homes we need to build, it is a danger to say that modular has to be all things to all men.’

‘Factory-made’ does not mean something entirely new and mass produced: in fact, even traditional methods of construction generally use about 40 per cent components manufactured and brought to the site in complete or near-finished form, such as doors and window frames.

The Mayor’s London Housing Strategy 2018 uses the definition of: ‘Homes built using a high proportion of components which are produced using modern and technologically driven methods of manufacture, with this production often taking place offsite and the components then assembled onsite.’

This is broadly the definition used in this paper, though the preference here is for the description ‘factory-made’ rather than ‘precision manufactured’, the term favoured by the Mayor. Even this wording is complicated by the lack of quantification of what ‘high’ means: ‘there is a lot of talk about embracing “modern methods of construction”, says David Jones, modular integration director at Legal and General, ‘but I don’t think that policymakers are strict enough in terms of indicating exactly what this means in terms of percentage of manufactured elements – we need more clarity.’

‘... purposeful and strategic industry leadership is needed, driving investment in new technology and manufacturing capability that will grow over time to boost capacity and productivity.’

Mark Farmer, Modernise or Die: The Farmer Review of the UK Construction Labour Model (2016)

‘We shall be judged for a year or two by the number of houses we build; we shall be judged in 10 years’ time by the type of houses we build.’

Aneurin (‘Nye’) Bevan, Minister for Health, 1946

‘FACTORY-MADE’ CONSTRUCTION: WHAT DOES IT MEAN?

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WHAT IS FACTORY-MADE HOUSING?

SECTION ONE

PREFABRICATED BUILDINGS IN THE UK: A SNAPSHOT

Structures for shelter and other purposes erected partly or entirely from elements that were tooled or fabricated elsewhere – making the best use of available resources – must undoubtedly have been known to some of the earliest human societies. In recorded history, lightweight, portable and demountable buildings made of prepared components have long been associated with military engineering and fortifications, as the need to quickly establish a foothold in enemy territory made speed, economy and robustness of construction (and de-construction) the overarching priorities. Many of the earliest castles or towers built in England by the Normans after the Conquest of 1066, for example, were made not of stone – seen in surviving examples today – but prefabricated timber elements that could be built on top of mottes (flat-topped circular mounds) and surrounded by a fortifying fence, or bailey: these could be abandoned or demolished with their components reused elsewhere as forces advanced inland.18

Most medieval barns were also erected in a similar way, from pre-cut components pegged together, generally in oak. Later, the first ‘prefabricated’ houses made in the UK were a product of the need to rapidly establish settlements in Africa, North America, India and elsewhere as part of European colonisation and exploration. One of the earliest and most often-quoted examples were the wooden houses for settlers made of components produced in England and shipped to Cape Anne, Massachusetts, in 1624. In the 19th century, when the British colonial agenda reached its apogee, the ‘Portable Colonial Cottage’ was developed by the London carpenter and builder Henry John Manning. Designed to be easily transported, even as far as Australia, it comprised a timber and panel infill system made up of grooved posts, floor plates and triangulated trusses forming a pitched roof, covered with wood panel cladding. It could be easily constructed by unskilled builders without nails, joints or cutting. Such was the success of the venture that Manning developed different sized models.

In the Victorian period, prefabricated structures became one of the most tangible ways of demonstrating ingenious engineering achievements on a vast scale. The best-known example is the Crystal Palace, designed by Joseph Paxton for the Great Exhibition of 1851 in Hyde Park, London. Funded by a public subscription – a precursor of today’s crowdfunding initiatives – the huge building, containing 100,000 exhibits and forming the largest covered structure in the world then known, was designed, manufactured and erected in just 16 months before the opening, on 1 May 1851. The building embodied the spirit of invention by being constructed of panes of the new material of sheet glass – over 18,000 were installed on site each week – on a modular cast-iron structure. Its huge size and distinctive form were directly determined by the maximum size of glass panes then available from the supplier, Chance Brothers of Smethwick, near Birmingham. Self-supporting, light but strong, this was the first iconic ‘modular’ structure, but it was sadly destroyed in a fire in 1936 in its new location in south London.

After World War I there was a serious shortage of skilled labour, essential materials and industrial capacity, since this had all been focused on the war effort. New and experimental forms of construction were explored to meet a critical housing shortage, including more than 20 different types of steel-framed housing systems, such as the Weir and Atholl systems, as well as those based on pre-cast and in-situ concrete, timber and (to a limited extent) cast iron. Today, however, the term ‘prefabricated house’ (or ‘prefab’) is still most closely associated with the large-scale building campaigns seeking to provide homes after the devastation of World War II, when more than a million dwellings in London were destroyed or damaged. This severe shortage, ‘combined with the need to replace surviving slum housing, required a massive and concerted effort to replace these homes on a scale never before attempted’.19 In 1942, the British wartime government had already established the Burt Committee (Interdepartmental Committee on House Construction) to examine this urgent problem.

The result was a decision in favour of prefabricated housing that led to the
Emergency Factory Made Homes programme, which delivered more than 150,000 houses between 1946 and 1949. A large part of the building programme used the capacity available in aircraft production as the war came to an end. Using a prototype, temporary steel bungalow – known as the ‘Portal House’ (named after the then Minister of Supply, Lord Portal) – private companies were commissioned to design and produce different versions, 11 of which were selected. Some used surplus and recycled (though not always inexpensive) materials from war production, such as aluminium, but despite the speed of production and erection, perhaps as many as 2,000 still survive and are still occupied as homes today.

A continued shortage of traditional materials such as brick and a continued urgent need for housing drove another rapid expansion of factory-made dwellings in the 1960s – the era associated with homes made from factory-made pre-cast concrete floor and wall panels; over 425,000 homes were built in 1968 alone.

This tragedy dealt a deep blow to public confidence in factory-made homes and has profoundly shaped perceptions which endure to this day: a survey carried out in May 2018 by YouGov for the Home Group showed that 41 per cent of respondents believed that ‘modular’ homes are less durable than conventionally built ones.

The priorities of delivering postwar housing through prefabricated construction were to respond to an urgent social and economic need to provide homes (and jobs) through, often, identical, repeated and standardised products. Undoubtedly these were boldly ambitious programmes which delivered on quantity. Much less emphasis was placed on quality, however, especially the long-term social and environmental impacts of such housing at scale, how it would respond to the character of specific places, and how it would be integrated with the wider urban fabric and infrastructure – though over time, a strong community identity emerged in many developments.

The damaged reputation of factory-made homes meant that for several decades innovation was largely restricted to bespoke developments or prototypes that remained one-off, experimental and small-scale, such as 22 Parkside, Wimbledon (1967), by Richard and Su Rogers, using prefabricated steel and glass components – one of the better-known manifestations of the idea of ‘system’ building in the late 1960s and early 1970s. Around the same period, Hopkins Architects developed its Patera Building System as a standardised, single-storey, metal-framed ‘kit of parts’ building suitable for industrial or office use. Other key projects included Walter Segal’s self-build houses, such as those in Lewisham of the 1980s. These created lightweight, simple and inexpensive buildings made mostly of timber and which – by removing the need for specialist trades such as bricklaying and plastering – enabled residents to construct their own homes, which they were eventually able to purchase.

WHAT IS FACTORY-MADE HOUSING?