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PREFAB ROADMAP

A WAY FORWARD for PREFABRICATION in NEW ZEALAND (2013–2018)

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EXECUTIVE SUMMARY

Prefabrication, also known as prefab or offsite manufacture, is an approach to constructing the built environment that has been at the leading edge of innovation for a number of years. It simply means manufacturing and assembling whole buildings or substantial parts of buildings prior to installation at their final location. Prefabrication spans from small components, two-dimensional panels, three-dimensional volumes through to complete buildings, including mixtures of these types with traditional.

Prefabrication is a strategy that affects the whole project from its start, rather than being just a selection of products or technologies applied later on. International reports have extolled its virtues as a valuable part of the built environment, yet there has not been a subsequent uptake by the design and construction industry in New Zealand. What's holding back the uptake of prefabrication in New Zealand?

New Zealand's design and construction industry identifies four key issues inhibiting the uptake of prefabrication:

- broadening perceptions through information to combat misconceptions
- connecting with clients to increase market size
- assisting innovation to market
- spreading technical knowledge to increase awareness

This Roadmap for prefab in New Zealand draws from a rich and lengthy historical context, to formulate a contemporary vision to increase the quality of prefabricated output and grow customer value. This vision is based on identifying key challenges holding the industry back, the resulting actions needed to address these challenges, and the relevant outcomes and outputs needed to achieve the actions.

Action areas can be grouped into five main areas:

- research
- communication
- dissemination
- education
- demonstration

Outcomes and outputs are wide-ranging and include the development of online tools such as a product database and interactive value case tool, together with targeted technical publications and broader exhibition events. The next step is to rank the priority of the outcomes and outputs, and identify organisations to assist in the delivery of these projects over the five-year timeframe of this Roadmap.

CONTEXT

Prefabrication has long been the innovative cornerstone of the New Zealand construction industry since before colonisation in the early 1800s.

It has offered a combination of design, functionality and value in a range of manifestations, some of which are more readily identifiable than others. Although transportable school classrooms of old are often the first to spring to mind, New Zealand's much-loved historic villas and bungalows were also from pattern-books and prefabricated parts, as was the 1833 Treaty House in Waitangi.

The Railways housing scheme began in the 1920s and used a combination of prefabricated components and standardised planning through pattern-books. Further New Zealand examples include:

- State housing (1930s - 1950s)
- Hydro scheme housing (1940s – 1970s)
- The first one-piece fibreglass bathrooms (from Industrialised Building Systems in the 1970s)
- Lockwood Group (1954 – today)
- Triboard and Metra Panel (1991 – today)

A focus on sustainability in modern construction has brought a wave of renewed interest in prefabrication, as demonstrated by 'green prefab' and 'offsite' movements around the world.

New Zealand is home to innovative new-generation prefab products, including housing solutions such as the HABODE and ipad, production technologies such as cross-laminated timber (CLT), structurally insulated panels (SIPs) and file-to-factory techniques.

See Glossary of Terms

VISION

A successful prefabrication industry producing high quality, well designed, affordable, functional and inspiring residential and commercial buildings for satisfied customers.

A strong prefabrication sector will deliver genuine benefits for the whole New Zealand construction industry, encouraging innovation and improved efficiency through this streamlined building process.

Builders will become adept at using and modifying prefabricated systems – motivated by the opportunity to save time and money while delivering a high quality product – while clients will enjoy the benefits of known quality, accurate costings, and assured timeframes. Developers will understand the commercial advantages of prefabricated building, utilising covenants which favour modern, high-quality prefabrication on site, thereby dispelling outdated images. Designers will educate clients on prefabrication benefits and the quantity surveying profession will support informed decision-making by taking time-savings into account on project cost estimates. These projects will see prefabrication become increasingly 'mainstream' in the minds of politicians, quantity surveyors, local council and policy-makers.

The streamlined, high-quality characteristics of the prefabrication method will result in desirable and functional buildings for all New Zealanders, delivering quality products to a radically under-supplied market and improving productivity and national gross domestic product (GDP) in the process.

THE BACKGROUND

New Zealand's prefab construction industry was supported by the Government at its inception, as demonstrated by the historical examples previously mentioned. This support was typically in response to a temporary and finite need (the Hydro-scheme project houses, for example, or a burst of large-scale migration); once the urgent need abated, industry reverted to the former status quo. Genuine transformation requires the clear identification of barriers, in order to find sustainable solutions.

A 2009 Victoria University of Wellington Master of Architecture thesis by Pamela Bell, entitled 'Kiwi Prefab: Prefabricated Housing in New Zealand', identified two key areas and 15 specific recommendations for the design and construction industry to improve the uptake of prefabrication in New Zealand. The two key areas are research and development, and marketing and communication.

In February 2010, Victoria University of Wellington hosted the 'Kiwi Prefab' workshop to test the recommendations of the thesis on industry members. The key outcome of that day was the unanimous decision to form an industry body to address key challenges and opportunities. A steering group was voted in and the by mid-2010, PrefabNZ Incorporated was born.

The main role of PrefabNZ is as an umbrella organisation, to connect, inform, educate, influence and catalyse action to address prefab misconceptions. Industry largely agrees that the market's lack of understanding about prefab as a quality solution is holding prefabrication back. Education of the construction industry, the design profession and the wider public is an ongoing process to clarify definitions, terminology and merits of prefabrication.

WHY THE DRIVE FOR PREFAB AND WHY NOW

Why Prefab?

The New Zealand construction industry is frequently criticised for its low productivity, lack of consistent quality, insufficient innovation, and lack of ability to address the strong construction demand existing in most of New Zealand.

So, why prefab? The answer is that in the face of these significant challenges, sector-specific research has shown that prefab processes are one solution to many of these issues.

Prefab construction offers a series of practical benefits, including climate-controlled environments; reduced onsite work; onsite staff; heightened quality control; enhanced waste capture, reuse and recycling; quality in mass and custom design; teams rather than individuals; improved health and safety. The use of increased levels of automation in offsite construction leads to the employment of skilled workers. Machines do what they can do well, and humans do tasks that require skilled hands. Moves towards increased automation can improve speed, cost, quality, and minimise waste in projects.

See Appendix for a summary of national and international prefab-related research findings.

Why Prefab – Why now?

Auckland alone needs approximately 10,000 new homes per year for the next decade, yet only 3,500 are currently being delivered.[1] At the current rate of growth, in the next 30 years Auckland will need to house another million residents in 400,000 new dwellings.[2] This means that over the next 20 years Auckland will be missing 90,000 houses,[3] representing around a quarter of the required stock. The wider region faces urban design issues about constrained land supply and educating the market about well-designed multi-density infill housing options.

- In **Canterbury**, between 15,000 and 17,000 homes have been damaged beyond repair in the earthquakes and a further 15,000 require repairs worth more than $100,000 each. There are 20,000 homes needed for the Canterbury Rebuild in the wake of the ongoing earthquakes since late 2010. This work continues to be held up by insurance issues with each recurring quake. There is an overall estimated cost to the economy of $30 Billion.[4]
- There are around 42,000 **Leaky Homes**, as well as schools and apartment buildings requiring specialised repair to constrained sites needing repairs or replacement.[5] The legacy of the 'leaky buildings' crisis is litigation and a fear of alternative materials, products and systems.
- **Affordable housing** supply is at a critically low level in urban centres. There is increasing awareness of the need to increase density and build on urban infill sections to reduce

the impact of sprawling cities. The Auckland Council Housing Action Plan (2012) identifies the need to create exemplar high-quality medium-density urban neighbourhoods. In many cases, these types of constrained sites cannot accommodate traditional construction that requires site offices and material storage.

- New Zealand has a wealth of **geographically isolated sites**. Offsite construction is a more viable option for remote sites with reduced access, whether on mountain-tops, rugged beach-fronts or offshore islands.

There are serious doubts that the contemporary industry can meet demand with its present structure and traditional methods of construction.

INTERNATIONAL EXPERIENCE

Prefab is widely utilised in many overseas markets where it is viewed as a high quality and innovative option which has often been used to address inefficiencies in building and construction industries.

Key findings of the McGraw-Hill Construction 2011 SmartMarket report Prefabrication and Modularisation: increasing productivity in the construction industry showed the following productivity improvements from the architecture, engineering and construction professionals surveyed:

- 66% decrease in time (35% by 4 weeks or more)
- 65% decrease in cost (41% by 6% or more)
- 77% decrease in site waste (44% by 5% or more)
- 98% expect to be using some prefab on some projects by 2013

Although the New Zealand market is distinct, much can be learnt from overseas experiences. The following table summarises the prefab experience in selected overseas markets

Country	Characteristic
Australia	• Modular building sector supplying mass housing for mining camps • Architect and manufacturer collaborations for high-end custom houses • Peak prefab / offsite industry organisation being established 2012 / 2013 • Multi-unit student accommodation projects
Japan	• Housing viewed as a consumable or 20-30 year depreciable asset • 74% of homes 27 years old or less in 2008 6 • Prefabrication seen as a medium to high-end product • Up to 20% of domestic market is prefabricated homes 7 • Five major businesses supply 80% of the prefab home market • Investment in R&D since 1946 means a mature prefab market today • R&D centres offer customised choice of fittings, options, finishes material choices • Steel-frame, panel and modular systems dominate 8 • Highly mechanised, automated due to influence from manufacturing industries 9 • Most construction owner-initiated
USA	• Big firms build 66% of new houses • Most single-family homes • Similar materials • Established modular and factory-built, manufactured, home construction industry • Up to 1/3 all new single-family houses are modular or manufactured 10 • 10% of market is high-end architecture 'modern green prefab' 11 • Exhibition and book on prefab at Museum of Modern Art, New York, 2008 12
UK	• Similar industry set-up to New Zealand, but higher productivity • Barriers to innovation, including aversion to timber structure • Housing shortages • Wary of prefabrication / offsite construction due to post-WWII temporary 'prefabs' 13 • Prefab housing makes up less than 4% of new buildings (2005) • BRE Innovation Park showcases housing in Watford and Scotland • Government push for Modern Methods of Construction (MMC) target 25% for social housing (2007), 200,000 homes in 20 years using fast-track technologies (2004) 14
Scandinavia	• Pre-cut timber standalone houses and precast multi-unit affordable housing • Prefab makes up 90% of housing in Sweden 15 and more than 50% in Finland 16 • Ikea partnered with largest builder Skanska to provide affordable housing • Long acceptance of prefabrication / offsite construction • Quality focus for prefabrication / offsite construction • Drive for energy efficiency, environmental protection
Broader Europe	• Long history and acceptance of prefabrication / offsite construction – with prefab housing making up 5% in Spain and France, and 10% in Germany 17 • Prefab show-home parks in Germany and Austria – 50-100 houses each park • Focus on timber products, sustainability and family-owned small-scale operations • Drive for high-quality and cost efficiency through standards and certification

KEY PLAYERS IN NEW ZEALAND

The uptake of prefabrication in New Zealand is dependent on a contemporary understanding of prefab and a collaborative approach throughout the supply chain, from customers to designers to manufacturers and builders, with support from regulators and governance.

Clients

Public / Developers / Project Managers

Clients are the patrons of design and construction projects as they facilitate the initial need, vision and payment of the building. However, many clients are dependent on their specifiers for advice and guidance, hence they are influenced by their specifiers' knowledge, preferences and prejudices.

Specifiers

Building Professionals (Architects, Designers, Engineers, Builders and others)

Specifiers take the clients' needs and provide detail to the vision – making sure the building is fit for purpose, compliant with legislation, functionally resilient, aesthetically appealing and environmentally sustainable.

Producers

Manufacturers, Fabricators, Suppliers, as well as Builders and Sub-contractors

Producers provide the documented elements from the specifiers' plans – a mixture of products, materials, fixings, fixtures and elements. These may include prefabricated components, panels or modules transported to the building site where they are assembled to produce the finished building.

Regulators

Building Officials (Territorial Authorities, Building Consent Authority and Ministry of Business, Innovation and Employment)

Regulators oversee the translation of building policy through the compliance system.

Government

Political Party in power, together with Ministry of Business, Innovation and Employment

Government has an obligation to set the policy for the design and construction industry, through Standards and Building Consent regulation. The government is also looked to for leadership on critical issues facing the industry.

Industry Leadership

Industry leadership in the prefab sector is provided by PrefabNZ, a not-for-profit incorporated society which is funded by membership and industry sponsorship. PrefabNZ was established as a mechanism to implement the recommendations of the Kiwi Prefab thesis. The organisation regularly engages with industry and responds to member needs through surveys, networking, educational and marketing opportunities for members; acting as a conduit to government and international organisations.

PrefabNZ utilises a range of communication channels including monthly e-newsletters, a portal website, informative networking events in city centres and regional areas, and major showcase projects such as the HIVE Home Innovation Village, Canterbury Agricultural Park, Christchurch – a two-year temporary showcase on council land – opened April 2012 to over 2,000 people in the first weekend.

As of the end of 2012, 9 of the original 15 Kiwi Prefab thesis recommendations are either underway or complete, however challenges remain; consents are languishing at around 50% of their levels 5 years ago, the Canterbury industry remains stalled by insurance delays, while an impending wall of work – Auckland, leaky buildings and the rebuild – looms.

CHALLENGES AND ACTIONS

The design and construction industry in New Zealand is trapped in a cycle of boom and bust using 200 year old traditional craft-based production techniques. In order to break this cycle, a radical rethink of design and construction delivery would need to take place. A collaborative approach would address the interlinked nature of the challenges – perceptions that affect market demand, that in turn influence industry decisions, together with regulatory constraints, which affect feasibility of start-up costs, and in turn inhibit prefab market expansion.

Research points to misconceptions as the number one issue inhibiting uptake of prefabrication. Research also points to the barrier being with designer not specifying prefab, although the design profession points to the challenge in fact being with the acceptance of prefab by the client as they are the patron of the design and construction process.

Issues for a strong New Zealand prefabricated design and construction industry include prohibitive start-up costs, resistance from the traditional construction industry, and widespread misperceptions about prefab and even architectural quality. Contemporary challenges that inhibit commercial success of prefabrication include:

- tight macroeconomic conditions
- construction industry resistance to innovation
- the small, disparate and competitive nature of the overall industry
- over-emphasis on component and complete building typologies, to the detriment of alternative methods such as panel and module prefab typologies
- a lack of future-proofing in terms of intellectual property protection and uptake of recent manufacturing technologies to remain locally and internationally competitive

Contemporary actions that should be evaluated for a successful New Zealand prefab industry include:

- targeting offshore markets to increase consumer market size
- sourcing fabrication and manufacturing offshore
- creative out-of-the-box designs for transport limitations
- design flexibility of component-based systems
- advancing innovative products and systems through research and development
- collaborations between industry and tertiary institutions
- architect-designed housing models to target a specialised niche market of early adoptors
- utilising marketing tools such as show-homes, plan-books and housing events

Misconception

Historical misconceptions are of uninspiring standardised designs, temporary structures, low-quality construction and poor site choices and orientation of structure on site.

Quality-based misconceptions focus on light-weight, flimsy and cheap materials that represent a poor investment. Aesthetic misperceptions arise when unconventional materials and appearance are aligned with poor performance. Socio-cultural misperceptions are that mass-production is an attack on individuality.

Points for Action – changing misconceptions is a cornerstone of mainstreaming prefab building systems in the New Zealand industry.

Misconception outputs and outcomes would include:

- Portal website that is useful and informative for participants across the value chain
- Online interactive value case assessment tool
- Accessible technical information in print and web form
- Robust financial information including value case
- Exhibitions, events, demonstrations and show housing – e.g. HIVE Home Innovation Village
- Mainstream publications – book, magazines, media, TV
- Clear leadership – PrefabNZ

Market Size

The constrained market size makes it difficult to achieve economies of scale in manufacture. This is despite a latent capacity to provide a substantial number of houses. In 2011, PrefabNZ surveyed 46 businesses to find they had the capability to supply 750 3-bedroom houses. A consistent market demand is limited by the unpredictable nature of the market and a lack of access to the project decision-makers at an early stage of the process when prefabrication can be considered.

Market opportunities are further exacerbated by the boom: bust cycle of the design and construction industry. The companies that survive the fluctuating market are those that respond with flexible strategies and provide a diverse range of product offerings. It is a challenge to create a transparent pipeline of incoming work that will enable investment in technology and an economy of scale to be achieved to make larger repeat manufacture more profitable. A further challenge is to enable an efficient supply chain of materials to be provided on a timely basis to support delivery.

Points for Action – increasing market penetration in New Zealand and looking beyond our borders to grow export markets will grow the use of prefab systems.

Market Size outputs and outcomes would include:

- Client-focused market research to assess demand for prefab, better understand price and value drivers, and to match up client needs with current prefab systems
- Key market areas, leaders and project decision-makers identified
- Prefab value case information targeted at key market leaders and project decision-markers
- Development of a transparent pipeline of incoming work to enable forward planning
- Single portal website for all prefab-related information

- Potential export market growth areas identified
- International trade tour to export markets
- Marketing via trade show attendance in targeted export markets
- Entry into new or growth areas of domestic and export markets

Start-up Costs

The large start-up investment needed to establish a prefabricated product or system represents a significant barrier to market entry, which is closely linked to the limited market size which constrains demand, and ongoing financing and supply-side difficulties.

The industry would benefit from better understanding the parameters required for a successful business case, including the break-even scale of production, and the period of time required to verify consistent market demand. Exploring opportunities within the retrofit market could offer new insights into the proportion of prefab technology being used in new and existing buildings, and how to leverage the retrofit market as a showcase for prefabrication.

Points for Action – addressing the challenge of large start-up cost investment will go some way to assisting innovative prefab products and systems to market.

Start-up Costs outputs and outcomes would include:

- Research what is the break-even point to bring a new prefab product to market
- Value case for investment in prefab production
- Quantity surveying profession is knowledgeable about value of time and lifecycle costing and able to accurately assess prefab projects
- Forums to connect manufacturers with clients
- Pipeline of visible future work
- More research and development (R&D) investment in prefab products
- Access to an innovation portal for funding
- Collaboration across industry sectors
- Product integration with BIM and national online consenting
- File-to-factory technology available and utilised

Consent and regulation integrated with product development

Technical Knowledge

A lack of prefabrication education persists at the design inception part of the construction process. Specifiers could educate their clients on the benefits of prefabrication as an alternative to traditional methods. Construction professionals could build prefab efficiencies into planning and bidding, including allowances for green factors. Manufacturers could promote the green benefits of prefab products and produce BIM objects of prefab products to enable easier specification. A more collaborative and informed approach across the design and construction team would lead to a smoother process and result in less defects – delivering increased value to the client and repeat business opportunities.

Points for Action – spreading technical knowledge results in a better informed and more prefab-literate design and construction industry, to deliver better value to clients.

Technical Knowledge outputs and outcomes would include:

- Agreed terminology across sector
- Property covenants encourage prefab, rather than exclude
- Continuing Professional Development (CPD) programme embedded in sector
- Case studies
- National Conference
- Events to connect products and specifiers
- Established education deliverers such as Polytechs provide programmes
- On the job training for builders and assemblers
- Tech series seminars and publications
- Quality assurance scheme
- Single portal directory to prefab products
- Online product database linked to product information and technical specifications
- Database also integrated with Building Information Modelling (BIM) and national online consenting

There is a level of risk awareness and risk aversion across the design and construction sector. This is understandable given the level of investment required and the longevity of the product, in other words choices made in building have long legacies. Particular areas of concern are around the perceived risks of changing business as usual. The subsequent challenge is to facilitate a change management process that has industry buy-in at all levels. Collaboration is key.

LOOKING TOWARDS THE FUTURE

What will success in the future look like for each group?

The design and construction industry supply chain looks to the government for strong leadership on critical issues, and to the regulators to enforce subsequent policy decisions using the latest technology available. Future success would look different to business as usual today. At a broad level, the industry would be recognised for its significant contribution to the nation's GDP (4-8%).[18] There would also be measures in place to grow this contribution – increasing productivity through greater uptake of prefabrication is one way to achieve this – a 10% increase in productivity equates to a 1% increase in GDP.[19] At a working level, there will be an increased flow of accessible information that clearly sells the value case for prefab.

Clients

In the future, clients will receive increased value through high-quality buildings delivered on time and on budget. They will understand the design and build process, make informed decision and be knowledgeable about cost implications of design changes. During the build process they will be kept in touch with digital technology to observe the manufacture and assembly. At the end of the build process, commercial clients will retain a BIM model for on-going maintenance and asset management. Most importantly, clients experience a smooth building delivery and limited disruption at site, so will recommend the team they worked with and be willing to embark on a design and build project again.

Looking forward to the future:

- Clients have access to understandable relevant information on prefabricated products
- Clients can experience prefab products and buildings in demonstrations and exhibitions
- Clients use a web-based decision-making tool that quantifies time benefits and lifecycle benefits to compare prefab methods with traditional
- Clients know that prefab products are Building Code compliant so there are no increased risks
- Clients get the best value through collaborative procurement processes with design briefing meetings together with specifiers and producers
- Clients feel more involved in the design and building process through digital walk-throughs, factory video cameras and site-based images.
- Clients have increased satisfaction and value after handover due to the short defects liability period

Specifiers

In the future, specifiers collaborate with clients and producers early in the design process. They use digital technology to share files with producers, to access online product information, and to submit Building Consent packages. Specifiers are able to access clear and relevant information about prefab for themselves and their clients. Importantly, specifiers take a lead role in educating clients and assisting their informed decision-making. Awards, published case studies and public celebrations provide incentives to work with prefab.

Looking forward to the future:

- Specifiers and producers are part of a collaborative design briefing process
- Specifiers pass on client prefab education material as part of the briefing process
- Specifiers use a web-based decision-making tool that quantifies time benefits and lifecycle benefits to compare prefab methods with traditional
- Specifers use an online database to choose from a range of pre-consented products, components and assemblies
- Specifiers freeze the design early and communicate this to clients prior to manufacture so the client understand how design changes affect the project cost
- Specifiers utilise file-to-factory technology to link with production
- Specifiers access technical information about prefab products through online web portal, events and publications
- Specifiers are incentivised by prefab awards, publication and celebrations

Producers

In the future, producers collaborate early in the procurement and design process to achieve cost and time savings using innovation where possible. A visible pipeline of upcoming work assists in smoothing out boom and bust cycles. Locally-made or imported products are of a consistent high-quality standard and Building Code compliant, delivered through a secure and dependable transport system. At site, electronic tags provide technical product information and assembly directions to hand-held digital devices. Electronic verification enables self-compliance on-the-job, further reducing time for external building inspectors to conduct inspections.

Looking forward to the future:

- Producers plan forward according to a visible pipeline of major project work
- Producers can access clients through coordinated projects, events and networks
- Producers manufacture according to digital files direct from specifiers
- Producers rely on a quality assurance system backed by the Building Code and international standards, accessed digitally and remotely
- Producers gain efficiencies through supportive transport and product delivery services
- Producers can self-certify towards Building Code compliance, saving time and money
- Producers provide more consistent working conditions and receive more reliable staff
- Producers make cost savings which can be passed on to clients, as well as improving their own profit margins

Regulators

In the future, regulators use a consistent shared terminology for prefabrication terms and have a familiarity with different systems that removes fear and undue risk in the Building Consent assessment process. Specific prefab queries are directed to a single portal organisation. There is increased use of a flexible pre-consent tool, based on standardised details and product packages, to speed up the consent process and reduce costs to clients. Regulators facilitate on-the-job inspections by producers and monitor this through the national online consenting portal.

Looking forward to the future:

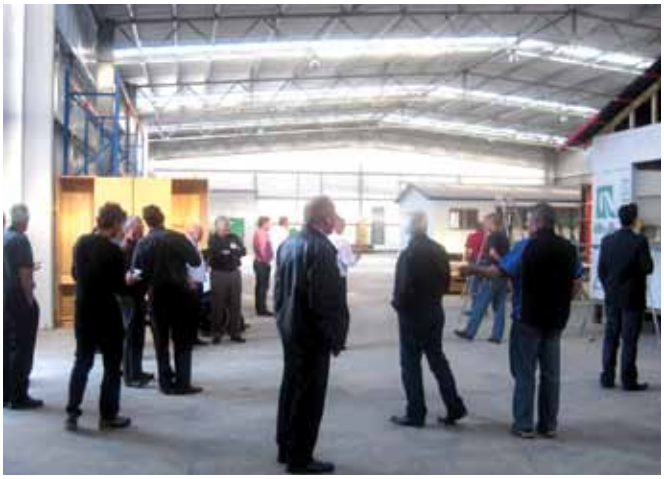
- Regulators dramatically reduce processing time of Building Consents
- Regulators use a standard set of prefab terms and have base knowledge of a number of prefab systems
- Regulators know where to go to find out more information about prefab products
- Regulators support self-inspection at site by producers

Government

In the future, government takes a proactive leadership approach to continuous improvement and leading by example. As a result of consistent communication, the design and construction industry and the public are aware of contemporary relevant policies. Major projects consider prefabrication technologies and value cases. Major procurers are aware of prefab case studies and value cases. There are increased communications between government departments and with the design and construction industry. A focus on collaborative procurement, a transparent pipeline of upcoming work, and management skills support for small to medium enterprises (SMEs) leads to a smoothing of the boom and bust cycle. Mandates are put in place to encourage the uptake of BIM, green and prefab in multi-unit projects for schools, social housing, affordable housing, hospitals, retirement villages and corrections facilities.

Looking forward to the future:

- Government and the design and construction industry work closely together
- Government leads by example, mandating for increased uptake of BIM, green and prefab in their own multi-unit projects
- Government supports standards for BIM, green and prefab



ACTION PLAN

Addressing the challenges outlined above will require a varying mix, comprising research, communication, dissemination, education and demonstration. This one-page summary diagram captures measures, challenges and actions in an at-a-glance format.

PREFAB ROADMAP

A WAY FORWARD for PREFABRICATION in NEW ZEALAND (2013-2018)

Industry Vision:

A successful prefabrication industry producing high quality, well designed, affordable, functional and inspiring residential and commercial buildings for satisfied customers.

MEASURES OF SUCCESS:

Clients
receive increased value through high-quality functional buildings delivered on time and on budget

Specifiers
collaborate with clients and producers early on, and use digital technology to share files with producers

Producers
collaborate early on to achieve cost and time savings using innovation and technology where possible

Regulators
use consistent terminology for prefab terms, are familiar with different systems and use online tools for assessment

Government
takes a proactive approach to continuous improvement, leading by example and communication

CHALLENGES:

Misconceptions

- Tainted image from historical experiences
- Standard designs
- Temporary structures used past use-by-date
- Poor site orientation
- Lightweight and cheap materials
- Mass-production versus custom
- Poor performance
- Risk of non-traditional

Market Size

- Limited market size
- Economies of scale unknown
- Project decision-makers carry risk
- Access to design team at early stage
- Boom: bust cycle
- Unknown demand and incoming work
- Existing capacity not being utilised

Start-up Costs

- Large start-up investment needed
- Financing difficulties
- Unknown break-even point
- Unknown pipeline of incoming work
- Suppliers disconnected from specifiers
- Products need a clearer path to market

Technical Education

- Lack of product awareness
- Need for specification technical guidance
- No quality assurance system
- Assembly and installation info needed
- Maintenance and asset management guidance needed

ACTIONS:

- Portal website
- Online tools and info
- Case study precedents
- Value Case
- Interactive tools
- Exhibitions
- Showcase / Demo
- Events
- Conference
- Publications
- Media, TV, radio
- Leadership

- Transparent pipeline of incoming work
- Client-focused market research
- Portal website as single source of information
- Understanding market needs of price: value
- Identify key market areas and decision-makers
- Investigate export markets with NZTE
- International site visits and events
- Tap into expat networks

- Transparent pipeline of incoming work
- Research on break-event point for investment
- Develop value case for investment in start-up
- Connect manufacturers with major project clients
- Encourage R&D investment
- Access funding for innovation
- Product integration with BIM + online consenting
- Consistent consent and regulation process

- Agreed terminology across sector
- Case study precedents
- Events to connect products and specifiers
- Use established education deliverers
- Facilitate on-the-job training
- Technical series seminar + publications
- Quality assurance scheme
- Online technical info with BIM product specs

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GLOSSARY OF TERMS

Building information modelling (BIM)

BIM is the wider set of integrated software tools of which digital drawing is just one tool. Elements embedded in a three-dimensional digital model are assigned values which can be independently accessed and cross-referenced to produce useful data during the construction coordination process.

Complete buildings or complete building prefabrication

These are units that enclose usable space and actually form part of the completed building or structure (units may or may not incorporate modular coordinated dimensions). This includes the traditional transportable housing industry.

Component-based or componentised prefabrication

Components are relatively small scale items that are invariably assembled offsite, such as light fittings, windows, and door furniture. It includes structural members (trusses and frames), fittings, fixtures, and joinery that is cut, sized or shaped away from the site for assembly on site. A complete set of components is commonly referred to as a kit, kit-of-parts, or kitset.

Computer assisted design (CAD)

Computer software that enables designs to be drawn, rendered, rotated and checked in three-dimensions.

Computer numerically controlled (CNC)

Cutting or machining technology that is controlled by computer programming. It is the interface between computer software and manufacturing hardware which enables designs to be directly translated from digital to physical means without manual interference. The manufacturing sectors use this technology widely, whereas the construction industry generally uses the software to produce drawings, but not physical products. CNC machinery is usually programmed with CAD software.

Cross laminated timber (CLT)

CLT is a timber panel produced by gluing layers of solid timber continuous boards together, with subsequent layers rotated 90 degrees to create a 'giant plywood' that can be used for a variety of applications, including roofs, walls and floors.

Green modern prefab

The term 'green modern prefab' refers to prefabricated housing that is architect-designed, has neo-Modernist design aesthetics and exhibits sustainable technologies or features.

Hybrid-based or hybridised prefabrication

Hybrid-based prefabrication is also referred to as semi-volumetric prefabrication. It consists of a mixture of volumetric or modular units and non-volumetric or panelised units (module plus panel). It may also include component and site-built elements.

Industrialised housing

The term industrialised housing was popular in New Zealand in the 1970s and 80s. It refers to a large-scale manufacturing-type approach to construction. Prerequisites for industrialisation include a large consumer market and high volume output. Industrialised systems may use prefabrication, but the two terms are not interchangeable.

Mass-customisation

This is the use of digital technology and CAD-CAM interfaces to produce individual custom designs from standard manufacturing technologies.

Mobile

This is an obsolete term for manufactured housing in the United States. It is still used in New Zealand to refer to transportable buildings. A mobile building is manufactured away from site, and transported to the site in a largely completed state with minimal on-site labour. A mobile building does not conform to building codes and is not necessarily fixed to permanent foundations at the site.

Modern Methods of Construction (MMC)

MMC is a British term adopted by their Housing Corporation. It refers to both offsite or prefabricated construction technologies and innovative technologies applied at site. It also includes techniques such as thin-joint block-work and tunnel-form construction.

Module-based or modular prefabrication

These are units that enclose usable space and are then installed within or onto a building or structure. They are typically fully finished internally, such as toilet/bathroom pods or plant-rooms. Structural units are rooms or large parts of the building referred to as modules, volumes or sections. Non-structural units are used inside conventional buildings or modules, usually to contain utilities, and are referred to as cores or pods.

Offsite or off-site or offsite manufacturing (OSM)

Offsite is a term used to describe the spectrum of applications where buildings, structures or parts are manufactured and assembled remote from the building site prior to installation in their final position. In other words, moving operations that are traditionally completed onsite to a manufacturing environment.

Panel-based or panelised prefabrication

These are planar units that do not enclose usable space, such as panel systems and cladding panels. They may include windows, doors or integrated services, and are either open-framing or closed-in with clad and/or lining. They are transported to site as flat-packs.

Portable

Portable buildings are generally those intended for short-term temporary applications such as utilities at events or site offices. Portable housing infers a small building such as a cabin, studio or sleep-out.

Prefab or prefabricated

This widely refers to materials or combinations of materials prepared away from the construction site for assembly at the final site, and ranging from components, panels, modules, hybrid and complete buildings.

Pre-nailed

This refers to complex components of materials that are cut, sized or shaped and joined together using nail-plate technology. Nail-plate technology comprises engineering software, computer-controlled cutting machinery, and steel plate fasteners. It is a technique commonly used for roof trusses and wall framing in traditional housing construction.

Relocated, relocatable housing or 'reloc's

A relocated or relocatable building can be of any style, age, or material. It does not necessarily infer a new prefabricated house. It is a dwelling that is built or assembled at one site and then transported in parts, or in whole, to an entirely different site.

Structurally insulated panels (SIPs)

Panels are typically made using expanded polystyrene (EPS), or polyisocyanurate rigid foam insulation sandwiched between two structural skins of oriented strand board (OSB).SIPs are used as building panels for floors, walls and roofs in residential and commercial buildings.

Standardised

Standardised housing utilises components, methods or processes in which there is regularity, repetition and a background of successful practice. Standardisation is useful to gain efficiencies in prefabrication, but it does not infer standardised product or system outcomes.

Transportable housing

Housing that is transportable includes any house that is purposely built in order to be moved to another location. In New Zealand, this includes yard- and factory-built housing which is supplied by a number of businesses.

INTERNATIONAL AND NATIONAL RESEARCH SUMMARY

A brief summary of international and national prefab-related findings are presented in chronological order below.

Michael Latham's **Constructing the Team** report in 1994 and Sir John Egan with the Construction Taskforce's **Rethinking Construction** report in 1998 both identified construction industry inefficiencies in the UK:

- The **Latham Report** was not the first report to identify systemic failings in the UK construction industry; previous reports dating back to the 1960s had identified similar issues and made similar recommendations. However, this report did gain industry and government support. Most notably, the report urged reform and advocated partnering and collaboration by construction companies.
- The **Egan Report** took a manufacturing approach to the construction industry and advocated an integrated project process based around four key elements including production of components.

The National Institute of Standards and Technology (NIST) in the USA produced the **Advancing the Competitiveness and Efficiency of the US Construction Industry** report in 2009. It showed that construction productivity is influenced and improved by five main drivers, including Automation and Prefabrication. Five breakthroughs to improve the efficiency and productivity of the US construction industry are itemised, including breakthrough number three: "Greater use of prefabrication, preassembly, modularization, and off-site fabrication techniques and processes."

Various taskforces have been set up by the New Zealand Government since 2008, leading to the development of the **Productivity Partnership (PP**) joint venture with industry in 2011 and the launch of a **Research Action Plan (RAP)** in 2012. The PP found that industry is struggling with a lack of reliable economic data, as is the case internationally, which makes improvements in productivity difficult to measure. However, it also suggested that prefabrication processes are one way to improve productivity.

- Under its Industry Processes section, the PP RAP queries the fundamental barriers to using prefab technologies, including:
  - What is stopping us from using more efficient construction processes?
  - What are the barriers to uptake of standardisation and how can it be made more attractive?
- The PP RAP extends these questions in its Technology section, where it highlights the trend towards prefab and suggests where cross-industry lessons could be learnt:
  - What lessons for increasing productivity can be learned from assembly industries, such as the car industry, and applied to construction in New Zealand?
- Prefabrication emerges yet again as a central theme in the Canterbury Rebuild section, where the PP RAP identifies the need for a quantitative mix of bespoke and standardised construction in Canterbury, asking:
  - What is the change in mix of bespoke compared with standardised design and construction?
  - How has client perception of standardisation changed?
  - How are uptake and integration of innovations changing during the Canterbury rebuild?

- The PP RAP also notes the connection between the elevated cost of new houses and bespoke design; land prices aside, it can cost up to 30% more to build a house in Auckland than it does to build a similar house in Australian cities. The RAP states that these building costs can be reduced through greater uptake of standardised designs and building techniques.

McGraw Hill Construction's Smart Market Report in 2011 **Prefabrication and Modularisation: Increasing Productivity in the Construction Industry** confirmed the link between prefab, sustainability, BIM and productivity – all rising trends identified by construction industry leaders in the US.

- McGraw Hill's 2009 report on Building Information Modelling (BIM) found a key benefit of BIM is to enable increased use of prefab techniques, which in turn improve productivity and project return on investment (ROI).
- McGraw Hill's 2010 report on Green BIM looked at green BIM practitioners who saw model-driven prefab as a way to design and construct greener buildings and have a greener site.

The Canterbury region of New Zealand was rocked by a series of devastating earthquakes from 2010 to 2012. New Zealand structural engineers are international leaders in seismic resistant design using a variety of materials to create prefabricated rocking wall panels, PRESSS and Pres-lam structural components. These can be seen in a growing number of buildings including the Nelson Marlborough Institute of Technology (NMIT) Arts and Media Building (2010), and the Massey University Wellington College of Creative Arts (CoCA) building (2012).

In 2011, a strategic focus in New Zealand on value-added manufacturing exports was publicly put forward by Sir Paul Callaghan. This focus was being picked up by the timber industry through a Bay of Plenty report released in July and a wider timber industry strategy in 2012. There is wide industry thought that value-added timber products such as cross-laminated timber (CLT) and glue-laminated (gluelam) structural components are potential for export growth.

In 2012, a focus on unaffordable housing was provided by the New Zealand Productivity Commission's **Housing Affordability Inquiry** report. Land prices were identified as a barrier, as were building costs, cited to be 30% higher than Australian equivalents. Consumer preference for bespoke buildings was cited as a challenge to incorporating more standardised designs and products.

BRANZ is the New Zealand construction industry's independent research organisation. BRANZ's investment of the Building Research Levy is guided by the information needs of the industry.

- The 2012 BRANZ Building Research Industry Agenda (BRIA) priority topics for the next five years include productivity, and automation, industrialisation and new technologies.
  - The BRIA priority topic Productivity calls for information that supports new approaches to the processes and technology of building, particularly in discovering the necessary framework to encourage novel or disruptive technology such as prefab construction.
  - The BRIA priority topic Automation, Industrialisation and New Technologies anticipates an increasing need in the industry for competence with advanced manufacturing and emergent technologies. The integration of BIM is the key information and communication technology in building that can work alongside new construction methods and processes.

BRANZ's **Construction Industry Data to Assist in Productivity Research** report found that quality is closely related to perceived value by customers. New house owners satisfaction levels are high yet call-backs occur in 60% of new houses. Overall the level of satisfaction with house designs was high and it was interesting to note the standard designs with no changes did not score significantly worse than the changed standard plans or one-off designs (Ian Page, BRANZ report SR256, 2011).

Underpinning a value case for prefabrication and offsite construction is the inherent time savings. BRANZ's **Value of Time** report shows the dollar value of time savings and estimated one week of saved time amounts to a $1,000-1,600 saving on a stand-alone residential build (Ian Page, BRANZ report SR259, 2012).

The **Auckland Council Unitary Plan** will be released in late 2013. The draft plan is ambitious and strongly rooted in multi-unit housing; if approved, the scale of building outlined below will require an engagement with prefab technology to deliver effectively.

- Under the draft plan, over 50% of Auckland's residential land will be rezoned for apartments and intensification to house an additional one million people by 2040. The intensification will be staggered, with apartments of 18 storeys allowed in 10 areas, and four to eight storeys allowed in a further 37 areas. Beyond these areas, the council proposes a 250 metre zone for terraced housing and apartments of between four and six storeys. The remaining residential areas will have a mixed-housing zone, allowing for one house per 300 m^2 with no density limits when developers land-bank more than 1,200 m^2 to build five or more houses.
- The draft unitary plan aligns with the **Auckland Plan**, which aims to contain 60-70% of new houses within the existing urban limits.
- The draft **Housing Action Plan** identifies 12 priority areas with Area 1 Action 8 identifying the Council's willingness to work with industry groups to deliver exemplary medium-density housing showcase projects like the HIVE Home Innovation Village by PrefabNZ.

Building a Better New Zealand: The Research Strategy for the Building and Construction industry is a collaborative strategy in 2012-13 which emerged from a process of industry-wide consultation underpinned by a comprehensive industry needs survey, and is supported by key industry leadership and co-ordinating bodies, including the Construction Strategy Group (CSG), the Construction industry Council (CIC), the Ministry of Business, Innovation and Employment (MBIE), and BRANZ. This new strategy is intended to provide a strong strategic foundation to underpin both the direction and funding of building research across the whole New Zealand building research community.


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