

R.G.S. Beatson: from student work to Auckland houses

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Abstract

Prefabrication is again being discussed as a possible answer to the current shortage of affordable houses in New Zealand. This paper looks in detail at another occasion just after WWII when prefabrication of houses was seen as a way of providing houses at less cost, by focusing on the work in this field of Ronald Guthrie Senior Beatson (1903-1996).

*The paper begins with a brief background to the life and work of R.G.S. Beatson and the practice of which he was a founding member in 1940, Massey, Beatson, Rix-Trott, and Carter. It then looks at Beatson's 1939 thesis on prefabrication showing how it drew exclusively on USA sources. The paper then discusses the two prefabricated houses Beatson built for his family and the articles on prefabrication in *Home and Building* during the 10 years he was joint editor.*

This paper is a fragment of a larger project on R.G.S. Beatson and the practice and work of Massey, Beatson, Rix-Trott, and Carter.

Introduction

“My father was an architect. He was also a woodwork teacher, but that was before I knew him.”¹

Most of us are satisfied with one career as an architect, but Ronald Guthrie Senior Beatson had several. Not only was he a partner in one of Auckland's leading architectural practices from the 1940s to the 1970s, he was a skilled photographer, made furniture and musical instruments of wood, and was a keen gardener. He was active in the affairs of the New Zealand Institute of Architects and alongside Charles Irwin Crookes he edited *Building Today* (later

Home and Building) from 1937 until 1946. After initially training as a teacher, in the 1930s he studied architecture in Auckland, producing his 1939 BArch Thesis on prefabrication. This would be a life-long interest. This paper on his explorations in prefabrication is a first step in an on-going larger project with the aim of recognising this important figure in New Zealand architecture.

Beatson was a man always ready and willing to tackle the job in hand, whether designing buildings, making toys for his four children, or taking photographs for the journal. Our paper draws on Beatson's thesis, family memories, and articles on the prefabricated buildings designed by Beatson. His fascination with making things in wood and deep knowledge of working with timber contributed to his system for the design and construction of prefabricated houses. Beatson argued that prefabrication in timber was the way "...to produce single family units at a price within the range capacity of the occupants,"¹ a sentiment that is still being repeated today.²

The grandson of London-trained, early New Zealand architect William Beatson (1807–1870),³ R.G.S. Beatson studied wood-carving at the Nelson Technical School, where in 1926 he gained a City and Guilds pass in Grade 1 Carpentry and Joinery and a second class pass in Grade 1 Cabinetmaking.⁴ He started his working life as a woodwork teacher from 1921-23 at the Nelson Technical School and then at Takapuna Grammar School in Auckland before gaining entrance to Auckland University College to study architecture in 1930.⁵ Completing most of his coursework by 1935, the following year he was advertising tenders for his own design as well as contributing to projects by one of the city's leading architects, Horace Lovell Massey (1895-1978); notably drawing, and probably designing, the fitted interiors of the moderne 1936 Cintra House in Auckland, for which Massey won a Gold Medal the following year.⁶

In 1940 Massey and Beatson went into partnership with Beatson's former fellow-students Alwyn Rix-Trott (1906-1994) and George Neild Carter (1909-1999) to form the practice of Massey, Beatson, Rix-Trott, Carter and Co.⁷ That year they were already described in an Auckland Council document as "prominent Auckland

Architects.”⁸ Designing educational, commercial, industrial and domestic projects they developed a national reputation for excellence. Their Norwich Union Insurance Society building (1963) in Queen St was the country’s tallest reinforced concrete building at the time of its construction. They designed educational buildings for Otago, Massey and Auckland universities including Auckland’s university library, the upper and lower lecture theatre building (demolished 2008), its biology building and its Fine Arts School. However, it was their domestic work that shone. In the first 5 years of the 1950s they won 3 of the 6 Bronze medals awarded by the New Zealand Institute of Architects for domestic architecture (the Beatson family possesses one of these medals). In addition other houses by Massey and Rix-Trott had won the award in earlier years. It was a formidable practice.

Despite this success, the practice has attracted only a little attention in subsequent years. Nikolaus Pevsner illustrated none of their projects in his 1959 article in the *Architectural Review* on architecture in New Zealand and the Architectural Centre book project does not appear to have included any of their work.⁹ People were nevertheless made aware of their achievements. In his 1962 account of New Zealand suburban house, Peter Middleton mentioned Beatson’s 1939 thesis study on prefabrication, inferring it as having something of a trailblazing status.¹⁰ In a 1982 lecture to the Architectural Association of Auckland, Imi Porsolt stated that Geoff Rix-Trott’s house in Remuera should never be omitted when listing the pioneer works of modern architecture in New Zealand.¹¹ Despite such acknowledgement, the publication that accompanied the 1992 ‘50s Show’ at the Auckland Art Gallery listed almost 100 biographies of architects, designers and craftspeople, yet failed to include Massey, Beatson, Rix-Trott or Carter.¹² In his 1990 history of New Zealand architecture Peter Shaw discussed a 1950 *Home and Building* article on the firm’s Flynn house, but only because the writer was prompted to ask if a Pacific style could be developing, rather than identifying any merit in the design itself.¹³ Shaw wryly noted, “On the evidence of the design, its architects were hardly familiar with the work of Californian architects.”¹⁴ Douglas Lloyd Jenkins similarly drew attention to the 1950 writer’s speculation towards an emerging Pacific style, but

dismissed the flat-roofed home as a “solid, even conservative...a 1940s house,” adding “By the time this house was published the thinking this house represented had already been superseded by houses that were more progressively open and casual.”¹⁵

Walker and Clark made greater mention of Massey, Beatson, Rix-Trott and Carter in their 2004 text *Looking for the Local*. They noted that the Architectural Centre book project did not include the practice, mentioned Porsolt’s respect for the Rix-Trott house and footnoted Middleton’s acknowledgment of the Beatson thesis on prefabrication along with a reference to the Beatson prefabricated bach at Lake Rotoma.¹⁶ While clearly interested in the work of the practice and its members, this fell outside the scope of their book, and so the practice remained largely undiscussed. In response to the limited attention given to the practice over the past decades, our present paper on Beatson’s investigation and practice of prefabrication seeks to draw attention to the work of both Beatson and the practice.

Prefabrication

“All steel framed windows [were] designed by Dad to fit within the prefabrication grid that he devised.”¹⁷

Beatson qualified as an architect at the University of Auckland as a mature student. His 1939 BArch Thesis, entitled *Unit Design for Mass Production of Houses*, dealt with prefabrication as a means “...to produce single family dwellings cheaply.”¹⁸ This thesis was singled out in the annual *New Zealand Herald* article on the Auckland School exhibition as being of “...unusual and special interest.”¹⁹

In the thesis, having dealt with the post-WWII need for housing in New Zealand, Beatson opens his discussion of standardisation with a quote from *The Auckland Herald* April 14th 1939 (his underlining):

Considering that most dwellings in New Zealand are of wood and have a definitely limited life [referring of course to replacement] the country has a long task before it in providing homes for its people unless pre-fabrication and other methods of producing houses in mass become established here and supersede traditional methods of building.²⁰

New Zealand followed the UK in discussing prefabrication as a way of supplying the much needed houses after WWII at a time when materials were already in short supply.²¹ Prefabrication had also been espoused by modernists, such as Gropius who had built experimental houses for mass production in 1932 in Germany²², and after he had moved to the USA.²³ It had earlier found favour when it came to housing a mobile workforce, or supplying houses for workers, as evidenced by the TVA programme in the USA²⁴, and at a smaller scale the pre-fabricated (strictly pre-cut) railways workers houses made at Frankton and distributed by rail throughout the North island of New Zealand,²⁵ and the later sectional houses for timber workers.²⁶ Within this context a thesis on prefabrication of houses seems timely.

In his thesis Beatson reviewed a number of prefabricated systems, drawing heavily on the three volume study of housing, including what the authors Alfred Bemis and John Burchard called 'Rational Design'.²⁷ This suggests that Beatson's research into prefabrication drew on USA rather than UK published resources. This is confirmed by examining the 21 out of a possible 98 systems Beatson selected for his summary of prefabricated systems for houses. These had originally been described and illustrated in what is called 'The Supplement' to volume three of "Rational Design". Beatson included two further systems that were not part of the supplement. The first was referred to as Fort Wayne and described as a unit house of prefabricated panels. This is in fact housing designed by the Federal Housing Administration (FHA) described in a 1939 article in *Architectural Record*. The FHA "...had just completed fifty plywood houses at Fort Wayne, Indiana. Erection of each unit took only 1 hour and 40 minutes." The factory made houses used prefabricated structural, insulated and plywood faced panels, bolted at the corners to steel ties threaded through them.²⁸ The second was Le Tourneau and refers to the 1937 all steel welded five room houses that

were completed in the shop and then trucked to site by R.G. Le Tourneau's firm,²⁹ although Beatson's interest in this house was because "...it could be transported to site by floating on waterway [sic]."³⁰ This comment refers to six Le Tourneau houses that involved "...floating the completed houses across the Illinois River on their own bottoms."³¹ The inclusion of these two systems both described in USA architectural journals makes clear students at that time were looking to the USA for leading ideas in architecture. This is further supported by the fact Beatson made no reference to a 1936 *RIBA Journal* article on timber building that included the USA timber unit house that could be purchased complete "...even to the food in the larder and the blankets on the bed," and the prefabricated sectional house of timber, which "...has been fully worked out in Sweden."³²

A discussion of the thesis examples is as much interesting in what Beatson left out as what he included. 'The Supplement', which was written by John Burchard, includes the 98 illustrated systems and a further list of another 129 systems, known as the 'Mention List'. The illustrated systems can be broadly broken down into 50% concrete, 38% steel, 10% wood and 1% plastic.³³ Additionally, 73% came for the USA, 17% from the UK, 4% from Sweden (all timber) and 5% others, the latter being three from Germany including that of Gropius, one from Austria and Le Corbusier's system from France of steel frame with straw filled and externally zinc faced wall panels. This was included by Burchard "...because most of the labour can be performed at the factory," with the majority of the elements dry assembled on site.³⁴ Apart from five from the UK and nine from other parts of the world all other systems in the 'Mention List' are from the USA. Beatson only draws his examples from Burchard's main illustrated group. His first three are also the first three in this main group (Aluminaire, American Motohomes,³⁵ and Armco) and then Beatson becomes more selective. He does, however, deal with the next but one entry on Grosvenor Atterbury. This system was based on precast hollow concrete walls and is discussed in more depth than the first three examples, although Beatson made no mention of the fact Atterbury was a pioneer of prefabrication in the USA, and his early interest in prefabricated concrete could well be the reason behind half of Burchard's illustrated systems being in some form of this material.³⁶ In 1902 Atterbury started his investigation into improving construction systems, had travelled abroad, and knew of City Engineer John

Brodie's 1904 three storey flats at Eldon Grove, Liverpool,³⁷ made from prefabricated concrete slabs.³⁸ Atterbury devised a system of lightweight, prefabricated hollow concrete slabs, which in 1918 he used for groups of cottages at Forest Hills Gardens.³⁹

Apart from Buckminster Fuller's Dymaxion House, which Beatson leaves to the end of his examples, the other 20 are presented in the order in which they appear in the supplement.⁴⁰ Of more interest are the examples he chooses to mention at length, including the Dymaxion House. Others are the Forest Products stressed skin plywood bungalow, which was later documented in the UK,⁴¹ and the Neutra Diatom, where the walls are suspended from a number of masts with floor and wall panels precast from steam and pressure treated diatomaceous earth.⁴² Beatson did not comment on the fact the design of Neutra house allowed for sequential purchase of units. The main unit housed small family group of parents and one small child, with later purchases of the separate children's three bedroom unit and a two car garage.

The other named architect in Beatson's selection is John Lloyd Wright, though the entry for his father F. L. Wright does not appear. John Lloyd Wright's system was formed of in-situ concrete poured between precast stack bonded hollow blocks to make a very lightweight concrete house. The system was used in 1930 in Los Angeles for the house for Louis Samuel,⁴³ a somewhat unusual inclusion for New Zealand as this was "...a residence of reinforced concrete, glass, and metal throughout—walls, floors, ceilings, roofs, girders, foundations, doors, windows, and radio antennae included. No wood has been used except during construction for a certain limited amount of temporary scaffolding..." The emphasis on prefabrication using concrete in the examples extended to inclusion of Edison's poured in situ concrete house using cast iron moulds, with Beatson describing it as an example of "A monolithic house made like a machine casting."⁴⁴ Edison applied for his patent in 1908 and built a sample house which was published the following year.⁴⁵

Although the fact Beatson ignored the post-World War I UK prefabricated systems, also developed in response to the housing shortage of the time, both of

concrete (for example the Airey Duo slab) and of steel whether for frame or cladding (for example Atholl and Telford) seems entirely reasonable as not being applicable to New Zealand, the biggest surprise, perhaps, is that only 2 of the 21 thesis examples are prefabricated timber systems (Forest products and Enterlocking). The timber tradition of house building in New Zealand would suggest this would be the direction taken by prefabrication. The four examples of Swedish timber prefabrication, in which building labour by the family that were to occupy them could be substituted for cash,⁴⁶ are ignored by Beatson.

Having gone through the examples and before describing the design of his thesis house, Beatson comments on the Rational Design of Bemis and Burchard. This was a modular system that sought to simplify construction through repeated use of standard members. However, Beatson felt that Rational Design was "...far too complicated for practical consideration, and the unit or module suggested too small."³⁷ His solution was to use a horizontal unit of 3ft 6in which was simply based on the "...smallest common unit of space in a house...—the passage."⁴⁷ The remainder of the thesis is then devoted to explaining how the module would be translated into a buildable, prefabricated house once the foundations were in place. This included a 3ft 6in roof 'tile' that was fixed to rafters gridded with cross members at the same centres.

Not content with supplying a thesis with scale models of the proposed system to become qualified as an architect, and without the massive resources of MIT that were available to Bemis and Burchard, Beatson later built his own prefabricated house to his module and then made a second prefabricated house which was built in the garden of the first. The latter is the house in Hurstmere Road (figure 1), demolished to make way for the Bruce Mason Centre, and the second the family bach at Lake Rotoma.



Figure 1: Prefabricated house at Hurstmere Road, Takapuna
(Source: K. Beatson)

Beatson's view of the prefabrication of houses was of a system rather than complete prefabricated buildings. In writing about the Hurstmere Road house he noted its four main design parameters as the characteristics of the occupants, their housing requirements, potential changes to these in the future, the site characteristics, and its locality.⁴⁸ Setting up a factory on the site, the wall panels were mass produced, although the floor and most of the roof were described as being of normal construction, with the roof covering of asbestos cement sheets and the floors finished in polished rimu. The steel windows and doors were also designed by Beatson to fit in the module.⁴⁹ He was also not averse to recycling with the hall parquet floor being made of squares cut from tea chests.

The Rotoma bach (figure 2) was built and painted in sections in Takapuna, disassembled, shipped on a 10 ton truck and then reassembled high up on a bush covered hillside overlooking the lake, on prearranged blocks and stringers. The erection only took 14 hours. "Erection was begun at 2.00pm on Saturday afternoon and by late Sunday evening the owner was able to sleep in his one-and-a-half-day old cottage."⁵⁰ Beatson referred to himself as "the owner" because the architects of the cottage were given as Massey,

Beatson, Rix-Trott and Carter. The cottage was a long rectangle with the long side facing the view. Looking from the lake at the left hand end were two bedrooms, each with two bunks, which could be curtained off from the main space. The right hand end had a similar bedroom on the lake side and a kitchen on the other. The fireplace was on the back wall and door between it and the kitchen gave access to the outside and right angles to this the door of the lean-to washroom. On the lakeside was a long deck entered off the living room and steps down at the kitchen end.



Figure 2: The bach at Rotoma from the lake
(Source: K. Beatson)

To transport the prefabricated cottage, this simple plan has been cut into 2ft 9in sections for loading on the lorry. This same approach had been used in the UK Temporary Housing programme, where the single storey aluminium AIROH bungalow was built in four sections, each designed to go on the back of a flat-bed truck. The 1945 AIROH prototype was erected in seven hours, from 9.00am to 5.00pm.⁵¹

The walls of the Rotoma cottage were one board thick and were joined by studs placed back and front on site (figure 3). The ceiling and roof were

made on the same principle. All wood was treated with three coats of sprayed creosote after erection and the panels then given a coat of tung oil. Internally the walls were finished with tung oil and the ceiling was painted pale blue. “One novel if unintentional effect rather astonishes visitors to the cottage when they observe the paw-marks of a cat on the ceiling. This particular phenomenon was the result of a cat walking over the freshly painted ceiling lying on the ground in “Takapuna.”⁵²

Recollections of holidays at the bach and of sailing on the lake in a boat also made by Beatson include memories of the building. “The design of the Bach was beautifully simple; there was one main room with four rooms off it—a kitchen and three bedrooms. Each of the bedrooms has two bunks. And to the delight of all us children, each bunk bed had its own porthole window.”⁵³ All fittings were, like those of the Hurstmere Road house, purpose made, including a rack for Lilliput magazines that also housed a radio over the fireplace (figure 3).



Figure 3: Interior of prefabricated bach at Lake Rotoma
(Source: K. Beatson)

Beatson also wrote about prefabrication in *Home and Building*. In 1937 he and Irwin Crookes were appointed editors on the advice of the NZIA starting with the second ever issue. Apart from the three years when Crookes was on active

service, during which time Rix-Trott took over as joint editor,⁵⁴ the pair worked together and, with the rare exception, it is hard to know who wrote the editorials that introduce each issue. One exception is that of January 1943 entitled 'Will Prefabrication "Take on?"'.⁵⁵ This editorial makes reference to a recent issue of *Architectural Forum* that had featured designs for a factory for mass producing small houses.⁵⁶ Beatson suggested that prefabrication of houses should appeal to those with less money, including "...the thousands who wish to be owners with the privilege of paying interests and the other thousands who prefer to be tenants with the privilege of paying rent."⁵⁷ He also noted that proper insulation would be an important ingredient of the prefabricated house some 20 years before the DSIR published their booklet on improving the insulation of New Zealand houses.⁵⁸ Allusion was made to the BArch thesis with the suggestion "...it should be possible to build the ideal home from prefabricated units."⁵⁹

Beatson's authored article on the Hurstmere Road house has been discussed above but the journal included other contributions on prefabrication. The same year the September issue included an article by Gordon Wilson on how prefabrication could aid the national housing programme, pointing out that unlike the monotonous but cheap and practical by-law housing in the UK that was produced to improve the lot of the workers, prefabricating homes could lead to much greater variety in design. Wilson also mentioned evolution in house building and how many items like doors, windows and staircases were already made off site, noting ready-mix concrete as the latest addition to these prefabricated housing components.⁶⁰ In fact the Housing Division of the Ministry of Works had developed a prefabricated storey height panel system in 1942⁶¹ with 200 such houses erected by 1949.⁶² This experiment was not continued because the market was not large enough to sustain it.⁶³

Beatson's last article just before he ended his joint editorship concerned housing for growing families, although prefabrication is no longer the focus. Rather the article looks at designing affordable houses that were not cramped. However, it was illustrated with a photo of the prefabricated Hurstmere house deck complete with two Beatson rocking horses. Although this deck is described as the "...ideal open-air play space...paved with pre-cast concrete slabs" with prefabricated

railings, Beatson is also critical of the design. "There are two disadvantages in the example shown: the horizontal railings which, of course, the children could climb, and the glass doors which have glass within 6" of the floor."⁶⁴ He does offer solutions to both problems. Perhaps more prophetic he also anticipates the kitchen of today. "Some day an enterprising firm will manufacture a range with separate oven and cooking top which can be completely built in, both oven and cooking top at the most convenient height."⁶⁵

In 1945 the journal had an article said to be based on an RIBA pamphlet, which went over the familiar ground of making houses as mass produced as aeroplanes and cars, noting that many Swedish houses were assembled on site from pre-made parts,⁶⁶ as had also been noted over a decade earlier by Burchard. Of more import, perhaps, is that the same issue also featured the Christchurch prefabricated houses designed by Paul Pascoe.⁶⁷

Nevertheless, the Post WWII hope that prefabrication would solve the housing crisis proved groundless, not least because there was no support for creating an artificial market to help get over the tooling up costs of the prefabricated house,⁶⁸ while the prevalence of prefabricated kitchens comes from their much lower setting up costs.

Conclusion

It is difficult to reach a conclusion in an article that is part of a larger investigation. What does emerge is that students at the Auckland School of Architecture in the 1930s were looking towards the journals and books emanating from the USA rather than those of the UK, at least when it came to advances in housing through the use of prefabrication.

¹ Ronald Guthrie Senior Beatson, "Unit Design for Mass Production of Houses," BArch diss. University of New Zealand, 1939, 3.

² Rod Stock, "The Future of NZ housing is prefabs, and 180,000 'tiny' homes," available at <https://www.stuff.co.nz/business/money/101956360/the-future-of-nz-housing-is-prefabs-and-180000-tiny-homes>, accessed 21 May 2018.

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- ³ Ian Bowman, *William Beatson: A Colonial Architect* (Auckland: Balasoglou Books, 2005).
- ⁴ Document in possession of Beatson family.
- ⁵ "Nelson Technical School," *Nelson Evening Mail*, January 31, 1922, 1; "University Tests," *New Zealand Herald*, October 25, 1930, 15.
- ⁶ "To Contractors" (Beatson tender advertisement), *Auckland Star*, September 8, 1936, 20; Anon, "Cintra," *Building Today* 1, no. 1 (October-December 1936): 19-21.
- ⁷ CPRW Fisher, "History," 2017, available at <http://cprwfisher.co.nz/practice/>, accessed 26 Jan 2018.
- ⁸ John Brown, "Orewa Coastal Retirement Resort Development, 488 Hibiscus Coast Highway and 25- 35 Annalise Place, Orewa," Auckland: Heritage Impact Assessment, 2015, available at <http://temp.aucklandcouncil.govt.nz/EN/ratesbuildingproperty/consents/getinvolved/Documents/luc-60070192-22.pdf>, accessed 26 January 2018.
- ⁹ Justine Clark and Paul Walker, *Looking for the Local* (Wellington: Victoria University Press, 2000), 54-55.
- ¹⁰ Peter Middleton, "A House is a House is a Home: the New Zealand Suburban House and its Image," *Journal of the New Zealand Institute of Architects* 29, no. 6 (July 1962): 152.
- ¹¹ Clark and Walker, *Looking for the Local*, 58.
- ¹² *New Zealand Home and Building Souvenir Edition: the Newstalk 1ZB 1950s Show* (Auckland: Auckland City Art Gallery, 1992).
- ¹³ Peter Shaw, *New Zealand Architecture: From Polynesian Beginnings to 1990* (Auckland: Hodder and Stoughton, 1990), 163; "Is a Pacific Style Emerging," *Home and Building* 12, no. 5 (April-May 1950): 20-23.
- ¹⁴ Shaw, *New Zealand Architecture*, 163.
- ¹⁵ Douglas Lloyd Jenkins, *At Home: a Century of New Zealand Design*, (Auckland: Godwit, 2004), 122.
- ¹⁶ Walker and Clark, *Looking for the Local*, 54-55, 58.
- ¹⁷ K. Beatson, *My Recollections of my Father*, 5.
- ¹⁸ R.G.S. Beatson, "Unit Design for Mass Production of Houses," 3.
- ¹⁹ Anon, "Students' Work," *New Zealand Herald*, October 25, 1939, 12.
- ²⁰ R.G.S. Beatson, "Unit Design for Mass Production of Houses," 8.
- ²¹ Brenda Vale, *Prefabs: a History of the UK Temporary Housing Programme* (London: E. and F.N. Spon, 1995).
- ²² Gilbert Herbert, *The Dream of the Factory-made House: Walter Gropius and Konrad Wachsmann*, (Cambridge, Mass: MIT Press, 1984).
- ²³ Anon, "Prefabrication," *Architectural Forum* 78, no. 6 (June 1943): 89-96.
- ²⁴ Julian Huxley, *TVA Adventure in Planning* (London: The Architectural Press, 1943); Hugh Casson, *Homes by the Million* (Harmondsworth: Penguin, 1946).
- ²⁵ Laura Kellaway, "The Railway House in New Zealand: a study of 1920s prefabricated houses," MArch diss., University of Auckland, 1993.
- ²⁶ Graham Dawson, "House Construction," *Journal of the New Zealand Institute of Architects* 17, no. 3 (June 1950): 45-48.
- ²⁷ Albert Farwell Bemis and John Burchard, *The Evolving House* (Cambridge: The Technology Press, MIT, 1932-36).
- ²⁸ Anon, "Fifty Plywood-panel Houses Built a Rate of One a Day," *Architectural Record* 85, no. 3 (March 1939), 38-40.
- ²⁹ "Products to Practice," *Architectural Forum* 67, no. 1 (July 1937): 53-56, 82.

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- ³⁰ Beatson, "Unit Design for Mass Production of Houses," 29.
- ³¹ "Products to Practice," 56.
- ³² Richard Furneaux Jordan, "Modern Building in Timber," *Journal of the Royal Institute of British Architects* 43, no. 5 (January 1936), 225-241.
- ³³ Many systems are hybrids so this classification is based on the major structural material. Percentages may not add to 100 because of rounding.
- ³⁴ Norman N. Rice, "The Minimal House: a solution," *Architectural Record* 68, no. 2 (August 1930): 133-137.
- ³⁵ Beatson lists this as Motohomes.
- ³⁶ Peter Pennover and Anne Walker, *The Architecture of Grosvenor Atterbury*, (New York: W.W. Norton and Co., 2009), 254.
- ³⁷ Demolished 1966 although the same system used on the 1906 tram stables at Walton part of which still exists on the corner of Rice Lane and Queens Drive (see <http://streetsofliverpool.co.uk/page/13/?s=st>).
- ³⁸ Anon, "Cheaper Housing: an experiment with clinker slabs," *The Building News*, 88 (June 16, 1905), 848; Christopher Crouch, *Design Culture in Liverpool, 1880-1914: the origins of the Liverpool School of Architecture*, (Liverpool, Liverpool University Press, 2002), 182-13.
- ³⁹ Pennover and Walker, *The Architecture of Grosvenor Atterbury*, 255, 265.
- ⁴⁰ The order is not alphabetical as Beatson does not give the full name and in place substitutes 'Enterlocking' for 'Interlocking'.
- ⁴¹ Richard Sheppard, *Prefabrication in Building* (London: The Architectural Press, 1946).
- ⁴² John Burchard, "Research Findings of Bemis Industries, Inc.," *The Architectural Record* 75, no. 1 (January 1934): 3-36.
- ⁴³ Pauline Schindler, "The Samuel House, Los Angeles: Lloyd Wright, Architect," *The Architectural Record* 67, no. 6 (June 1930): 525-30.
- ⁴⁴ Beatson, "Unit Design for Mass Production of Houses," 21.
- ⁴⁵ Anon, "The Edison Concrete House," *Scientific American* 101, no. 9 (28 August 1909): 141-42.
- ⁴⁶ Linton Wilson, "Sweden's Small House Answer," *Architectural Forum* 60, no. 4 (April 1934): 295-300.
- ⁴⁷ Beatson, "Unit Design for Mass Production of Houses," 36.
- ⁴⁸ R.G.S. Beatson, "The Shape and Shadow of Homes to Come," *Home and Building*, 6, no. 2 (December 1942): 9-11.
- ⁴⁹ Beatson, "The Shape and Shadow of Homes to Come," 9-11.
- ⁵⁰ Anon (but written by R.G.S. Beatson), "A Prefabricated Cottage at Lake Rotoma," *Home and Building* 15, no. 6 (November 1952): 29-31.
- ⁵¹ John Madge (ed.) *Tomorrow's Houses* (London: Pilot Press, 1946), 215.
- ⁵² Anon, "A Prefabricated Cottage at Lake Rotoma."
- ⁵³ K. Beatson, *My Recollections of my Father*, 3.
- ⁵⁴ Rix-Trott worked on the magazine from the January 1942 issue and Irwin Crooks returns for the December 1946 issue.
- ⁵⁵ Editorial, "Will Prefabrication 'Take on?'" *Home and Building* 6, no. 3 (June 1943): 3, 40.
- ⁵⁶ Anon, "Products and Practice," *Architectural Forum* 67, no. 1 (July 1937): 53-56, 82.
- ⁵⁷ Editorial, "Will Prefabrication 'take on?'"

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- ⁵⁸ Lyndon Bastings, *Handbook on the Insulation and Heating of Buildings with Special Reference to Dwellings*, (Wellington: DSIR, 1964).
- ⁵⁹ Editorial, "Will Prefabrication 'Take on?'"
- ⁶⁰ Gordon Wilson, "Prefabrication as applied to a national housing scheme," *Home and Building* 6, no. 4 (September 1943): 10, 37, 39.
- ⁶¹ Dawson, "House Construction," 47
- ⁶² Gael Ferguson, *Building the New Zealand Dream*, (Palmerston North: Dunmore Press, 1994), 128.
- ⁶³ Dawson, "House Construction," 46.
- ⁶⁴ R.G.S. Beatson, "Can We make out Homes more Attractive to Mr. Stork?" *Home and Building* 7, no. 1 (December 1943): 12-13, 42, 45.
- ⁶⁵ Beatson, "Can We make out Homes more Attractive to Mr. Stork?"
- ⁶⁶ Anon, "Prefabrication—The Answer?" *Home and Building* 8, no. 2 (June 1945): 7-9.
- ⁶⁷ Anon, "Eight Prefabricated Houses in Christchurch," *Home and Building* 8, no. 2 (June 1945): 12-13.
- ⁶⁸ Vale, *Prefabs*, 179.