

## Abstract

This design's vision is to provide spaces that unite the community and enhance residents' quality of life, with a minimal environmental impact over the project's lifespan. All apartments have been designed with a connection to nature by maximising natural light and passive ventilation, to improve residents' mental and physical health.

The principles of the circular economy have been embraced, with an existing warehouse being converted to a commercial space, and surplus materials such as bricks and timber that are already on site, being re-used to construct paths and other facilities.

A communal vegetable garden has been provided to allow social interaction between residents, whilst teaching the principles of sustainability.

Innovative modular construction techniques reduce the project's overall cost whilst respecting the environment. All of the residential spaces are constructed with Glulam beams and columns, cross-laminated timber (CLT) flooring, and a combination of CLT walls and stud-framed walls, to provide a sustainable alternative to traditional building materials. Surefoot footings were chosen to minimise the physical and environmental footprint. The use of adhesives has been avoided to ensure modules can be disassembled and materials reused at the end of the project's lifespan. North-facing solar panels reduce energy consumption over the building's lifecycle.

## Executive Summary

Innovation in building design is essential to reduce construction costs, ensuring affordability for consumers, and profitability for developers. This project transforms a derelict site in Fremantle into a vibrant mixed-use development that embraces sustainability, affordability, and the circular economy, using modular construction techniques. The site is located on the corner of Stack Street and Wood Street, Fremantle, at the boundary of a light industrial area and a residential area.

The proposed design was developed in consultation with three engineering students and incorporates four two-bedroom apartments, four one-bedroom 'build to rent' units, six one-bedroom student apartments, and various commercial spaces. The residential accommodation is comprised of pre-fabricated modules made from locally-sourced cross-laminated timber floor (CLT), Glulam columns and beams and timber stud framing which are constructed off-site and transported to site for final assembly. CLT is a sustainable material, which is ideal for modular construction due to its light weight and low cost compared to steel or concrete (Roberts 2020). All materials have a lifespan over 50 years, and modules will be assembled and connected with bolts and screws rather than adhesives, to allow disassembly and re-use of materials at the end of the building's lifecycle, minimising the overall environmental impact. Modules are self-contained, allowing easy transport to another site with minor adjustments. Service shafts are located externally, to minimise the penetrations needed in each module. Split system air conditioning is provided, with a single outdoor unit servicing two wall-mounted indoor units for the living and bedroom areas in each module.

The development consists of two buildings - a two-storey building situated near the northern boundary, and a four-storey building to the south, which adjoins part of an existing warehouse. The height differential reduces overshadowing of the southern building, ensuring most apartments receive northern light. The warehouse building has been repurposed as a commercial space, and houses a café, convenience store and 'click and collect' facility, whilst retaining its historically significant façade. The design fully complies with NCC standards and local municipal requirements. The entire site is wheelchair- accessible, excluding the two-

storey building. Many apartments include a balcony to provide a dedicated outdoor space for residents and opportunities for interaction between apartments in periods of isolation. The balconies were inspired by stories of Italians singing from their apartments during COVID-19 lockdowns (Kozłowska and Todd 2020).

The design includes numerous elements to minimise its overall environmental impact. Solar panels reduce grid energy consumption, and water consumption is reduced by diverting waste water from showers and basins to toilet cisterns. Innovative Surefoot footings provide a sustainable alternative to concrete footings, and minimise ground disturbance for installation and removal. The site has been designed to provide a sense of community to residents, with shared facilities such as barbecues and a communal vegetable garden. The café provides a connection between residents and the community. The circular economy principle of reuse has been adopted, with landscaping features being built from surplus timber and bricks already on site.

This project demonstrates that innovative design and construction methods can reduce the cost of housing, without compromising on environmental sustainability or occupants' quality of life.

## References:

Kozłowska, Hanna and Sarah Todd. 2020. "Italians are singing on their balconies to create community in the age of coronavirus". <https://qz.com/1818573/italians-singing-on-their-balconies-create-community-despite-coronavirus>.

Roberts, David. 2020. "The hottest new thing in sustainable building is, uh, wood". <https://www.vox.com/energy-and-environment/2020/1/15/21058051/climate-change-building-materials-mass-timber-cross-laminated-clt>.

# AFFORDABLE MODULAR HOUSING

The vision for this design is to provide spaces that bring the local community together and enhance residents' quality of life, with a minimal environmental impact over the project's lifespan. All apartments have been designed to provide a connection to nature by maximising natural light and passive ventilation, with the intent of improving residents' mental and physical health.

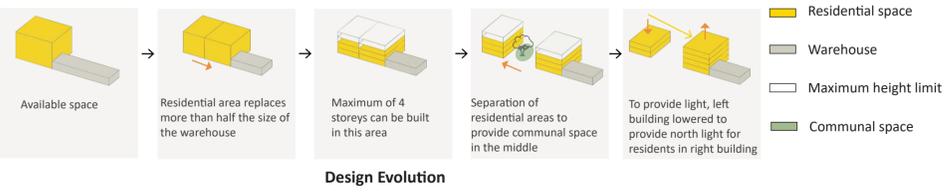
The principles of the circular economy have been embraced throughout the project, with an existing warehouse being converted to a commercial space, and surplus materials such as bricks and timber that are already on site, being re-used to construct paths and other communal facilities. A communal vegetable garden has been provided to allow social interaction between residents, whilst teaching the principles of sustainability.

Innovative modular construction techniques have been used to reduce the project's overall cost whilst respecting the environment. All of the residential spaces are constructed with Glulam beams and columns, cross-laminated timber (CLT) flooring, and a combination of CLT walls and stud-framed walls, to provide a sustainable alternative to traditional building materials. Surefoot footings have been selected to minimise the physical and environmental footprint. The use of adhesives has been minimised to ensure modules can be disassembled and materials reused at the end of the project's lifespan. North-facing solar panels reduce energy consumption over the life of the building.

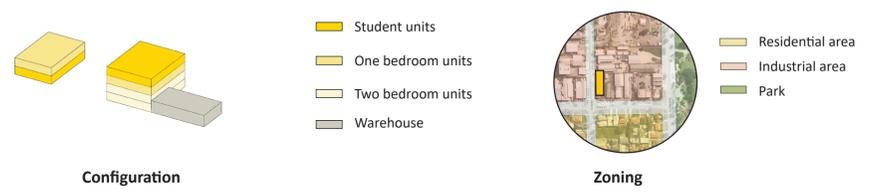
This design demonstrates that innovative construction techniques and materials can create spaces that enhance residents' quality of life whilst minimising the impact to the environment.



Site Analysis

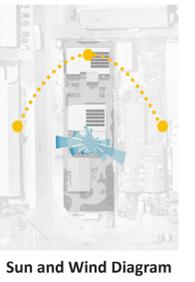
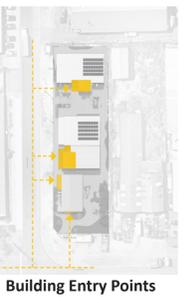
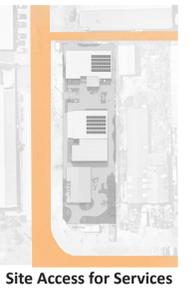


Design Evolution



Configuration

Zoning

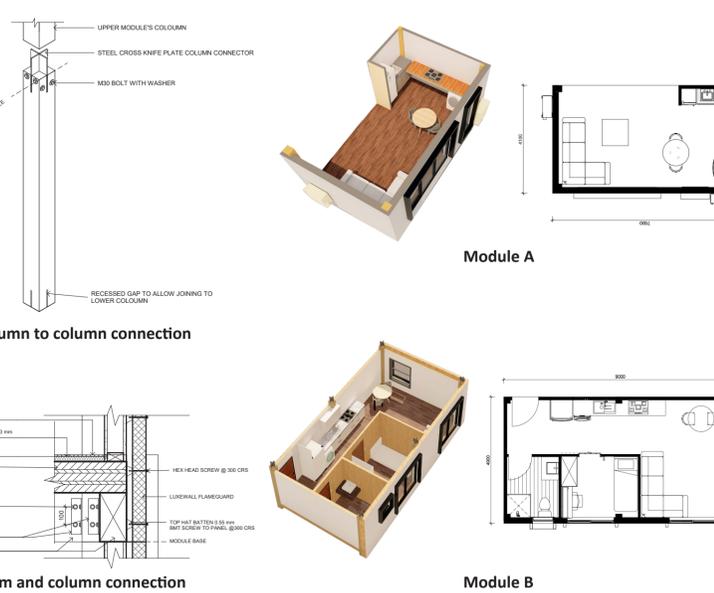
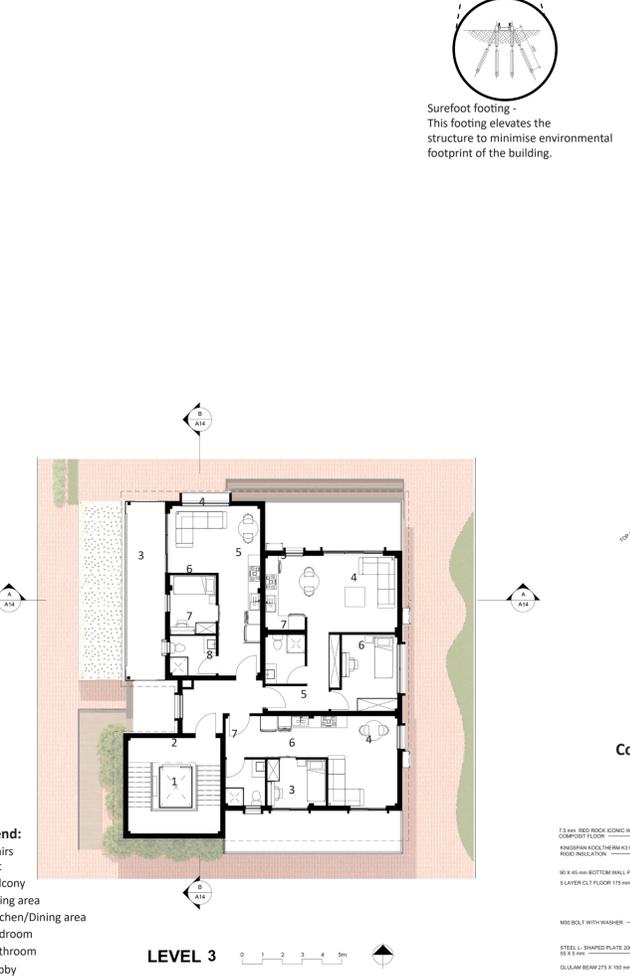
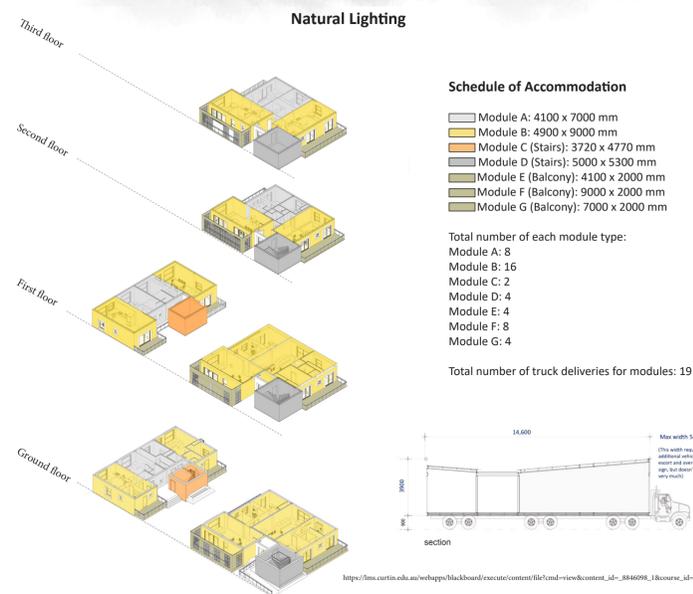
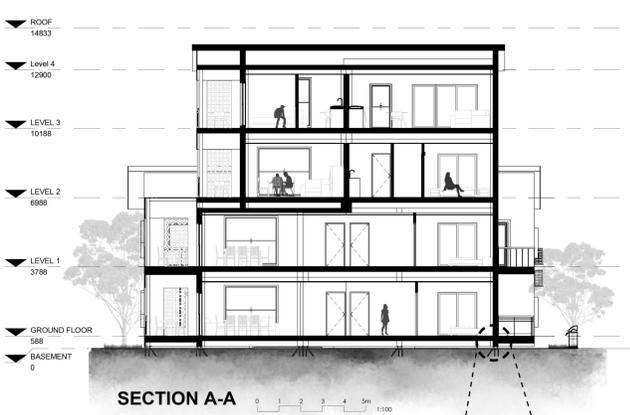


- Legend:**
- 1- Cafe
  - 2- Convenience store
  - 3- Click and collect
  - 4- Storage and staff entrance
  - 5- Stair
  - 6- Lift
  - 7- Balcony
  - 8- Master bedroom
  - 9- Bathroom
  - 10- Bedroom
  - 11- Living area
  - 12- Kitchen/Dining area
  - 13- Lobby
  - 14- Ramp
  - 15- Communal space
  - 16- Cafe outdoor area





Grey Colorbond steel is used for all roofing and wall cladding of warehouse to represent the industrial context. Graffiti on wall is inspired by graffiti on neighbouring building to the north of the site.





West Balcony

- Recycled Spotted Gum timber decking
- LuxeWall FlameGuard wall with Shale Grey Colourbond cladding
- White laser cut aluminium external shading
- Grey laser cut external shading
- Glulam beam



Communal Space



- Recycled Spotted Gum timber ramp
- LuxeWall FlameGuard wall with Basalt Colourbond cladding
- Double hung window with black aluminium framing
- Reused existing bricks on site - circular economy
- Sliding adjustable external shading

Sliding external shading allows flexibility for residents to adjust shading to block harsh west sunlight as they desire.



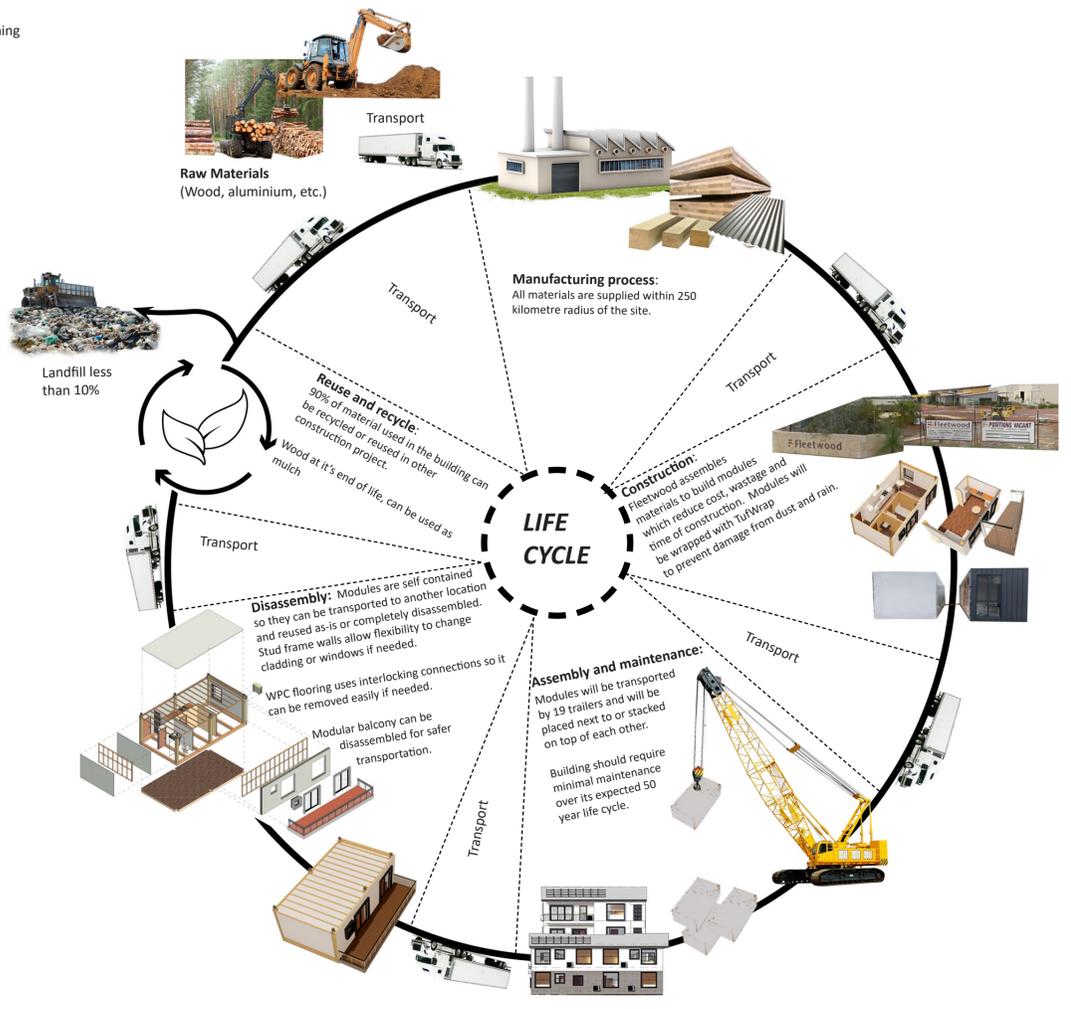
Interior of Cafe

- Cross Laminated Timber (CLT)
- Existing concrete foundation
- Existing heritage brick wall
- Colourbond Surfmist cladding



Interior of One Bedroom Unit

- Fyrchek plasterboard
- Red Rock Wood Composite Flooring (WPC)
- Glulam columns



SOUTH ELEVATION



EAST ELEVATION



NORTH ELEVATION

