Seven Generations for Wood

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While there is much interest from both the construction industry and government to develop new pathways for salvaging and recycling wood products there has not been significant movement in implementing large scale wood recycling initiatives. Despite having one of the strictest recycling programs in the country, the city of Vancouver still a significant construction and demolition (C&D) waste problem. The Zero Waste Policies from Metro Vancouver Municipalities has allowed 78% (1.3 million tonnes) of all waste streams to be diverted from regional landfills, but wood C&D waste (31% of all C&D waste) still largely ends up in the landfill.[1,2] Given that about 57% of new buildings in Vancouver are light-wood type buildings and the Vancouver Landfill is slated to be decommissioned in 2037, the city needs a strategy to divert these large volumes of wood from being landfilled.[3] This project presents a method to recycle salvaged wood from deconstructed light-wood buildings and use those materials in new deconstructable assemblies. Common wood waste such as dimensional lumber, plywood, oriented strand board (OSB), laminated strand lumber (LSL),and laminated veneer lumber(LVL) can be recycled into new wood products including finger-jointed lumber, OSB, OSB/LSL or Plywood/LVL crosslam tiles, and wood fibre insulation. Typical light-wood frame construction can then be altered to incorporate these recycled materials and to facilitate deconstruction and further reuse. This project proposes that with proper recycling infrastructure and construction practices the value of wood extracted from the urban environment can be maintained across multiple generations of buildings creating a true circular economy of wood materials.

Figure 5. proposes a system that allows a variety of wood waste to be recycled into new products and demonstrates how those products can be continually recycled or reused. The first process produces finger-jointed dimensional lumber from sections of salvaged lumber. Finger-jointing short pieces of lumber produces wood that is even stronger and straighter than regular dimensional lumber. This wood can be used any kind of light-wood framing application and it can be made in any standard size, providing there is sufficiently wide feedstock. Due to code restrictions, this kind of recycled lumber cannot be used in any structural applications, however, the states of Washington and Oregon in the US have adapted their code to allow structural reuse of salvaged wood at an assumed no. 2 rating, acting as a potential precedent for changes to BC's building code.[4,5]

OSB recycling takes advantage of whole wood that is too short or otherwise unsuitable for finger-jointed lumber and turns it into strand-based engineered wood such as OSB or LSL. In this process, lengths of whole wood are cut into thin strands in a specialized shredding machine. These strands are then coated in an adhesive, arranged into large mats of alternating direction, then pressed, cured, and cut to size. The resulting OSB can be used for things like shear walls or subflooring, and LSL can be used for structural beams. This process borrows from existing OSB and LSL production technology, but it has not been done with recycled wood, and the strand making machine would need to be adapted to use small pieces of dimensional lumber rather than whole logs.

Crosslam recycling is a more experimental and is a method of recycling engineered wood products such as Plywood, OSB, LVL, and LSL into tiles that can be used for exterior cladding or interior finishes. Though similar products exist, the industrial line pictured in Figure. 5 is more illustrative than practical and would need to be altered for scalability.[6]

The final recycling process is to make wood fibre insulation. The rigid insulation board performs similarly to rockwool and is waterproof so it can be used as exterior insulation. The boards are milled with tongue and groove profiles meaning that when properly installed the wood fibre insulation acts as an air and weather resistant barrier. This manufacturing process already exists for new materials but shows promise in being able to adapt to the use of salvaged materials—including engineered wood—as it has the benefit of being able to use very poor-quality wood as feedstock.

These products can all be combined in a light-wood construction system that is fully deconstructable. The system is adapted from typical construction practices so that this style of building could be easily integrated into Vancouver's construction industry. The assembly takes a basic light-wood frame wall and swaps out all new materials for recycled-products. The framing is made with finger-jointed lumber, which is assembled with screws and double-headed nails so that it can be easily deconstructed. OSB sheathing is also installed with double-headed nails or screws. Wood fibre insulation is installed over

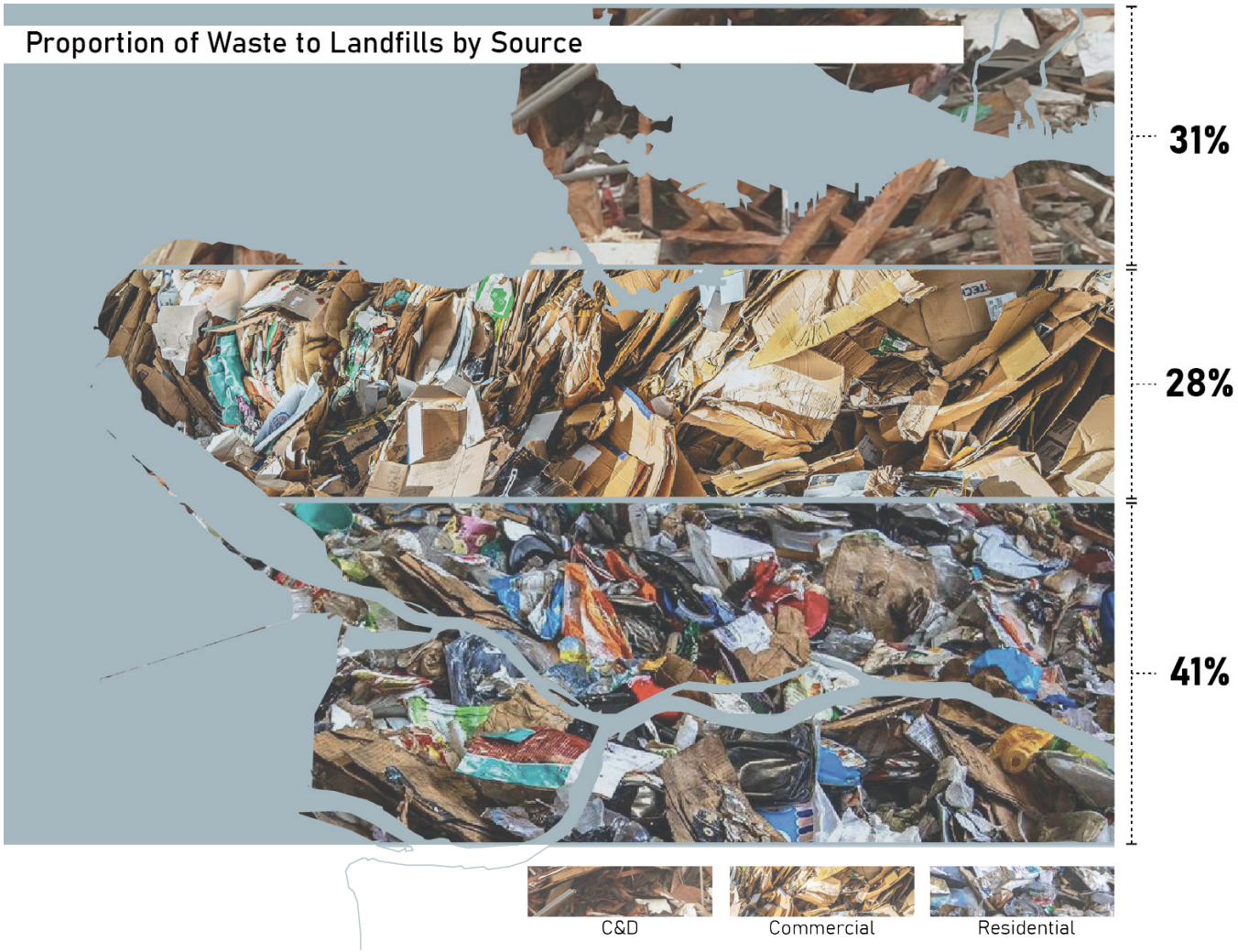

Figure 1. Proportion of waste to Vancouver landfills by source. Author.

Total # Issued Permits 2017-2023: 34,677
Total # Issued Permits for Dwelling-type buildings= 24,699
Dwellings Make up 71% of all issued permits
The 6 specific use categories make up 95% of Dwelling permits

Average mass of wood available in a standard dwelling based on Vancouver's average home size 130 sqm=30 tons of wood material (weight taken from Metro Vancouver recycling calculator)

Average Annual Wood Input = 34, 000 tons
Average Annual Wood Output = 21, 000 tons

Figure 2. Number of issued Building permits for dwelling-type buidlings in Vancouver 2017-2022. Author.

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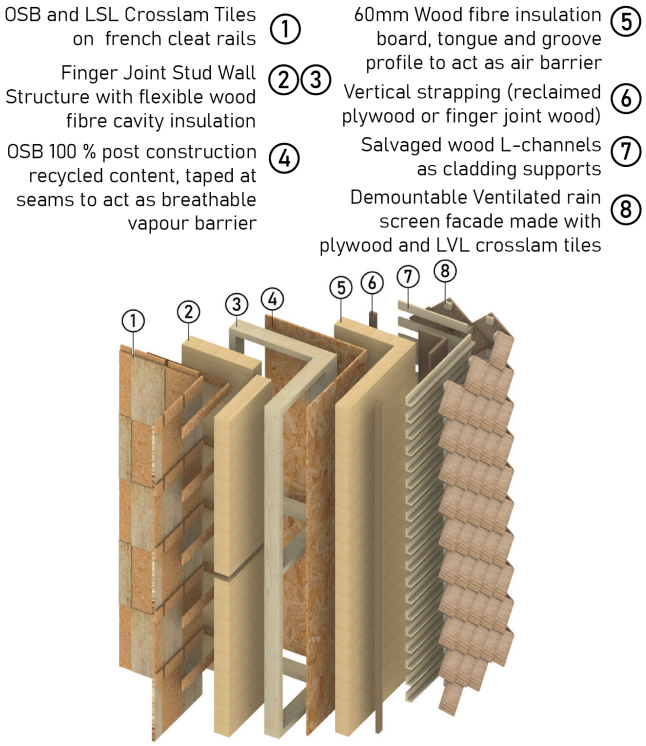

Figure 3. Exploded wall section. Author.

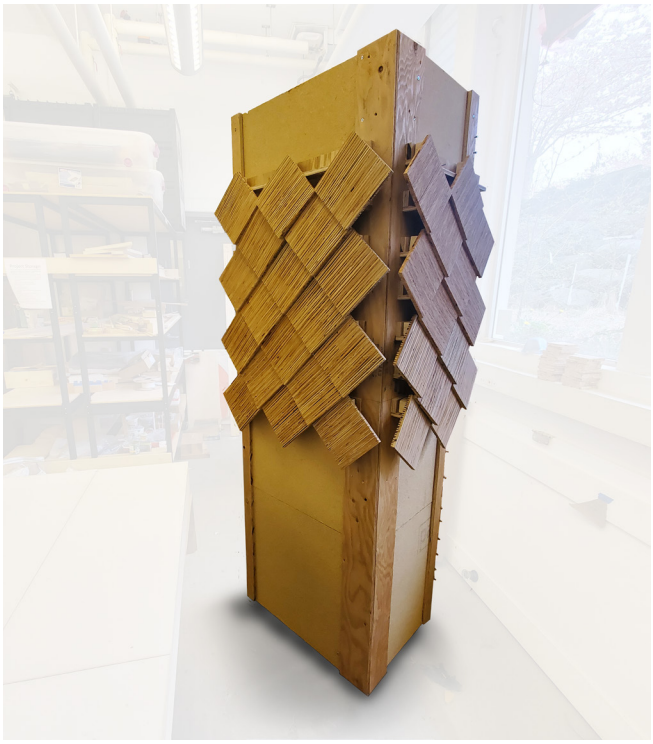

Figure 4. Mock-up of light-wood frame wall prototype. Author.

top of the sheathing and secured with the strapping. Plywood and LVL crosslam tiles are mounted onto the strapping using a demountable rainscreen system so that any damaged tiles can be easily replaced. The interior of the wall has wood fibre cavity insulation and more removable crosslam tiles as the interior finish which provide an alternative to traditional drywall and create an accessible service cavity.

The wall system omits any adhesives or plastic films that would get in the way of recycling the wall components, but the OSB sheathing acts as a vapour permeable barrier and the exterior insulation is a complete air and weather resistant barrier making the whole system airtight but breathable to vapour. This system, as built in the mock up (Figure 4), has a thermal performance of R-22.3 which is on par with City of Vancouver recommendations.[7] And with slight adjustments it can easily achieve much higher ratings.

This project presents an infrastructure-based approach to recycling wood for continued use and would integrate with existing players of the circular economy for wood such as Unbuilders who provide deconstruction and salvage services for pre-1950s buildings and Can-do! who process waste wood into finger-jointed non-structural lumber.[8] [9]This goal of this project is to act as a launching point for further development of the circular economy for wood in Vancouver and precipitate the development of infrastructure to continually recycled wood within the construction industry.

ENDNOTES

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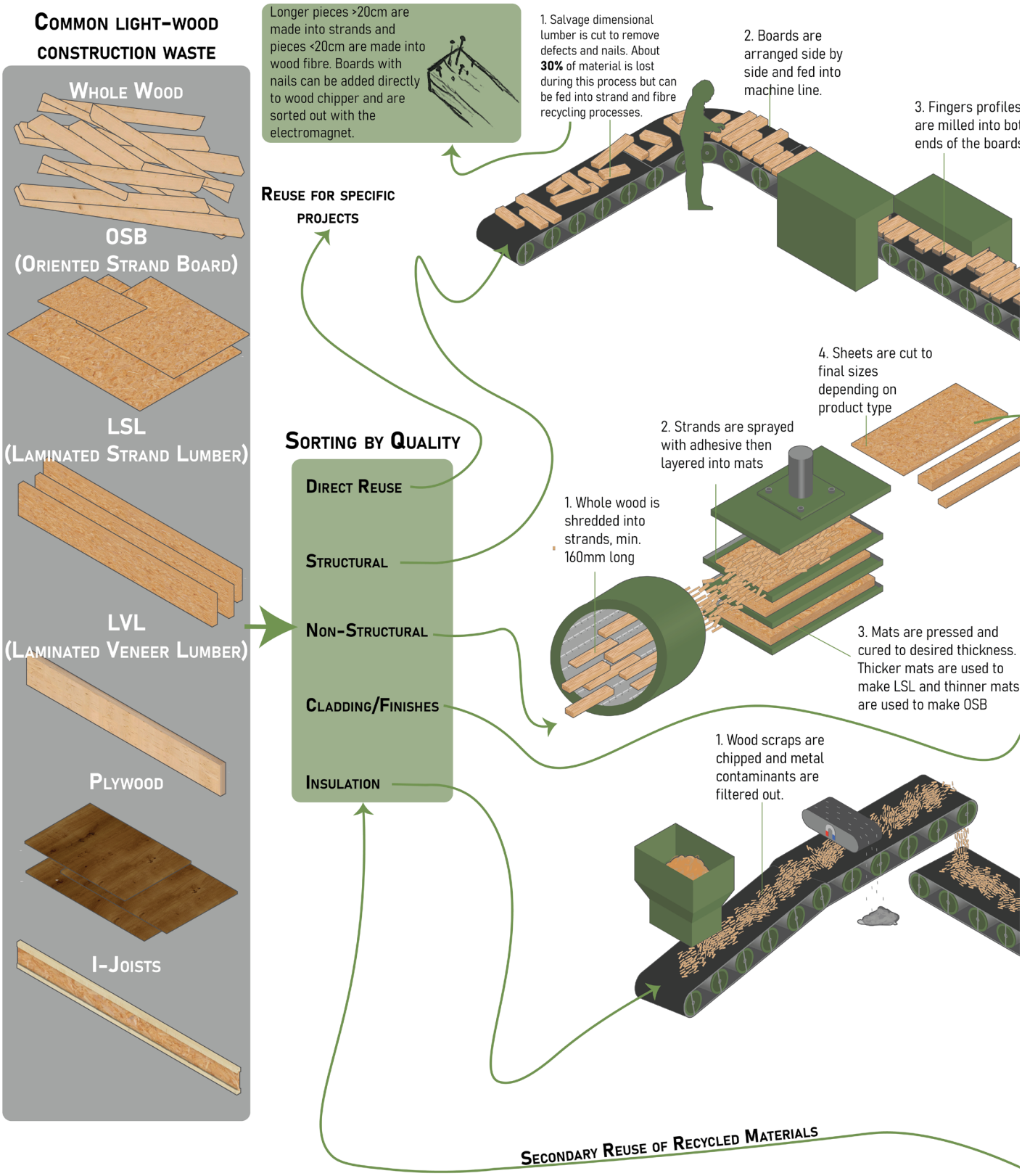
Common light-wood construction waste
Whole Wood
OSB
(Oriented Strand Board)
LSL
(Laminated Strand Lumber)
LVL
(Laminated Veneer Lumber)
Plywood
I-Joists
Longer pieces >20cm are made into strands and pieces <20cm are made into wood fibre. Boards with nails can be added directly to wood chipper and are sorted out with the electromagnet.
Reuse for specific projects
1. Salvage dimensional lumber is cut to remove defects and nails. About 30% of material is lost during this process but can be fed into strand and fibre recycling processes.
2. Boards are arranged side by side and fed into machine line.
3. Fingers profiles are milled into bo ends of the boards
Sorting by Quality
Direct Reuse
Structural
Non-Structural
Cladding/Finishes
Insulation
4. Sheets are cut to final sizes depending on product type
2. Strands are sprayed with adhesive then layered into mats
1. Whole wood is shredded into strands, min. 160mm long
3. Mats are pressed and cured to desired thickness. Thicker mats are used to make LSL and thinner mats are used to make OSB
1. Wood scraps are chipped and metal contaminants are filtered out.
Secondary Reuse of Recycled Materials

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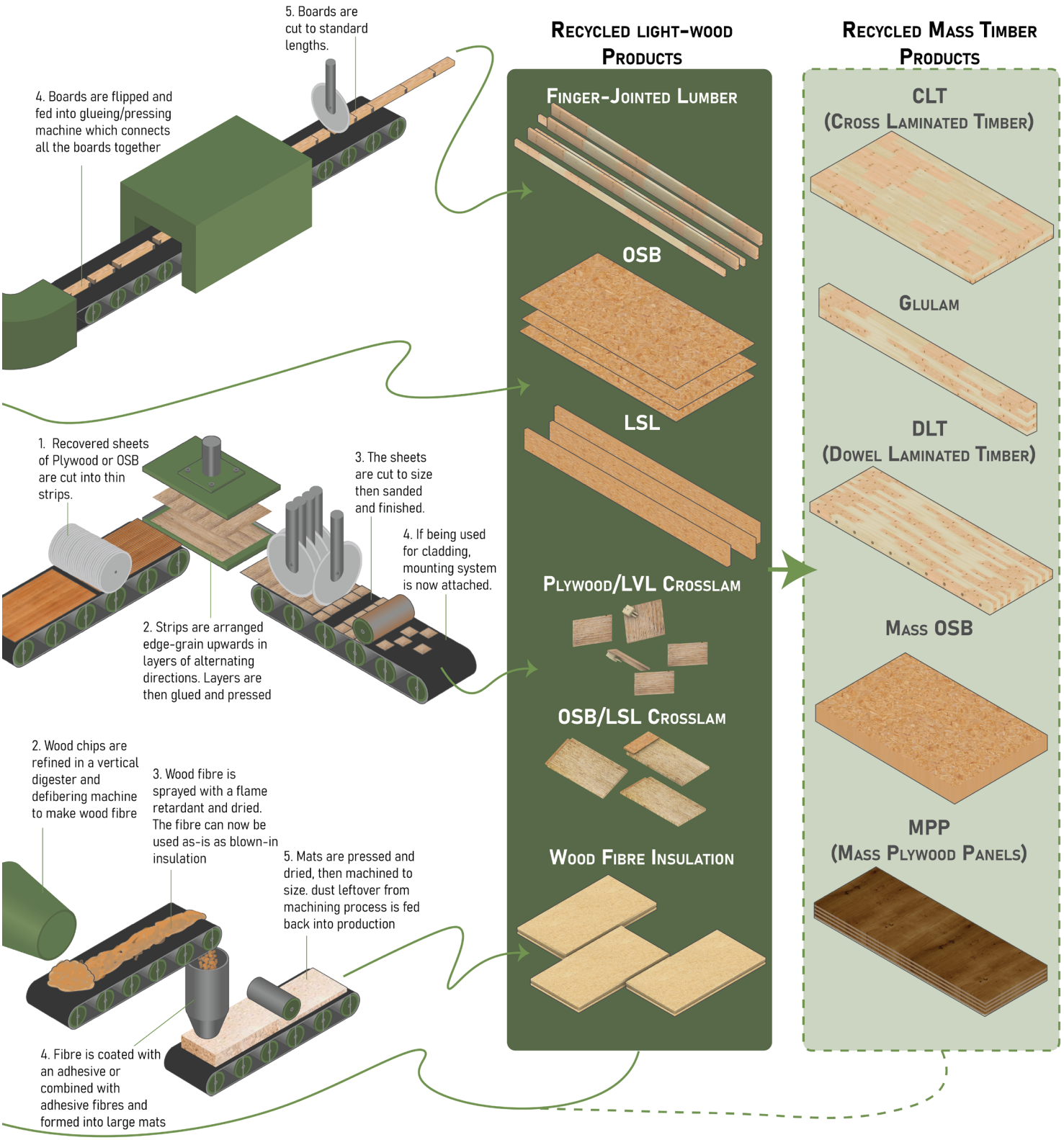

Figure 5. Theoretical model for recycling C&D wood waste. Author

Figure 6. Plywood Crosslam in a fishscale façade. Author.

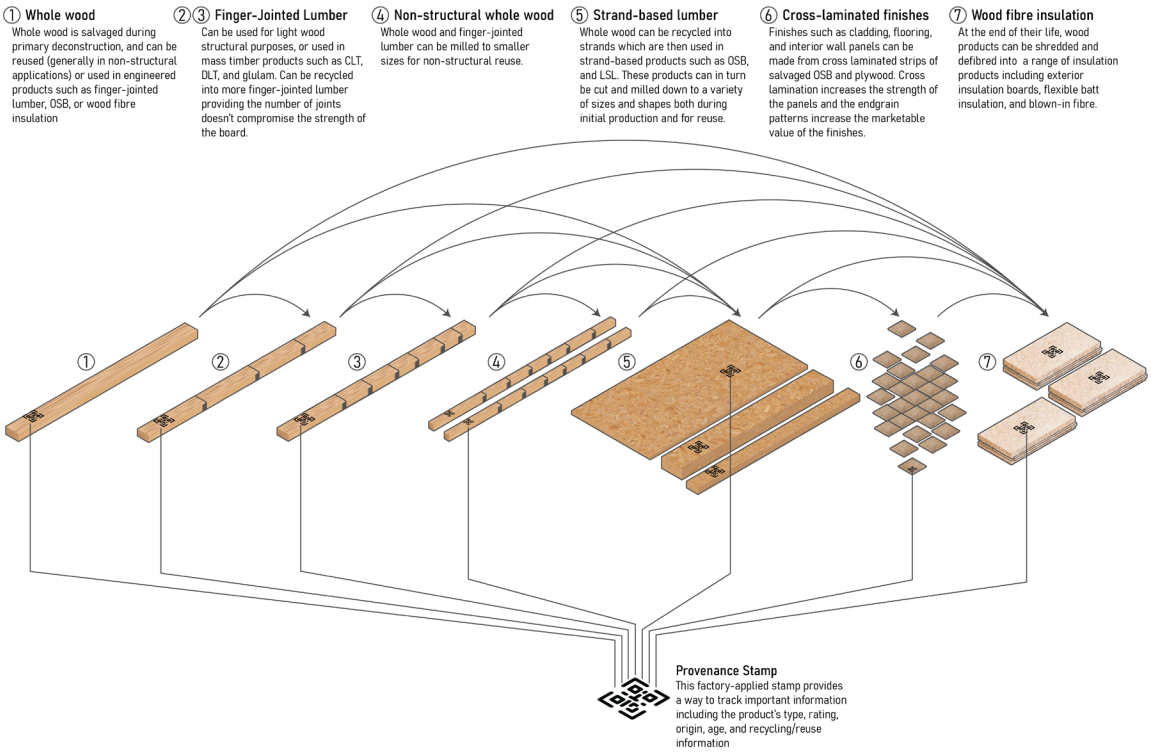

Figure 7. Wood reuse across seven generations of buildings.Author.

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