ABSTRACT: No architect will make a dent in the universe by designing an excellent services shaft or HVAC system, and yet architects could certainly do a lot worse than focusing on redefining the hidden innards supporting our built environment. Digitally manufactured building designs made from wood can help produce extraordinary cores for multi-storey timber buildings. This study aims at investigating the possibilities of such novel building cores. Based on the thesis that contemporary technologies supporting the production of large-scale timber structures offer unique opportunities to redefine the visceral parts of multi-storey buildings, which in turn has architectural effects throughout, the research shows how a combination of mass production and mass customisation strategies can be applied to timber architecture. The end result is a novel design and production strategy based on innovative manufacturing methods that give rise to new construction strategies, new structural ideas, new buildings, and new ways of using those buildings.

KEYWORDS: Wood architecture, multi-storey timber buildings, building services, building cores, living units, CNC, evolutionary solvers, evolutionary algorithms, prototype, branching, branching algorithms, Grasshopper, Moelven, Trä8, Martinsons, Byggma Masonite, WCTE 2014

1 INTRODUCTION

Heating, ventilation, cold and hot water supplies, air conditioning, drainage, sanitation, gas, electricity, refuse and sewage disposal, access control, communications, oil installations, fire fighting facilities, and transportation provisions: building services are in many ways responsible for the artificial environments in which we live and work. Their scientific history goes a long way back to (at least) Archimedes’s “spiral for movement of water” innovation and the underfloor heating of Roman palaces.1 While most of these electromechanical systems tend to be hidden from public view, they do account for between 50% and 75% of total construction costs, and can take up in the region of 15% of a building’s volume.2 At a point in time where we are not only increasingly aware of the detrimental effects humanity’s historical reliance on fossile fuels has had, but also understand that buildings account for at least one third of all human carbon emissions,3 the engineering of the cores that service our built environment plays a significant role in our quest for a more sustainable architecture.

The cores are of such importance, in fact, that the architectural and engineering community cannot simply hand over the responsibility for them to a motley crew of sub contractors, consultants, and building services engineers; we need to reconsider the importance of the building core and allow it to take centre stage by devising strategies for how to make its services more intelligent – more efficient, flexible, sustainable, and architecturally generative. Some contemporary technologies supporting

---

1 Alex Kaiser, Founding director, Ordinary Ltd, Unit 3A/4A, Regent Studios, 8 Andrews Road, London, E8 4QN, UK. E-mail: alex@ordinarystudio.com

2 Magnus Larsson, Founding director, Ordinary Ltd, Unit 3A/4A, Regent Studios, 8 Andrews Road, London, E8 4QN, UK. E-mail: magnus@ordinarystudio.com

3 Ulf Arne Girhammar, Professor, Timber Structures, Division of Structural and Construction Engineering, Luleå University of Technology, SE-971 87 Luleå, Sweden. E-mail: ulf.arne.girhammar@ltu.se
the production of large-scale timber structures offer unique opportunities to redefine the visceral parts of such buildings; this paper outlines one possible core strategy based on a mass-produced/mass-customised panel design that internalises the services within the building’s CNC-routered walls, allowing the structure to adopt a highly flexible branching arrangement that would previously have been too expensive or too complicated or both.

2 THE PRE-ROUTERED PANEL

The smallest scale of branching in the present building is found within each living unit, where the central input and output points must be connected to the use points within the living unit. That is to say, the electrical input point must be wired to each plug and light, and the water input point must be piped to each sink, toilet and shower.

The standard model for routing these services is to enclose them within the wall, floor and ceiling build-up. This makes the services inaccessible, inflexible and time consuming to install on site. Current pre-fabricated timber structures have identified this issue and supply panels with services pre-installed, with only end connections needing to be made on site. Whilst this greatly reduces installation time, it does not improve accessibility or flexibility. We propose that all wall, floor and ceiling panels should be routed to a standardised pattern on their internal face, providing an open and efficient network of recessed channels through which services can be passed freely to their destination. This allows for mass customisation of a standardised product on site, as well as fast and simple alterations at a later date. If left exposed, the panels would also turn the service routes into a key visual element of the interior spaces, much like an inverted version of the exterior of the Pompidou Centre or the Lloyd’s Building.

3 CONCLUSIONS

This is Hardcore started out as a speculation on how a CNC-routered plug-in services panel could allow for a new kind of branching typology scheme, and ended up as a novel combination of a series of rhizomatic living units suspended within an arborescent structural branching geometry: not so much a new kind of treehouse as a new kind of treehousing.

3.1 SITES AND BRANCHES

While we tend to think of tree houses as recreational follies, the Korowai (a Papuan tribe in the southeast of Irian Jaya, the western half of New Guinea, a province of Indonesia) might beg to differ. They still use stone tools, have no knowledge of the outside world, and lead their lives in tree houses – some nearly 40 metres off the ground – as protection against a tribe of neighbouring headhunters, the Citak.3 Tree-sitting activist Julia Butterfly Hill famously went higher, as she occupied a Californian Redwood for 738 days, saving the tree by living on two 3m2 platforms some 60 metres above the ground.4

If you were Korowai, or Hill, what would you consider when building your tree house? The first step might be a site analysis: where within the tree might there be a good “structural site” where your living platform can be positioned? What other “sites” within the tree’s branches might you need to consider? Camouflage? Distance to the ground? Wind shelter? Proximity to tasty apples?

Maybe the process actually begins one step earlier, with choosing the tree itself. You will want to do this quite carefully: your tree house will only work within the ramifications and possibilities of what the tree allows. The tree, or structure, determines the possible “sites,” or living units. This is the regular scenario for a standard stacked-floor skyscraper typology.

But what if you could design the tree itself after the fact? Then you could begin by finding the optimal “sites” within the volumetric envelope (as opposed to the structural system), and then connect those sites using an branching system optimised through evolutionary algorithms.

This is the logic deployed in the present scheme. The part (the pre-routered panel) makes way for the whole (the freely positioned living units sitting within the branching structure). The cores adapt to the locations of the living units, yet the system optimises the core structures for efficiency. The resulting building becomes an essay in services detailing, in the unique combination of mass production with mass customisation made possible through contemporary fabrication technologies, and in the diving tower-like branching structure that acts as static and services support. This innovative multi-storey timber building is thus designed from the inside out; the ordinary flows of fluids, energies, and sewage tracing the unconventional outline of an extraordinary future typology for upcoming housing schemes made from wood.

ACKNOWLEDGEMENTS

The authors express sincere appreciation for the financial support from the Regional Council of Västerbotten, the County Administrative Board in Norrbotten, and The European Union’s Structural Funds – The Regional Fund.

REFERENCES