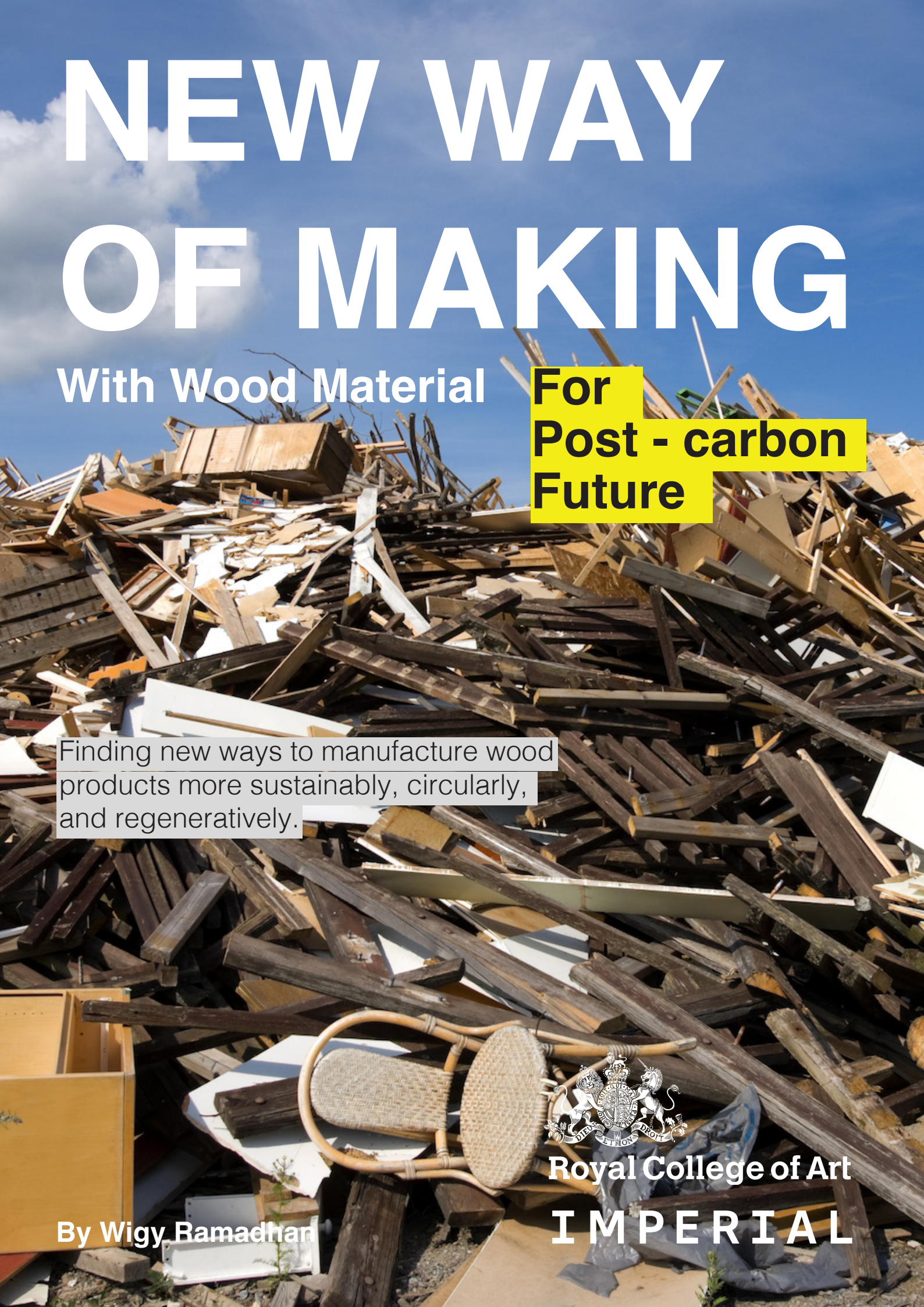
NEW WAY OF MAKING

With Wood Material

For Post - carbon Future

Finding new ways to manufacture wood products more sustainably, circularly, and regeneratively.



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IMPERIAL

1. Context

The rapid advancement of technology has significantly impacted the manufacturing industry. Manufacturing is no longer just about large machines operating in factories to produce goods in massive quantities. The introduction of 3D printing has revolutionized production, offering an alternative to injection molding, which requires substantial investment. Moreover, this technological advancement has made manufacturing more inclusive.

While most modern manufacturing tools are optimized for plastic production, **emerging trends are increasingly driven by sustainability, circularity, and regenerative goals—aiming to reduce material waste, energy consumption, and carbon emissions.** Many new technologies seek to combine manufacturing advancements with sustainable approaches to minimize environmental impact.

In the context of a sustainable and regenerative future, bio-based materials are a key consideration. These materials can be byproducts, waste from other manufacturing processes, or even recycled materials (Material Cultures, 2024). Bio-based materials are grown and fully biodegradable, such as wood.

Historically, wood was one of the first bio-based raw materials to undergo manufacturing processes and has played a significant role in shaping production methods. It has been an essential material for human life since ancient times. Even today, wood remains prevalent in buildings, furniture, decorations, utensils, and more.

In the UK, the country once had vast forests, but the Industrial Revolution led to massive deforestation (Material Cultures, 2024). Despite reforestation efforts, local wood production cannot meet the high demand. As a result, **80% of the timber in the UK is imported from Sweden, Latvia, Finland, and other countries to fulfil domestic needs (Forest Research, 2018; Confor, 2022; Forestry and Land Scotland, 2023).**

Unfortunately, most modern wood manufacturing processes are not sustainable, circular, or regenerative. Many processed wood products are unable to be recycled due to chemical treatments that classify them as hazardous. Consequently, incineration or landfill disposal often becomes the final option, neither of which are sustainable solutions.

This project explores innovative ways to produce wood products sustainably and responsibly, supporting the circular economy and design process by considering end-to-end production. It ensures that products can safely return to the environment at the end of their life cycle.

“In the UK, the country once had vast forests, but the Industrial Revolution led to massive deforestation” (Material Cultures, 2024)

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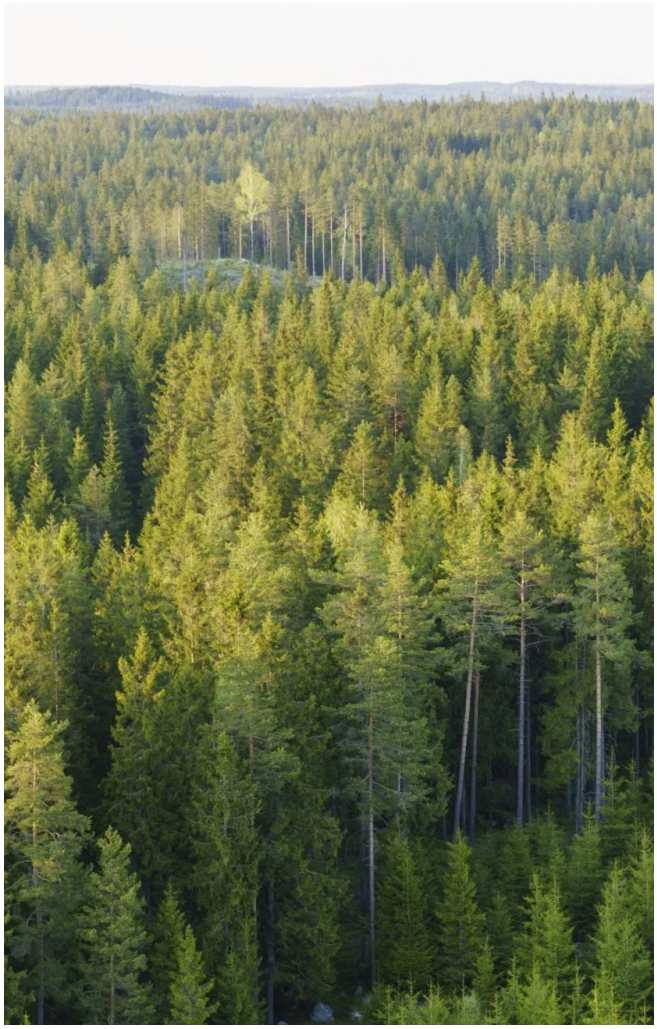

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2. Grounding

A

The Problem with Wood as a Material

When discussing the challenges related to wood, the raw material itself is not to blame. **The real issue lies in how we extract and process it.** Most industrial forests are monocultures, and large-scale clear-cutting practices often lead to severe land deforestation and degrading the land soil quality.

Beyond harvesting, the way we process wood also contributes to sustainability challenges. The excessive use of chemical treatments—such as adhesives in plywood and varnish for the finish—can render wood hazardous and unsuitable for recycling or even result in incineration. **Though wood is considered a recyclable material, not all wood can be recycled, the recyclability of wood depends on its classification and grade (Recycling Bristol, 2024). Factors such as paint, varnish, nails, plastics, and** other contaminants can negatively affect the classification and grading of wood. Given that **most wood products around us have undergone some form of treatment, they are often no longer recyclable.**

Figures:
1. Woodland in the UK (Timber Development UK, n.d.)
2. Pile of various kinds of wood waste (Bodens Group, n.d.)
3. Reclaimed wood piled up (Ramadhan, 2025)

The issue doesn't end there. Consumer behaviour also plays a significant role, as large amounts of wood products are produced but not utilised for their full lifespan, leading to an increasing amount of wood waste. **The UK alone generates 4.5 million tonnes of wood waste annually, with most of it ending up in landfills (Wood Recyclers Association, 2023).** A significant portion of this waste comes from the building and construction industry, where wood is often used for only a short period, remains in good condition for reuse, or, in some cases, is never used at all. Consumers tend to buy new wood materials rather than reclaimed wood, mainly because second-hand wood is often perceived as being in poor condition or simply looking dirty, even though it can still be reused.

3

B

The Past, Present, and Future of Wood Processing: Technology, Communities, and Sustainable Innovation

Uderstanding how the development of wood processing has been influenced by socio-technical factors is essential before introducing a new way of making, which is the goal of this project. Below are the outlines of how wood processing has changed over time—from the past to the present—and what the future may hold.

Ancient Time

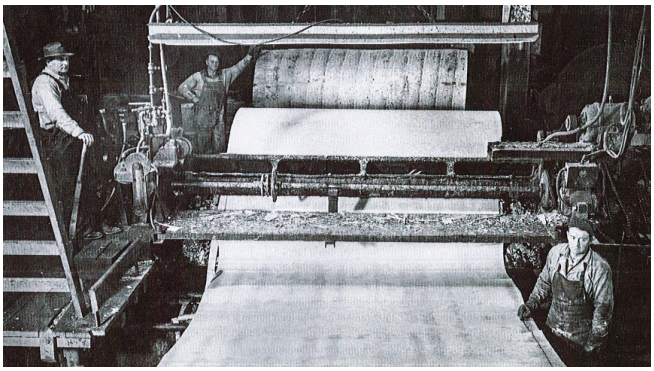
A long time ago Egypt had already come up with veneer and plywood production. The use of veneers in ancient Egypt is documented not only in surviving objects but also in wall carvings depicting the woodworkers, tools, working methods, and finished objects veneered in wood, including, furniture and jewellery boxes (Wilk and Bisley, 2017). Egyptian artists excelled in the technique of puzzling together small, irregular pieces of wood and pegged them into a place to create statuary, coffins, boxes and furniture (Dr Amy Calvert, 2015).

Figures:
Figure 1 and 2 are scanned from the book Plywood: A Material Story, 2017. London: Thames & Hudson.
1. The Mural Record of Veenering in Egypt. (Plywood, 2017)
2. The industrialisation of plywood making. (Plywood, 2017)
3. The diagram of digital technology integration plywood production (Raute, n.d.)

Current Industrial Practice

Industrialisation has involving heavy machineries process in Wood production. The current way of producing plank wood and plywood is not that much different from how it was made in the early and mid-twentieth century. But today the integration with digital technology is in many stages. One of the examples is the use of Data Analytics and Digital Processes to monitor the manufacturing process and Digital Fabrication such as CNC machines.

2



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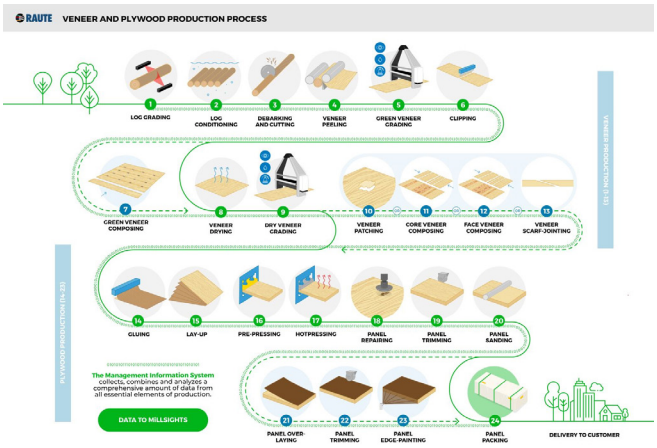

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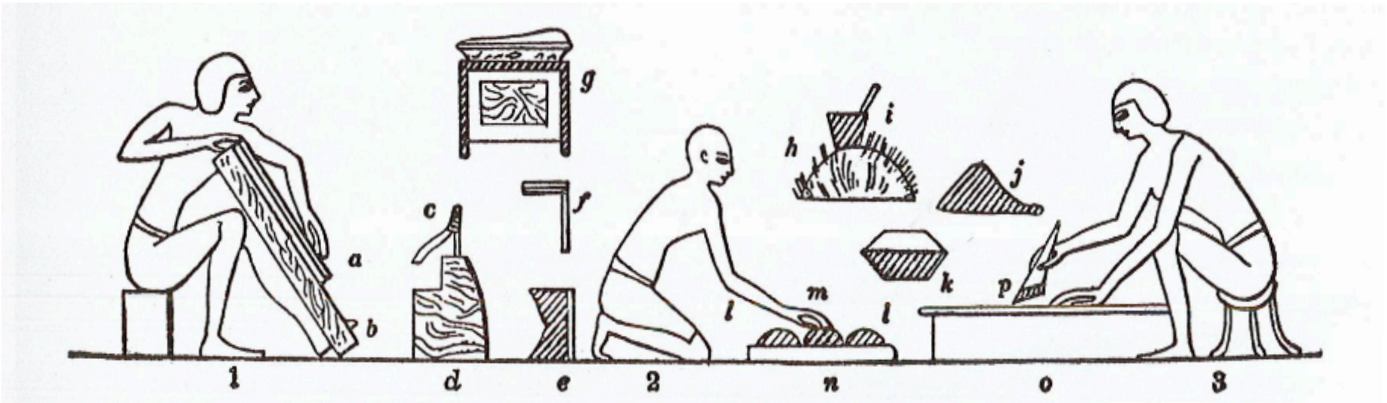

VENEERING AND THE USE OF GLUE. *Thebes.*

a, a piece of dark wood applied to one of ordinary quality, *b*.
c, adze, fixed into a block of wood of the same colour as *b*.
e, a ruler; and *f*, a right angle, similar to those used by our carpenters.
g, a box. *i*, a glue pot on the fire. *j*, a piece of glue.
Fig. 2 is grinding something. *Fig.* 3 is applying the glue with a brush, *p*.

Illustration I. Mural Record of Veneering, discovered in the Sculpture of Thebes and dated as early as the time of the Third Thothmes.

Reproduced from line drawing in "The Manners and Customs of the Ancient Egyptians," by Sir J. Gardner Wilkinson.

Community-Centered Sustainability Practice

In the context of socio-technical sustainability transitions, sutainability transition is often driven by local communities that play a key role in developing the collective user innovation (Kuu-Park et al., 2024) . Therefore, understanding how these communities engage in their practices is crucial for this study.

This research identifies five local initiatives in the UK, each making a significant impact on both local communities and the environment. These initiatives focus on alternative methods of producing wood materials and redesigning supply chains. Some are dedicated to developing new materials, others to reclaiming existing ones, and a few integrate both approaches to provide sustainable wood for building materials and furniture. Notably, all of them also actively contribute to sustainability literacy, further reinforcing their impact.

Material Culture

London, UK
Research & Architect

Material Cultures is a not-for-profit design and research organisation working at the intersection of natural materials, low embodied carbon construction and construction technology. ('Material Cultures', 2024)

Material Culture has shown many examples of how they aim to make a regenerative future by working with natural materials through their prototyping (see figure 3). Not just doing the research by themselves, Material Cultures work closely with the local communities through participatory process.

In 2021, Material Cultures and Arup published their research report with the title Circular Bio-Based Construction in the North East and Yorkshire.

Another relevant research project is Woodland Goods, 2024, exhibited at the V&A. This project explores alternative materials for creating more sustainable sheet/board products as replacements for plywood. While the scale of production and material quality are currently limited, the project demonstrates the potential of utilizing underused tree materials for more beneficial outcomes.

In the exhibition, it was highlighted that while the experiment revealed significant potential, there is still no machine in the UK capable of harvesting bark. This presents a clear opportunity to address.

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Figures:
1. The participants working on a building with MC (Material Cultures, 2024)
2. Sheet materials made from birch bark (Material Cultures, 2024)
3. Experiment Prototype (Material Cultures, 2024)
4. Circular Bio-based Construction Report (Material Cultures, 2025)

Fallen and Felled

London, UK

Sustainable Urban Tree Felling Company

To change the way people dispose of trees and to repurpose them. (Fallen and Felled, n.d)

A London-based timber company that repurposes fallen urban trees into hardwood timber and furniture, founded by Bruce Saunders in 2016 after he was surprised by how difficult it was to find locally grown English hardwood in the city. The company do not fell trees for their benefit, nor do they endorse felling urban trees for financial gain. Their mission is to change the way people dispose of trees and to repurpose them, regardless of the tree's condition—whether it has died due to age, disease, or urban development (Fallen and Felled, n.d).

Fallen and Felled has its own milling, and seasoning facility in Bulphan, Essex, whilst they have shop in London at Blackhorse workshop. Instead of selling timber as planks, they offer it in slices with irregular shapes or as tree trunks, showcasing the unique character of each piece.

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Figures:
1.Tree felling in urban area collaborating with local professional tree surgeon (Fallen and Felled, n.d)
2. Timber in unique shape (Fallen and Felled, n.d)
3. Timbers are being seasoned and labeled (Fallen and Felled, n.d)
4. Extracting timber with horses (Tinkers Bubble, n.d.)
5. Sawmill powered by steam engine (Tinkers Bubble, n.d)

Tinker Bubble

Sommerset, UK

Sustainable Woodland & Sawmilling Community

Tinkers Bubble is a small off-grid woodland community in Somerset. We use environmentally sound methods of working the land without using fossil fuels. (Tinker Bubble, n.d)

Tinker Bubble manage wooldland and sell sustainable produced timber in Somerset UK. Their process in not using fossil fuels. They fell the tree with felling axes and crosscut saws, transported the logs to the milling using horses and milled the log with the wood-fried steam engine-powered sawmill. They open for long-term residency and weekend volunteering programs, which become an inclusive space for people to learn about sustainable wood management.

Recollective and Solo Wood Recycling

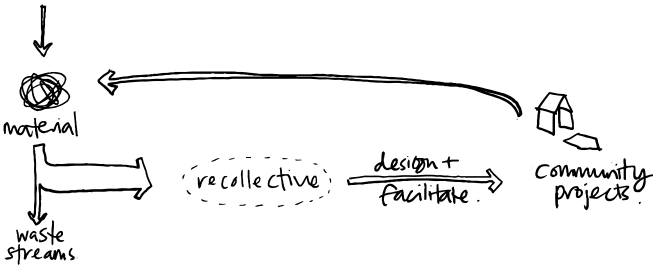
London, UK

Social Enterprise for Material Reclamation

Recollective direct construction materials away from waste streams and towards communities; providing built infrastructure that enhances social value and locks in carbon (Recollective.uk, n.d)

We are a not-for-profit social enterprise that specialises in working with wood that would otherwise be going to landfill (Solo Wood Recycling, n.d)

Though they are working in different style, Recollective & Solo Wood Recycler share the same mission of reclaiming wood materials before they become waste. Both are non-profit organisations with volunteer-based projects. Through conversations with this type of organisation, it was learned that recycling is not the best option to dispose wood waste; instead, reusing is a better approach, as it extends the material's lifespan without requiring a lengthy, exhaustive, and energy-intensive process.



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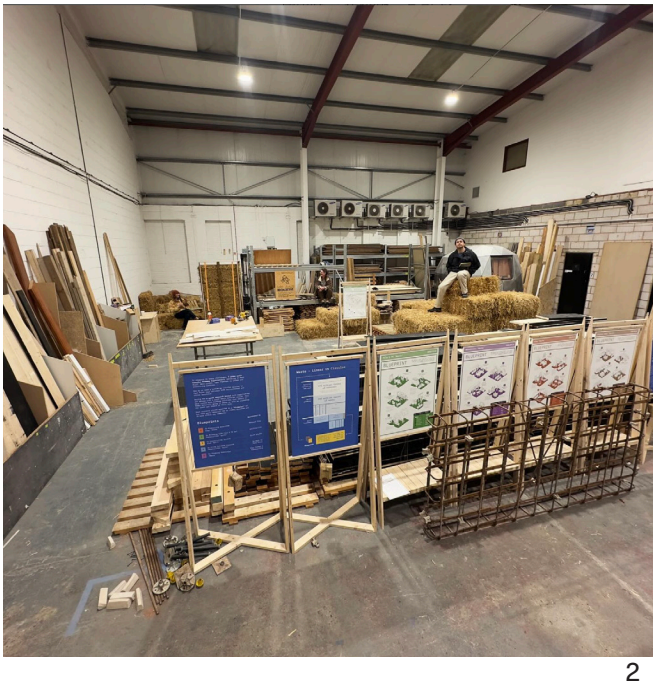

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Figures:
1. Recollective's Flow Diagram (Recollective, n.d.)
2. Recollective's depot space (Recollective, n.d.)
3. Pete from Solo Wood Recycling showing some of woods in his depot that can be taken for free (Ramadhan, 2025)
4. Pile of woods at Solo Wood Recycling depot (Ramadhan, 2025)

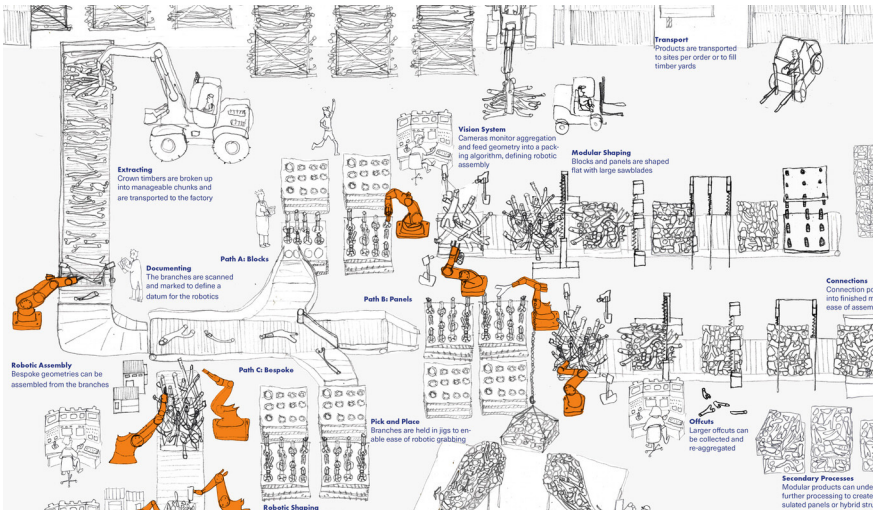
C

State of the Art: Development in Contemporary Practice with Advanced Technology

Many designers, architects, and materials scientists are exploring innovative solutions to address the issue of wood waste. Technologies such as 3D printing, 3D scanning, and digital fabrication methods like CNC play a significant role in the new era of wood material development.

Figures:
On the left, from top to the bottom
1. Favela Chair, by Humberto Campana (MutualArt, n.d.)
2. 3d printed sawdust, by Forust (Mesago, n.d.)
3. Stool from waste and dust (trendhunter, n.d.)
4. econitWood, 3d printed chair from sawdust (econit, n.d.)
5. econitWood, 3d printed computational generative design (econit, n.d.)

On the right, from top to the bottom
1. Living Tree Furniture Prototype, 3D scanned and CNC cut furniture from underused wood (SEKISUI HOUSE – KUMA LAB, 2024)
2. Board made from various wood bark (Material Culture, 2024)
3. Cladding made from redwood bark (Material Culture, 2024)



Figures:
1. Graphic of workflow process of the Densely-packed Timber Block Project (Hooke Park, n.d.)
2. Densely-packed timber installation (Hooke Park, n.d)

3D Scanning and Robotics in Wood Manufacturing.

3D scanning and robotics enable new construction techniques that reduce waste. Sebastian Birch, an AA School student at Hooke Park, explored this with Densely-packed Timber Blocks, using scanned tree branches for robotic assembly.

3. Enquiry: Research & Insights

A

Field Research

To better understand the topic of timber production, it is necessary to trace where the timber is sourced and where it goes at the end of its life. This project will involve visits to the forest, milling facilities, and waste management facilities to observe the processes firsthand and conduct ethnographic research.

1. Visiting Woodland

Starting by visiting the woodland and joining Tinkers Bubble volunteering events will help gain an understanding of how they practice in a community setup. A weekend volunteering event has been arranged from 20-23 March to experience life in the community firsthand.

2. Visiting Timber Milling Facility

Although Tinkers Bubble has its own milling facility, which uses a steam engine and is somewhat old-fashioned, it is also important to visit modern milling facilities. Therefore, a visit to Fallen and Felled will be considered to understand the sawmill process.

3. Visiting Waste Management Facilities

To understand end-of-life wood, three waste management facilities with different focuses were visited;

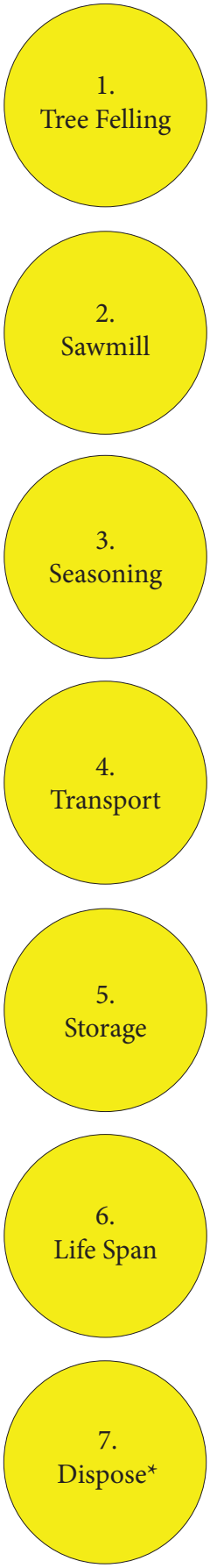
4. Visiting Wood Reclamation Non-profit enterprise

Solo Wood Recycling were visited to conduct in-person interview and site observation to understand the alternative stream away from waste stream.

5. Visiting Futurebuild Expo

To understand the stakeholders and current trends in the industry, it is important to identify areas where innovation can make an impact by examining what other key stakeholders are offering and make are the customer interest.

The Life Cycle of Wood Material

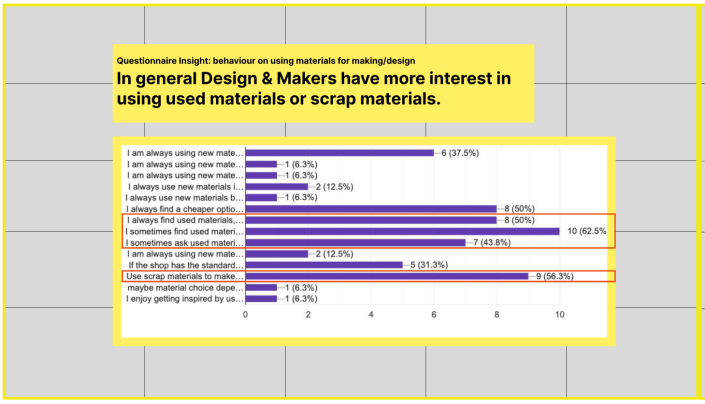


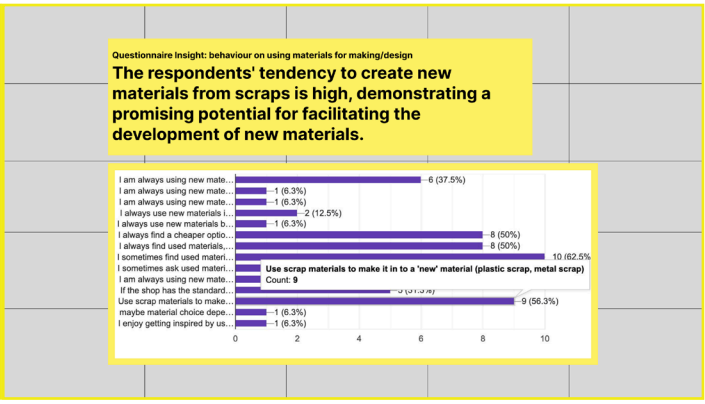
*) The current options for disposing of wood are either recycling or burning. Unfortunately, many types of wood cannot be processed through either of these methods due to treatments applied to the wood or other contaminants present at the end of its life. Alternatively, many social enterprises are working to reclaim this wood in an effort to prevent it from being burned or ending up in a landfill.

B

Questionnaire

During the early study, a questionnaire was conducted to understand designer and maker behavior regarding material use. This aimed to identify potential directions for the project.





C

Expert Interview

Some interviews with stakeholders have been conducted, while others are still in the outreach phase. Interviews are considered important to understand depper context for the study and will be conducted either through calls or on-site visits.

Figures:
Visit to Viridor Energy Recovery Facility in Croydon London (Clark, 2025)

Stakeholders Mapping

Institution

Centre for Alternative Technology
Canolfan y Dechnoleg Amgen

Forest Research

Wood Craftman

Robin Wood

Community Led Practice

Material Cultures

Tinkers Bubble

Waste Management Facility

W·R·W·A
Waste & Recycling Centre

VEOLIA
Material Recovery Facility

Viridor
Energy Recovery Facility

Top Influential Player in Industry

ARUP

Arup Explores:
Regenerative Design

Wood Reclamation Social Enterprise

Recollective

SOLWOOD THE SOUTH LONDON WOOD RECYCLING PROJECT

Sustainable Urban Wood Felling Enterprise

Fallen & Felled

D

Insights

Through Secondary and Primary research below area identified key insights:

1. Recycled is wrong, reused is better
All this time we campaigned to recycle the material at the end of life. What is more impactful is reuse. By reuse, we are stopping extracting and producing new materials. Recycling itself costs a lot of investment and energy to create a new material that can be used, moreover, most of the wood products around us can't be recycled.

A mix of companies, and community and non-profit organisations such as Fallen & Felled, Solo Wood Recycle, and Recollective are trying to reclaim some materials to save them from being burned or going to the landfill.

2. Distribute the Knowledge through Participatory Approach
Transitioning to bio-based material is not an easy process, through participatory approaches by involving citizens and professionals in the field will make the literacy and transition process smoother.

Material Cultures with their practice always try to involve stakeholders and citizens in their process to make the transition smoother. Through their collaboration with Civic Square, they invite students and construction workers to participate in their project on building by experimenting with the bio-based material.

3. Addressing the Socio-technical Issue, not the technology.
Developing the technology or new material is one thing to solve the sustainability issues in material development. The title of this insight quotes Mark Enzer OBE from his recent presentation at Futurebuild Expo, 2025 which resonates with the current most identified approach found by the author where Recollective, Material Cultures, Tinkers Bubble are actively sharing their research and involving citizens and stakeholders with their practice to make the sustainable transition happens smoothly.

4. Sourced it locally
The key to making the regenerative design successful is by using the source locally, most of the approaches by the selected communities approached by the author mostly sourced their bio-based materials locally with a non-mass extraction approach.

4. Opportunities & Conclusion

A

Design Opportunities

Through Secondary and Primary research below area identified key insights:

1. Designing for Sustainable Transition
By focusing on the wood production process from end to end, there are many opportunities to disrupt the current methods of producing timber and other wood products. Since the raw material itself is already regenerative, the key area for intervention is the process. The goal is to make it more sustainable and develop better end-of-life solutions to prevent waste from ending up in landfills.

2. Designing for the Socio-technical
Through the early study that has been conducted, emerging trends show how small communities drive sustainable change through participatory interventions. Empowering these communities by focusing on socio-technical factors rather than solely developing technology will be more beneficial in transforming how we produce timber and wood products.

3. Designing new material from underused tree parts.
A single tree holds more potential beyond just its wood. When we fell a tree, it disrupts the biodiversity of the woodland. Bark, often overlooked, becomes a waste material in timber production. However, certain tree species allow bark extraction without harming the tree, enabling it to remain in the woodland and sustain biodiversity for much longer.

Timeline

Jan - Feb

Context Exploration

Mapping Stakeholder
Interview
Questionnaire
Literature Study

Feb - March

Concept Development

Field Research
Understanding the wood production system
Material Exploration

March - May

Prototyping & Testing

Further Material Exploration & Experiment
Technology Exploration
Iterative Testing & Development

May - June

Validation & Impact Assesment

Asses Sustainability
Stakeholder Validation
On-site testing

June

Final Presentation &Exhibition

B

Conclusion: New Way of Making

This project began with a bold mission: to create a new way of making that addresses the complex challenge of unsustainable production, starting with a focus on wood.

What does a "new way of making" mean?
Based on the studies conducted, this project defines a new way of making through the following guiding principles:

1. Locally sourced, processed, consumed, and responsibly disposed of.
2. Using regenerative materials.
3. Processed with low energy consumption.
4. Low embodied carbon in all elements.

This study explores the possibilities of redefining the current production and supply chain systems, through materiality exploration with a focus on those four core values, and putting people—specifically small communities—at the center of innovation as it has proven how powerful they are as agent of change.

References

1. Material cultures, 2024. Material reform: building for a post-carbon future, Second edition. ed. MACK, London.
2. '2018 - Origin of wood imports' (no date) Forest Research. Available at: https://www.forestresearch.gov.uk/tools-and-resources/statistics/publications/forestry-statistics/forestry-statistics-2018/trade-2/origin-of-wood-imports/ (Accessed: 4 March 2025).
3. Confor warns of future crisis in wood supply (no date). Available at: https://www.confor.org.uk/news/latest-news/confor-warns-of-future-crisis-in-wood-supply/ (Accessed: 4 March 2025).
4. Timber Innovation for Forests of the Future (no date) Forestry and Land Scotland. Available at: https://forestryandland.gov.scot/news-releases/timber-innovation-for-forests-of-the-future (Accessed: 4 March 2025).
5. Nick (2024) 'The Ultimate Guide to Wood Recycling in 2024', ETM Recycling, 24 May. Available at: https://www.recyclingbristol.com/the-ultimate-guide-to-wood-recycling/ (Accessed: 4 March 2025).
6. Caelia (2024) Over 97% of UK waste wood processed in 2023, Wood Recyclers Association. Available at: https://woodrecyclers.org/over-97-of-uk-waste-wood-processed-in-2023/ (Accessed: 4 March 2025).
7. Wilk, C. and Bisley, E. (2017) Plywood: a material story. London: Thames & Hudson.
8. Calvert, A. (2015) 'Materials and techniques in ancient Egyptian art', Smarthistory, 8 August. Available at: https://smarthistory.org/materials-and-techniques/ (Accessed: 5 March 2025).
9. Plywood Production (no date) raute.com. Available at: https://www.raute.com/industries/plywood-production/ (Accessed: 4 March 2025).
10. Kuu-Park, G. et al. (2024) 'Materiality in community energy innovation: A systematic literature review of hands-on material engagement in energy transition', Energy Research & Social Science, 114, p. 103616. Available at: https://doi.org/10.1016/j.erss.2024.103616.
11. 'Material Cultures' (no date) Material Cultures. Available at: https://materialcultures.org/about/ (Accessed: 4 March 2025).
12. 'Material Cultures' (no date) Material Cultures. Available at: https://materialcultures.org/2021-circular-biobased-construction-in-the-north-east-and-yorkshire/ (Accessed: 4 March 2025).
13. 'Material Cultures' (no date) Material Cultures. Available at: https://materialcultures.org/2021-circular-biobased-construction-in-the-north-east-and-yorkshire/ (Accessed: 4 March 2025)
14. 'Material Cultures' (no date) Material Cultures. Available at: https://materialcultures.org/woodland-goods/ (Accessed: 4 March 2025).
15. Fallen and Felled | London Hardwood Timber Merchant | About Us (no date) Fallen & Felled. Available at: https://www.fallenandfelled.co.uk/pages/about-us (Accessed: 4 March 2025).
16. Tinkers Bubble (no date). Available at: http://www.tinkersbubble.org/index.php (Accessed: 4 March 2025).
17. Recollective (no date). Available at: https://www.recollective.uk/ (Accessed: 4 March 2025).
18. Solo Wood Recycling (no date) Solo Wood Recycling. Available at: https://solowoodrecycling.co.uk/ (Accessed: 4 March 2025).
19. 'econitWood_GuideLine' (no date) EconitWood. Available at: https://www.econit.info/econitwood_guideline/ (Accessed: 4 March 2025).
20. 'Living Tree Furniture Prototype Research' (no date) SEKISUI HOUSE - KUMA LAB. Available at: https://ut-iaep.net/en/activity/2024/project-en/living-tree-furniture/ (Accessed: 4 March 2025).
21. Densely-packed Timber Blocks / AA Design + Make (no date). Available at: https://designandmake.aaschool.ac.uk/project/dense-timber-blocks/ (Accessed: 4 March 2025).
22. Wood, R. (2014) 'Building a birch bark canoe, collecting materials', Robin Wood, 29 May. Available at: https://www.robin-wood.co.uk/wood-craft-blog/2014/05/29/building-birch-bark-canoe-collecting-materials/ (Accessed: 7 March 2025).
23. Enzer, M. OBE FREng (2025) 'The big picture of data and digital in the built environment', presentation at Futurebuild, London, 2025.