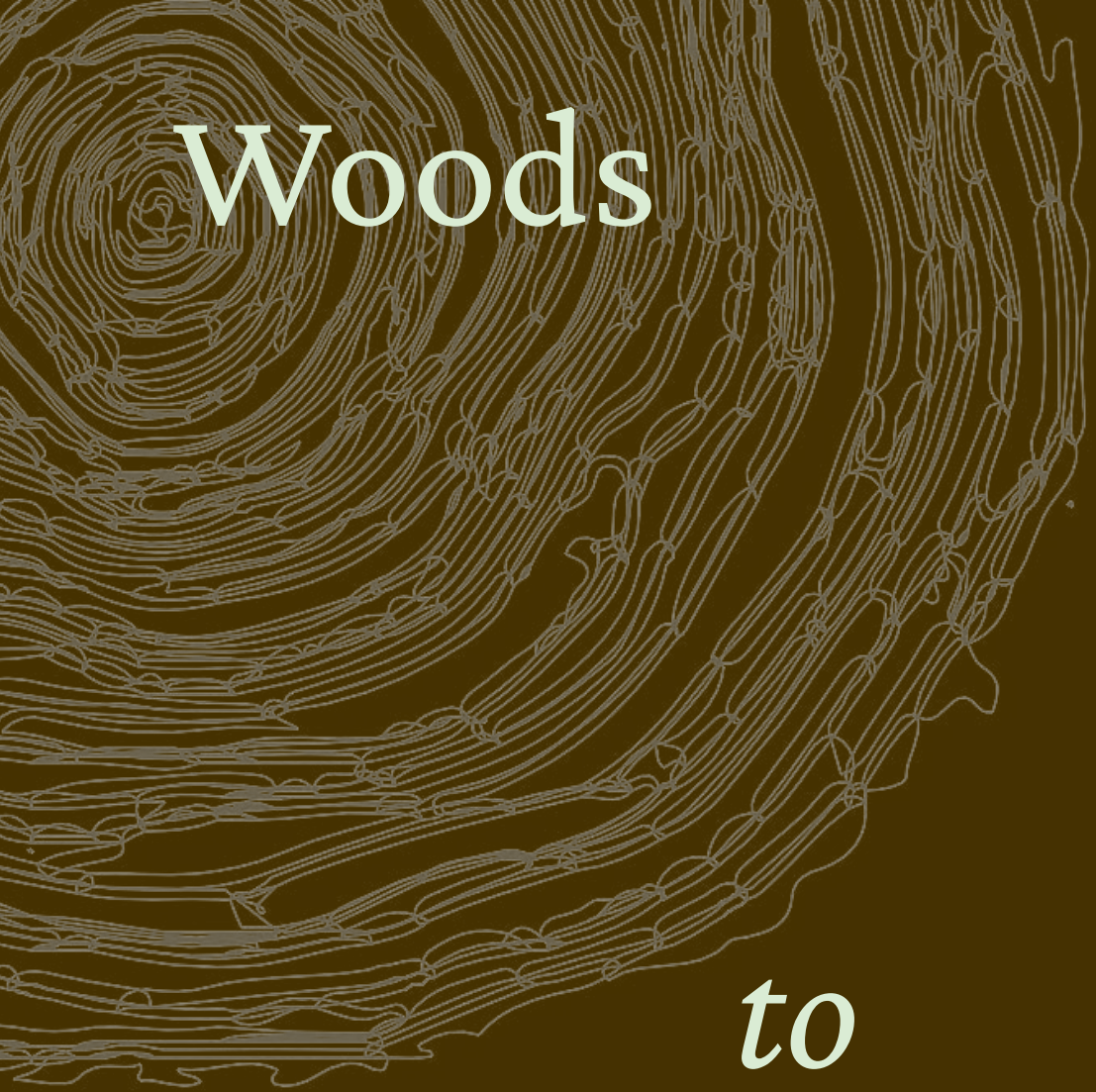


Woods *to* Outcomes

Contents

Chapter one:

- Executive Summary

Eastbourne Borough Council has a commitment to become carbon neutral by 2030, to develop a thriving local economy, and wherever possible use sustainable and environmentally positive materials in its construction work.

This research project supports these commitments in that tests the potential for Sussex timber to become a mainstream product in the social housing construction.

The project had a number of work packages utilising the skills and resources of the University of Brighton, Woodland Enterprises Ltd and the Council. The project focused on two construction products at different ends of the cost and complexity spectrum so that it could ascertain what the tipping point for viability was; these two products were skirting board and kitchen doors.

The conclusion is that Sussex Timber will struggle to be competitive just on cost in the social housing sector as production costs are too high. These costs could be reduced but it will take time to do so. That is not to say that a social landlord will not invest in Sussex Timber as there are additional benefits. But if budgets were the overiding factor, then it is unlikely to be persued.

Sussex Timber could create a larger foothold in the wider market as even though the product cost is too high for the social sector it can be competitive against other comparative products on the private market.

The other key learning points for this project are:

- It would be possible to create a large 'commodity bank' of hardwood from unmanaged woodland if it was planned in good time – instead of the just in time business model. This commodity bank could act as a long-term wood resource for joiners and be the platform for the Sussex Timber brand to establish itself.

- The green timber price (£/tonne) has little impact on the overall cost of the finished timber product. The main costs are the time it takes to handle the wood at the mill and the joiners. If hardwoods are being sold for fuel at £35/tonne then this price can significantly rise without impeding the construction product; this is good for the landowners as it will reward investment in forestry.

- It could be possible to produce planed Sussex Timber at £20 per unit, which is comparable to major timber outlets selling imported hardwood – some of which will be from tropical forests which will have ethical implications.

- It is possible to locally produce some of the fundamental products that service providers need to supply for social housing in locally sourced timber – however even the simplest products require engagement with a complex, stratified and disparate supply chain / industry. Planning and collaboration in the short and long term to address some of the key challenges.

- The cost of the product is not the only factor when considering whether or not to invest in Sussex Timber. For example; the hidden benefits of improving the local economy, social opportunities and the environment, products could be longer lasting last a long refurbishment in year 20 period, could have a second life either in the same homes or the re-use market and aesthetic appeal of the kitchen to wider users and market.

- Non-cost benefits are hard to sign up to when budget is limited so if Sussex Timber is to succeed as a brand it may require some upfront subsidy to try and get it on a level playing field.

- The creation of a 'Sussex Plank' and a level of standardization could help to significantly reduce the handling costs as no matter what the species, timber would always be felled and milled to the same dimensions making it easier for millers to produce and stockpile streamlined competitive timber at volume.

- Milling costs could be reduced further if products were air dried instead of kiln dried. Long term planning would be required though, but if UK hardwoods were seen as a valuable commodity then seed funding could be granted to get this started, and taken in conjunction with the commodity bank mentioned above could enable UK hardwoods to re-establish themselves.

- The Sussex Timber brand could establish itself utilising a cooperative of mills and joiners that only produce and standardised Sussex Plank products.

- Access to Woodland Management Plans (WMPs) has been difficult as landowners are cautious about sharing commercially sensitive or information or to invite scrutiny when multiple factors are impacting delivery of plans.

- Where we have obtained redacted versions of WMPs (so that data is effectively anonymised), the actual information being recorded is of limited use.

- More useful felling license data, which would identify what species and their amounts are being harvested in the next five years, could not be released by the Forestry Commission, even in an aggregated anonymised format. The project only required high-level volume data, but this was not forthcoming.

- There is a misconception that there is a surplus of hardwood timber but in reality, this is not the case as demand is reported as out stripping supply of English timber, let alone Sussex timber, resulting in hardwoods being imported from France and Spain.

- National policies and investments over the last 30 years have concentrated on softwoods which has resulted in the management of hardwoods being neglected and their only significant market being used for fuel. Hardwood plantations could be managed better to improve the amount of hardwood for the supply chain but there is currently little incentive for landowners to do this as the infrastructure is no longer in place and large areas have effectively been left to nature.

- Mixed species and age are required to delivery emissions, wildlife and resilience benefits and so interior products that can accommodate variability are relevant.

- Having areas left to nature, is beneficial to the environment but there is little commercial return for landowners to adopt this position – landowners are motivated by nature recovery focused forestry strategy and the associated status processes need to 'wipe their own face' financially. 'Making Nature' strategies that elevate narratives related to nature recovery and technologies that support local level monitoring are broadly welcomed.

- Multiple grants have previously tried to address the issue of hardwood commerciality, but national policy hasn't changed as a result of the grants being awarded. If hardwoods are seen as important then a long-term policy needs to be adopted by both DEFRA and the Forestry Commission to allow this to happen, and grant programs should either be stopped or altered as the same questions are being asked with no real change.

- Even with well managed forests, there will be a higher amount of wastage than continental timber as the UK's climatic conditions create product with more knots and twists.

- Despite the issues facing hardwoods, they have historically been a bedrock for national initiatives – from the use of oak in Henry VIII shipbuilding to the use of hornbeam in windmills. They could still play a role in our economy, but this will take time to roll out and it is currently unknown what the appetite for policy change is.

- Any future appetite may be curtailed if we do not control climate change. A worsening climate change will lead to the likelihood of more destructive pests and the decimation of species and with increased flooding unstable roots causing large amounts of trees to topple. If a worsening climate is looking more likely, then it would be prudent to set up the commodity bank for hardwoods (mentioned above) so that we have a future depository for future needs – a legacy period to capture local timber whilst we still have it.

Chapter two:

Project Objectives and Budgets

The original objectives of this project were to engage with the Sussex timber supply chain to understand (i) how much resource potential it has (ii) if it can competitively produce common construction products that are used in the social housing sector (iii) if yes, what is required to repeat this across other construction products (iv) what resources are required to meet future needs and growth.

The project started in July 2022 and finished March 2024. It had a budget of approximately £200k that was broadly equally split between two financial years. The following table shows how the main expenditure items have changed compared to the original budget.

The project has three key member organisations with particular skill sets and experience:

- Eastbourne Borough Council – Social Housing landlord, housing developer, and forest management within its own downland and commercial research.
- Woodland Enterprise Ltd (WEL) – Specialists in forestry management and supply chain, learning and research hub.
- University of Brighton (UoB) – Leaders in product design and sustainable materials.

This core project team is supported by other specialist SMEs for specific requirements.

	FY 22/23		FY 23/24		Totals		
	Original	Revised	Original	Revised	Original	Revised	Difference
Personnel costs	£49,835.00	£39,082.24	£84,025.00	£64,706.00	£133,860.00	£103,788.24	£30,071.76
Equipment contribution	£43,620.00	£46,583.46	£2,480.00	£1,345.80	£46,100.00	£47,929.26	-£1,829.26
Research costs	£5,510.00	£0.00	£4,020.00	£0.00	£9,530.00	£0.00	£9,530.00
Materials and supplies	£3,000.00	£7,000.00	£7,000.00	£7,000.00	£10,000.00	£14,000.00	-£4,000.00
Totals	£101,965.00	£92,665.70	£97,525.00	£73,051.80	£199,490.00	£165,717.50	£33,772.50

The project's methodology over the two years has been to:

1. Data-mine existing WMPs in Sussex to fully understand what resources (species, mills, drying and storage areas, logistics) are actually available.
2. Engage with other woodland estates to encourage the take up of WMPs and also to data-mine what resources they have.
3. Sort this data in into usable formats (including a base map, and database) to identify (i) which species and volumes are ideal for the two key construction products and (ii) carry out an analysis of the supply chain.
4. Scope and develop at least two construction products, to identify the best methodology with the resources available (using outputs 1 & 2).
5. Purchasing a mobile mill and timber to understand if forest managers can improve the processing process to improve the delivery price of finished timber.
6. To support 4 above, prototype a cost-effective eco drying area that can be readily adopted by woodland areas again to understand if this could help forest managers improve the delivery price of finished timber.
7. Assess routes to market and what is required to make the product competitive and scaled up.
8. Based on the above outputs create a simple model to identify the costs involved in creating a Sussex Timber product, and how viable it could be to be used social housing or other housing markets.
9. Assess if this can be repeated for other species and products and if so, what is required to make this happen (this project will not be delivering this but taking a view on what is needed to make this happen as it will require additional resources and budget not covered in this project).
10. Create a space (real and virtual) for timber users and primary producers to gain a mutual understanding of the potential supply / demand balance.
11. Create a methodology for mapping the biodiversity of woodland and to test its value as another metric that can be used by landowners to demonstrate the merits of investing in forestry.

Chapter three:

Context

The key question underpinning the project is:

Can we produce competitive, desirable and practical locally sourced timber products for social housing?

The recent DEFRA Timber in Construction Roadmap [1] recognises a need for good planning, management, and utilisation of timber in construction with devolved expectations for local authorities to also utilise this as a means to meet sustainable development ambitions.

Social housing is a significant contributor to the built environment and may enable some disruption as a new relatively large-scale market in a localised woodland industry. The project has been working with Eastbourne requiring approximately 3000 housing retrofits over a 10-year period. The local authority encounters scalar issues (and opportunities) associated with the provision of *healthy housing* that need directing and timber presents an apparent opportunity in Sussex as a wooded county.

The DEFRA roadmap acknowledges non-structural timber products as relatively small component of construction in housing and using more hardwood but implies that 'complexity of hardwood supply chains' is a limiting factor – however if this is not addressed and overcome, it could contradict the necessity to diversity resilient stock and support the eco-systems that help counteract issues of disease and the vulnerability of limited landscape variety. It is also considered vital for older growth stands and coppicing alongside fast-growing managed stocks to prevent carbon sequestration being (in effect) exported to other countries [2], [3] and greater use of timber products in building [4].

Woodland in the south-east of England

Woodland management has been defined by Dandy as "human intervention in the natural processes and growth of a forest in order to realise desired benefits and achieve pre-set objectives (such as timber production and/or nature conservation)" [5]. 59% of woodland in the UK is actively managed (F Comm 2020). Trees and woodland cover 13% of the UK. Due to the amount of woodland planting during the 1950s, what is now harvestable is getting larger. The UK consumes 500000m3 of hardwood a year, 10% of which is sourced in Britain. It is widely accepted that unmanaged woodland quickly becomes less biodiverse. Caroline Greenslade's thesis (2021) "Developing the wood fuel sector in South East England – how blockers, supply chain structure, individual motivations and value are restricting growth", summarises many difficulties in bringing all parts of the timber chain together to result in an effective industry supply [6].

Comments taken from survey results within the industry

The engagement with woodland owners commenced at the start of the grant term. The reluctance to engage in the widespread sharing of woodland assets took the team by surprise. We aversely had to conclude that the lack of trust between owners and third parties (Forestry Commission) precluded much willingness to aggregate and collate data. The method of approaching owners with woodland management plans and those without was difficult. Of the 36 sites with woodland management plans, none would engage in sharing their data or thoughts on how they saw the future. Meetings hosted in the evenings, exhibited a reluctance to change

1. Timber in construction roadmap, Department Environment, Food and Rural Affairs, 2023.
2. Luyssaert, S., Schulze, E. D., Börner, A., Knohl, A., Hessenmöller, D., Law, B. E., & Grace, J. (2008). Old-growth forests as global carbon sinks. *Nature, 455*(7210), 213-215.
3. Körner, C. (2017). A matter of tree longevity. *Science, 355*(6321), 130-131.
4. Burton, V., Moseley, D., Brown, C., Metzger, M. J., & Bellamy, P. (2018). Reviewing the evidence base for the effects of woodland expansion on biodiversity and ecosystem services in the United Kingdom. *Forest Ecology and Management, 430*, 366-379.
5. Dandy, N. (2016). Woodland neglect as social practice. *Environment and Planning A: Economy and Space, 48*(9), 1750-1766.
6. Greenslade, C., Murphy, R., Morse, S., & Griffiths, G. H. (2020). Seeing the wood for the trees: factors limiting woodland management and sustainable local wood product use in the south east of England. *Sustainability, 12*(23), 10071.

'Can we produce competitive, desirable and practical locally sourced timber products for social housing?'

the existing practices and there is competitiveness between contractors, agents, and owners to retain their own team and not engage with others. Over 69% of those approached would not engage at all and the input from the remainders was very limited.

- Hypothesis used was not successful and on reflection approaching the larger contractors, rather than landowners might be the way forward as there is already an element of trust there. There would need to be a significant change in the infrastructure of the system to achieve change.

- Lack of trust on a wide level prevented collaboration – contractors tend to work for the same landowner for years and would resist any risk to that contract.

- Woodland ownership has altered over the last 70 years – large estates have been broken up to some extent and new owners are happy to own the land and not manage it. Private shoots earn landowners more money than forestry extraction and sale.

- The financial gain to many is the capital asset of the land and inheritance tax advantages as opposed to cutting and taking wood to a market.

- Contractors do not tend to be ambitious they are content with earning a reasonable amount.

- Lack of positive examples – with the exception of the Darwell Community.

- Landowners, contractors, and agents work in a rural culture – are risk averse and reluctant to engage or be told what they should be doing with their woodland.

- Woodland purchased for under £150000 does not attract stamp duty.

Obstacles

Persuading woodland owners to engage in timber harvesting can be challenging for a variety of reasons:

- **Emotional and Aesthetic Values:** Many owners value their woodlands for reasons beyond harvesting for economic gain, such as beauty, privacy, wildlife habitat and for their personal recreation.

- **Environmental Concerns:** Owners have mentioned to us, the environmental impact on the ground, prioritising the conservation of their land.

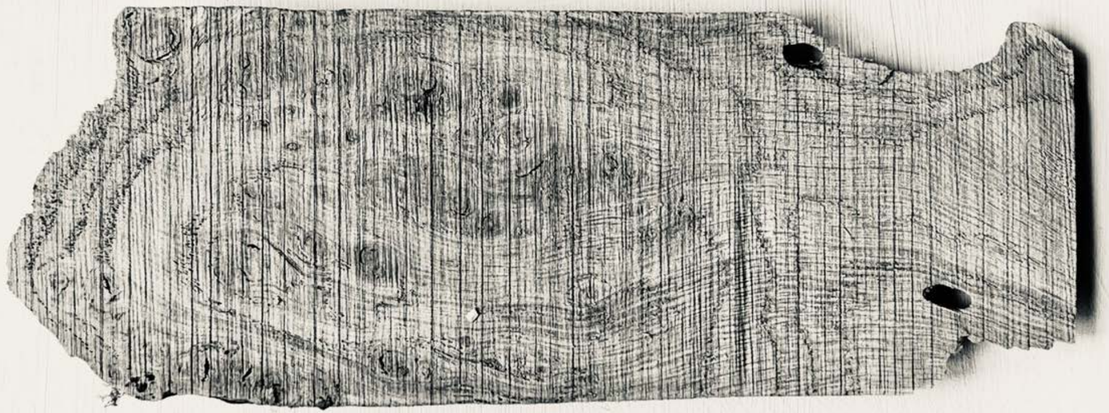
- **Knowledge:** Changes in land ownership, especially in the south-east has resulted in old practices being lost and the long-term benefits of selective harvesting.

- **Economic:** Many will not feel that the financial return is worth the obtaining of felling licenses and disturbance to their ground. If the landowner does not have an immediate financial need, there is little incentive to engage in timber harvesting.

- **Distrust:** Some landowners have expressed reservations about those in the 'logging' forestry industries.

- **Succession Planning:** Many woodland owners commented that their legacy will be to pass on the woodland to future generations and believe that keeping the woodland intact is the best legacy.

- Building trust and understanding can take a long time and we were not able to achieve this within the period of the grant.



Chapter four:

WEL

Eastbourne

Case

Study

The current range of factors which influence economic and financial decision making in the forestry sector are highly complex and do not easily lend themselves to traditional commercial analysis.

The average size of woodlands across Kent, Sussex and Surrey is approximately 25 ha (60 acres). The current market value of a woodland of that size would be around £600,000. To service the debt on buying land and establishing a forest is not financially viable. Therefore it is not surprising that many owners do not see their forest assets in commercial terms but they do want to cover the on-going management operational costs.

Operational costs on small areas of woodland is difficult because they can be highly variable over the rotation of a tree crop, with the majority of costs being spent during the first 3 years of planting but revenue stream not arriving until at least 30 years later. The temptation to cut costs at the early stages are high.

In addition to the long time-scales involved, anticipating the global market for timber in 30-50 years' time is not predictable. Other factors such as diesel prices can influence timber markets and widespread disease such as Ash die-back, Phytophtora ramorum in Larch can make the market appear unpredictable.

When the decision to harvest is made it is difficult to gauge the final return to the grower. Landowners tend to be reliant on contractors to harvest and market the product, with the contractor being paid from the final sale figures achieved.

In this context Bill Maynard carried out some small case studies to identify ways in which marginal returns can be potentially improved. The critical factor in all cases is the lack of economies of scale, as the largest the volume of wood only reflects harvest from about 0.1 ha of timber which would have been uneconomic to harvest head and forwarder for, in the real world such a small volume would most likely be felled by hand and extracted by tractor costing substantially more than £20/tonne.

Case Study 1

A block of Lawson Cyprus was felled and 20 tonnes was processed by a Woodmizer mobile mill to produce 11.64 m3. The timber was being cut for vertical external cladding at the end users were happy to use Lawson as a substitute for Western Red Cedar. They were cut 120mm x 24mm x 2.4 m. The size of the logs was taken from 35cm diameter and up at the narrow end.

The total number of logs used was approximately 20 taken from the lower 2 logs in each trunk as higher than that they narrowed to less than 35 cm so this was the timber from roughly 10 trees that would have all been about 45 cm to 50 cm d.b.h. (diameter at breast height). The 20 logs were taken off site to be milled even though it was a Woodmizer mobile mill it was static and set up in a yard 25 km from the felling site. The logs were cut to 2.4 m.

The conclusions to the case study are:

- It is possible to find a market for relatively small volumes of lesser-known species, but the longevity of the product remains unknown.
- The selection of stems that are of sufficient size is important as it will produce alternative markets for smaller stems and the residual logs.
- Larson Cyprus like Western Red Cedar is a durable timber in the log yard, this meant that the time taken from felling to processing the logs did not result in excessive degrading of the material.
- The amount of management time arranging the logistics of a single small order is significantly greater than "stock" order processing.

The financial analysis:

The financial analysis of cutting 10 m3 needs to be considered in the context of the larger operation, the timber was selected from trees harvested from a 3/4 ha area of selective thinning of Lawson Cyprus where around 50% of the existing stand was being extracted. There was also Scots Pine and Douglas Fir being harvested from the same woodland which meant there were economies of scale to use a harvest contractor with large scale handling equipment. The costing would have been different if the process was carried out with manual felling and tractor extraction. Costs below cannot be verified and are just a random sample.

Costs:

- Harvesting & extraction:
  20 tonne @ £20/tonne = £400
- Processing & transport:
  11.63 tonne @£515/tonne = £6,000

The mill in this instance charged a processing cost on the amount of usable timber produced and not the starting amount of green timber. A profit margin could then be applied and in this instance, it was £135 per tonne for 11.64 tonne, which was £1,571.

The price that would have been received for 20 tonnes of Lawson Cyprus at roadside would have been £80/tonne therefore the return would have been £60/tonne to the woodland owner £1,200.

The return to the woodland owner of £1,571tonne is a 30% increase on potentially selling the logs at roadside. The management and administration costs were higher, but this would not have been significant if the volumes were greater.

If this particular order was to be repeated the processing costs could be reduced considerably by selecting larger diameter logs, specifying random lengths and using a 5-cutter mill.

Case Study 2

Eight standard sweet chestnut trees were processed that were being felled because of the risk of being uprooted due to storm damage. Some of the trees had significant "shake" and degrade so there was a higher percentage of wastage than would be expected in timber that had been harvested on a planned rotation.

The timber was transported away from the felling site to be processed by a Woodmizer mill near the market location. The boards were cut as square edged boards rather than feather-edged which is sometimes traditional, this made the cutting much simpler and

less time consuming. Because the raw material quality was variable it was best to do most of the grading at the point where the boards were cut and there was significantly more wastage that would be expected with logs that were harvested from the normal harvest regimes.

In this case study it was possible to follow the process of the boards being cut at the start of the project through to their end use in construction. They were air-dried for 14 months bringing the moisture content down to roughly 18 percent, this was equivalent to conventional commercial boards. Used as weatherboarding it was possible to used random lengths so even when knots and defects were cut out the recovery was high, 85% and the overall wastage very low. The total area covered was around 73 square meters, it was placed on a rendered wall that was poorly finished and has provided excellent weather proofing and seems to be improving the isolation on a wall exposed to the prevailing weather. The boarding has been in place for about 12 months, so longevity has yet to be proven.

The sweet chestnut did contain a lot of tannin which was still leaching out even though the boards had been air dried for a year. The boards needed to be treated with specialised primer paint before the topcoat was applied.

The random lengths and need to cut out defects meant the team installing the weatherboard took around 20% longer than they might otherwise have done.

Storage space to air-dry the timber for 14 months was required.

To facilitate this kind of opportunistic use of timber that comes available because of unpredictable circumstances there are a number of prerequisites; first and most importantly there can't be a presumption by the owners of the timber there will be any profit or any value at all it the timber the best they can hope for is the service of harvesting, tiding up and removal is done at a subsidised rate, given that the cost of emergency tree surgery can be very high. in reality this can be a major benefit, but the perception is often not the case. It is necessary to have a network of contractors that can be drawn on at reasonably short notice, storage space and cash flow to pay them. There is a need to recognise that there will be a relatively high wastage factor, many of the trees will need harvesting because of defects - this means it is useful to have alternative markets for the waste material.

Case Study 3

The third case study has been based on the production of skirting board for social housing manufactured by Boutique Modern for Eastbourne District Council. The volume of skirting used in each unit is 0.131 m3 (H96mm x D15mm x L4200mm total 91 linear meters). It was decided to produce just under 1 m3, 500 linear meters, to ensure there would be enough timber for 5 units.

The timber used was Lawson Cyprus, the logs selected were all over 350 mm at the narrow end and had been stacked for 6 months before processing. It was expected that around 2 m3 of logs would be required but around 10 tonnes of logs (a full load) were moved to the mill site.

The costs as given by the mill are:

- Sawing/stacking and drying wide boards: £8.50
- Sawing/stacking and drying narrow boards: £10.00
- Planing: £1.00/m depending on the knife/cutter costs (should be low on Lawson)

In total, the milling costs worked out at about £400 for the milling/stacking/drying and £500 for the machining.

The volume of timber used in skirting for each unit is 0.131m3, that equates to say 0.3m3 of standing timber. On the assumption that 1 ha of woodland can produce 220 tonnes of logs it would be possible to get enough skirting for over 700 units from 1 ha of woodland

The Lawson Cyprus was very stable when milled, when the mill was set up the first planks were cut to 25 mm thickness, but it was possible to reduce the thickness to 22mm for the rough sawn as there was very little internal stress. This meant it was possible to get to the finished size of 19mm with only one pass through the planer. The lack of knots and small amount of sapwood meant the recovery was very good, from logs with a diameter of 250mm it was possible to get 26 linear meters of plank.

Cutting the planks to 22mm thickness also ensured it was possible to air dry them in 10 days in the exceptionally wet weather.

The relatively small volume of skirting produced for this case study meant there were a lot of fixed costs that were incurred to produce 1 m3 (or 500 linear meters) of skirting but if those costs were able to be spread over a regular order for 5,000 linear meters per month it would be possible to reduce the cost per m3 significantly. The realistic target would be to produce the skirting board for £750/m3 or £1.50/ linear meter.

The volume of round log used to produce 1 m3 of finished product is 2 m3 (assuming 50% wastage) The price paid for the timber to make it attractive for the woodland owner needs to have a 30% premium at least over the £80/tonne they might expect from the conventional market. It means that from the perspective of the woodland over to make selling to make skirting attractive £250 of the £750 should be the cost of the timber, leaving £500/m3 for the costs of transport, processing and all associated costs after the logs leave to roadside at the harvesting site.

Costs have not been verified with invoices to date.

Conclusions

The number and scale of case studies looking at the part of the trade chain from the standing tree to the point of primary production is on one level too small to draw major conclusions but there are some observations and lessons that can be made.

The volume of timber coming from individual harvesting sites is often too small to attract any economies of scale, for the individual woodland owner the marketing of logs which requires the identification of markets, the ability to grade timber by quality and size and the flexibility to store timber on site until it is needed is a major obstacle. It is often easiest to leave the marketing of the timber to the harvesting contractor. In both case study 1 and 3 the time between

the decision to harvest the timber and its removal to the buyer's site where it was required, was over six months and the payment for the harvesting was made 4 months before payment for the timber.

In both case 1 and 3 identify the market and pursuing the end users to accept the risk to use the timber was based on the desire to have local timber of known provenance rather than a purely commercial decision, it is possible to make assumptions that it would be possible to bring the production price down if there was consistency and economies of scale but this is unlikely to happen at the level of the individual woodland or harvesting site. For an average harvest area, the volume of softwood might the 220 tonnes / ha, which would potentially equate to 30,000 m of a "Sussex plank" measuring 100mm x 32. (The assumption being that there is around 60% waste in conversion from the log to the plank.) In a mixed species woodland, the volumes are likely to be lower and the wastage factor higher and it is less likely in most woodlands in the South East that as much as 1 ha of mixed broadleaf will be clear fell harvested at one time.

Case study 2 identifies how the opportunistic use of timber that came available because a small number of trees were harvested because of risk they would fall into a road.

The market examples of opportunistic operators tend to rely on the logs coming into their supply chain being either free or very low cost. These are often trees from gardens or public spaces. Even though the logs might be free there are costs involved in transport and storage that mean that that sale price for the timber at the end of the day is not lower than more conventional sources of timber.

The volume of timber in case study 3 meant there was no economies of scale, and the fixed costs were high relative to the cost of the end product. But the model indicated that it is possible to put together a trade chain from the standing timber to an end user that can substitute local timber for imported timber, create local employment, reduce transport miles and have the potential to link people in social housing in Sussex to woodland in Sussex. With a constant market it would be possible to identify ways to reduce production costs and ensure local timber is competitive.

One element that links all the case studies is an element of risk, in all cases the least risk approach would have been to sell to the conventional market. Though the returns might be lower, receiving £80.00/ tonne at roadside is much simpler than the time and effort involved in trying to identify and service alternative markets and work with direct sales to end markets. There is a great deal of suspicion. Given that the majority of small woodland owners are not in the business for purely financial gain in the first place, it is understandable they might be reluctant to seek marginal additional returns.

In many respects woodland owners and contractors involved in harvesting and primary production of timber can be seen as risk takers, they work within a sector where there can be a lot of economic volatility and they are all price takers in the market where the externalities are way beyond their control. On the other hand, they can be seen as highly conservative, minimizing risk and unwilling to explore anything

Right page: *Mobile mill*.
Image: Nick Gant, 2023

other than the most conventional markets because the financial margins are so thin that for any failure to get the returns that are available can result in major losses.

De-risking alternative markets without subsidies needs to focus on knowledge. It does seem like there is capacity throughout the supply chain, with the possible exception of transport and kiln drying. There are small mills throughout the South East, there is timber and there are markets but all the elements of the market chain do seem to be limited. There are significant gaps of communication within the industry, channels for primary producers to understand what the end-user market wants and for end-users to know what might be available. The difficulties faced in accessing data within management plans was a primary example of this. The inability to access primary data also indicated a lack of trust throughout the sector.

Three elements would potentially ease the flow of local timber into the market:

- improved market intelligence
- greater certainty about the stability of local demand
- greater understanding by the public that utilising local timber is beneficial.

Chapter five:

- The Prototype
- Design Approach

Scoping products

The team scoped three main categories of product exterior, mainly including cladding, interior fixtures and fittings to include kitchen units and worktops, skirting boards and architrave and interior doors and additional items such as common items of furniture.

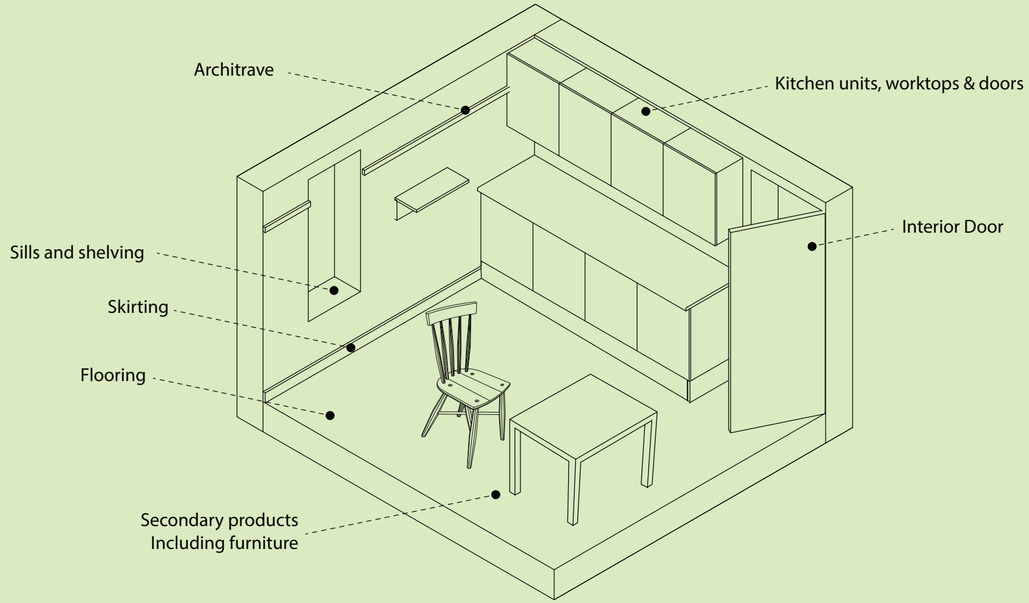
Government statutory targets for tree and woodland acknowledge an opportunity to make good use of the materials they might provide (DEFRA, 2023) for a range of social, cultural, economic, and environmental benefits. Moreover, it is hoped will drive investment in support of new economic and realising latent potential for more sustainable, domestic supply chains. All seven priorities in the Timber in Construction Roadmap (TCR) are geared towards utilisation of timber for construction but do not focus on items beyond the underlying substructure of buildings – our scope identifies domestic interior and exterior components as a critical aspect of timber supply chain potential.

We see interior items as offering potential with a skirting board and a hardwood kitchen door presenting the two levels of difficulty / complexity in construction. Other objects emerged out of aspects of the project that may help address issues associated with motivations (positive and negative) for the delivery of Woodland Management Plans, such as an approach to basic furniture (see Sussex S.E.E. Chair). Other issues associated with the amount of waste generated through processing also led to early experiments into composite materials and boards.

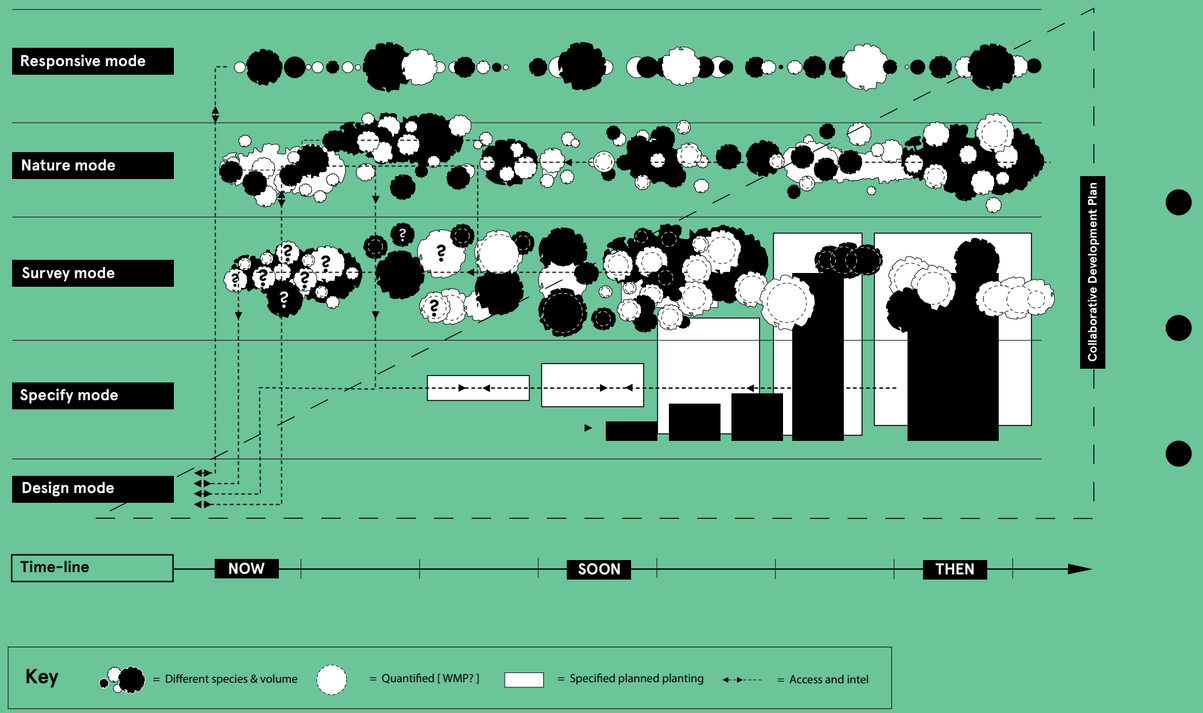
Directions were informed by sustainable and systemic design approaches that recognise objects and products as part of complex systems. Acknowledging *wood outcomes* as a manifestation of interactions between the landscape (woods), stakeholders (foresters, mill operators) and users (social housing providers and occupants) requires an engagement with this complexity as opposed to design dictation or the kinds of predetermined specification driven by 'market trends' (for example). The 'culture' of this approach being (in theory) more participatory in action and responsive in nature – the systemic characteristics of the 'industry', the behaviour of actors *and* environmental phenomena all informing 'designed outputs' that embody these dynamics, drivers and inter-relationships.

Engagements with stakeholders revealed a range of tensions and concerns and therefore it was not appropriate to undertake formal interviews (for example) and our developments were informed by informal feedback as well as wider reflections on literature and practice and the sustainable design experience of the team. The project methodology had to evolve through the time period to counteract a limited engagement with / from stakeholders, some of whom articulated their 'weariness of wondering about woods' and repetitive theoretical discussions about revived approaches and supposed, abundant and latent potentials of our woodlands. We were able to get excellent input and advise from some leading mill owners / directors and private and public sector woodland owners. Our underpinning developments ended up reflecting on, and responding to emergent observations and practical actions that were empirical in nature, rather than grounded in any particular theory or on data as this was not forthcoming or accessible due to 'commercial sensitivities' and

Ryan, A. (2014). A framework for systemic design *FORMakademisk, 7*(4).



Timber Access Gigamap



subject to general data protection policies.

The project then defined three aspects effecting the design and aspirations for competitive sustainable development: ***Modes*** of accessing timber, ***Scale*** of operation, community and geography and ***Time*** and the timespans impacting possibilities; now and in the near and further future.

Timber Access Gigamap

Giga-mapping is a method that visualises complex systems [1] and is a systems design method that aims to visualise the resource 'landscape'. This approach sought to provide a perspective suitable for the design team, not expert in the specifics of the Sussex timber industry, to help understand and unpack possible means that timber may be accessed. The giga-map was developed as a means to support discussion and a critique this understanding regarding the ways designers might interpret various means to access resources within the dynamic locally.

The map has been helpful in attempts to delineate the elements that define or channel potential resource supply chains at the woodland / raw timber stage and the characteristics that need consideration in each 'mode'. It appears to have withstood some limited levels of stakeholder / expert scrutiny and various engagements as means to simplify and represent the variability of resource supply between the various actors in advance of / or alongside design and production.

Survey mode: assumes a level of joined up capacity (building) around the explicit sharing and transparency of collective Woodland Management Plan (WMP) data, including planting and feeling (licence) data and associated underpinning of routine assessment of timber quality and quantity and growth and health monitoring in advance of planned felling for programmed, available use in products / construction / market. Initially the design team were expecting a consistency of available data and WMP progress feedback to enable effective planning and programming of design based. However our local discussions with land-owners (public and private) suggested (anecdotally) that WMP's were not in place in many areas (especially smaller private woods). Feedback suggested that WMP progress was often subject to issues associated with needing to be 'responsive' to disease and resulting health and safety management (ash die-back being a significant cost / concern) and impacts of public sector cost constraints / priorities / emerging economic contexts and impacts of the pandemic. Availability of WMP and felling licence data is also considered subject to commercial / data sensitivities.

In principle structured, collaborative and / or centralised data development and routine management of this data would support production planning and design – however for the purposes of this project the design approach had to consider more 'responsive' means to assess production potential that manifest within the design direction and the product designs and emerging strategy.

Responsive mode: is suggestive of timber being available in a broadly unplanned and reactive process where landowners are generating timber in accordance to individual concerns or as a result of specific

[1] Sevaldson, B. (2011). GIGA-Mapping: Visualisation for complexity and systems thinking in design. *Nordes*, (4).

Rogate Pine.
Image: Nick Gant, 2022

initiatives not outlined in WMP and may be as a result of windfall and storm events, disease ingress, health and safety measures, visual amenity management etc. Tree surgeons too may be generating timber based on similar unstructured tree management processes that are not currently rationalised in any centralised or accessible planning process. Here species, volumes and availability are all unpredictable.

Our project has revealed opportunities for centralised wood hubs receiving timber providing alternatives to the disposal of unplanned / responsive supplies that could add to feeder stocks subject to methodology design for grading and a level of standardisation (see 'Sussex shape / plank'), which is suggested would address some frustrations of landowners and / or tree surgeons who would prefer alternatives for 'usable' timber (other than biomass / burning). A consistent 'offer' of facilities for receiving timber (appropriate for processing) that provides storage, drying and some processing may provide a level of routine opportunity for stock and amenity timber that is not therefore being burned / biomass – this responds to a consistent concern and frustration expressed by both owners, processors and tree surgeons that 'good wood is being burned' due to a lack of opportunities / markets out of more structured / operationalized processes and plans.

Nature mode: This recognises the potential to engage wood resourcing and stakeholders through the prism of biodiversity and notions of nature conservation – the broad interpretation being that this mode of resourcing might need to recognise a diversity of timber species, ages, qualities and quantities that would orientate around landowner objectives driven primarily for natural amenity. This presumes a level of rotational felling and coppicing and development of 'mosaic' habitats (for example) that may provide timber resources as a result of nature focused and motivated woodland management. Our project revealed a consistent interest or expressed motivation of woodland owners (public and private and different sizes of wood) to support wildlife as a priority, narrative and even identity for their wood and management ambitions with timber as a bi-product of forestry rather than a primary objective [1], [2]. These also being broadly congruent with green management supply chain [3] and ecological accountability / accounting within the built environment [4] that face supply chain actors, including local authorities.

Therefore, the design approach subsumed aspects of this within the project thinking, which involved developing opportunities to highlight the wildlife amenity associated with some of the timber used to motivate the market / consumers and landowners and help deliver on social housing service providers / Local Authority policy and challenges. *Nature Mode* develops a collaborative multi-disciplinary management mode that includes ecological science and technology, forestry expertise and design thinking to support and optimise complimentary concerns for nature.

Specify mode: assumes a market (e.g. our social housing use) influencing growing, felling and management strategies that speculate on investments being made with a level of expectation around a continuous demand for timber. The demand being broadly aligned with metrics associated with social / political concerns for local / regional social, economic and environmental benefit where wood supplies may have a role. This envisions more definitive, measurable

[1] O'Hara, K. L., Seymour, R. S., Tesch, S. D., & Guldin, J. M. (1994). Silviculture and our changing profession: leadership for shifting paradigms. *Journal of Forestry, 92*(1), 8-13.

[2] O'Hara, K. L. (2016). What is close-to-nature silviculture in a changing world?. *Forestry: An International Journal of Forest Research, 89*(1), 1-6.

[3] Dadhich, P., Genovese, A., Kumar, N., & Acquaye, A. (2015). Developing sustainable supply chains in the UK construction industry: A case study. *International Journal of Production Economics, 164*, 271-284.

[4] Van der Ryn, S., & Cowan, S. (2013). *Ecological design*. Island press.

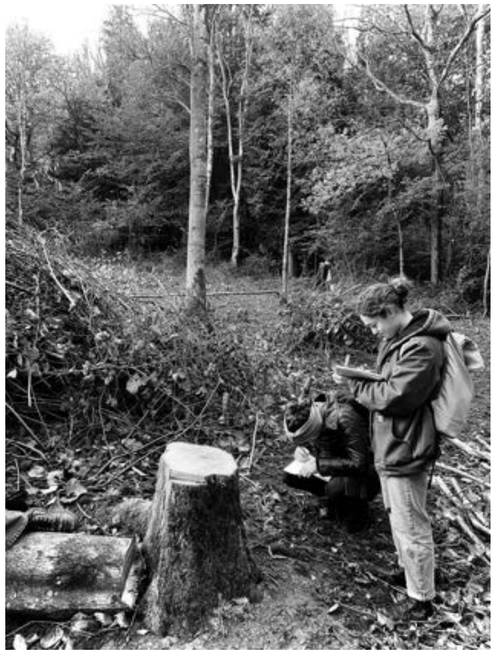
Stanmer Park coppicing.
Image: Nick Gant, 2023

Lesser spotted woodpecker hole on nest entrance.
Image: Nick Gant, 2023

Bird's eggs in nest.
Image: Nick Gant, 2023

Slowworm.
Image: Nick Gant, 2022

Standing dead wood in Stanmer Park.
Image: Nick Gant, 2022



Site-survey.
Image: Nick Gant, 2022

Lumber from nature reserve woodland.
Image: Nick Gant, 2023

and unified planning and assumptions for yield and species output in time and with certain investment and strategies being implemented (see findings). Land management and planning at a landscape scale could provide some of the collaboration and integrated management potential and co-delivery of metrics that current assessments suggest is currently lacking across the sector.

Design mode: This references a design team's needs to both define and form possible responses to each modal dynamic, rather than assuming a specification-based approach that demands particular stipulations of timber. Feedback provided by stakeholders clearly expressed a need to recognise and design based on 'what's really out there' and 'be more realistic' in recognising the 'actual state of our woodlands and the industry'. This in many ways defines the experience of the team negotiating the different conditions we are faced with when seeking to define a sustainable production model for social housing products made of locally sourced timber.

The project's prototyping approach has sought to try and acknowledge each mode (where possible) and to acknowledge both the issues and opportunities to design within realistic parameters, whilst needing to deliver against the very real needs for localised timber products.

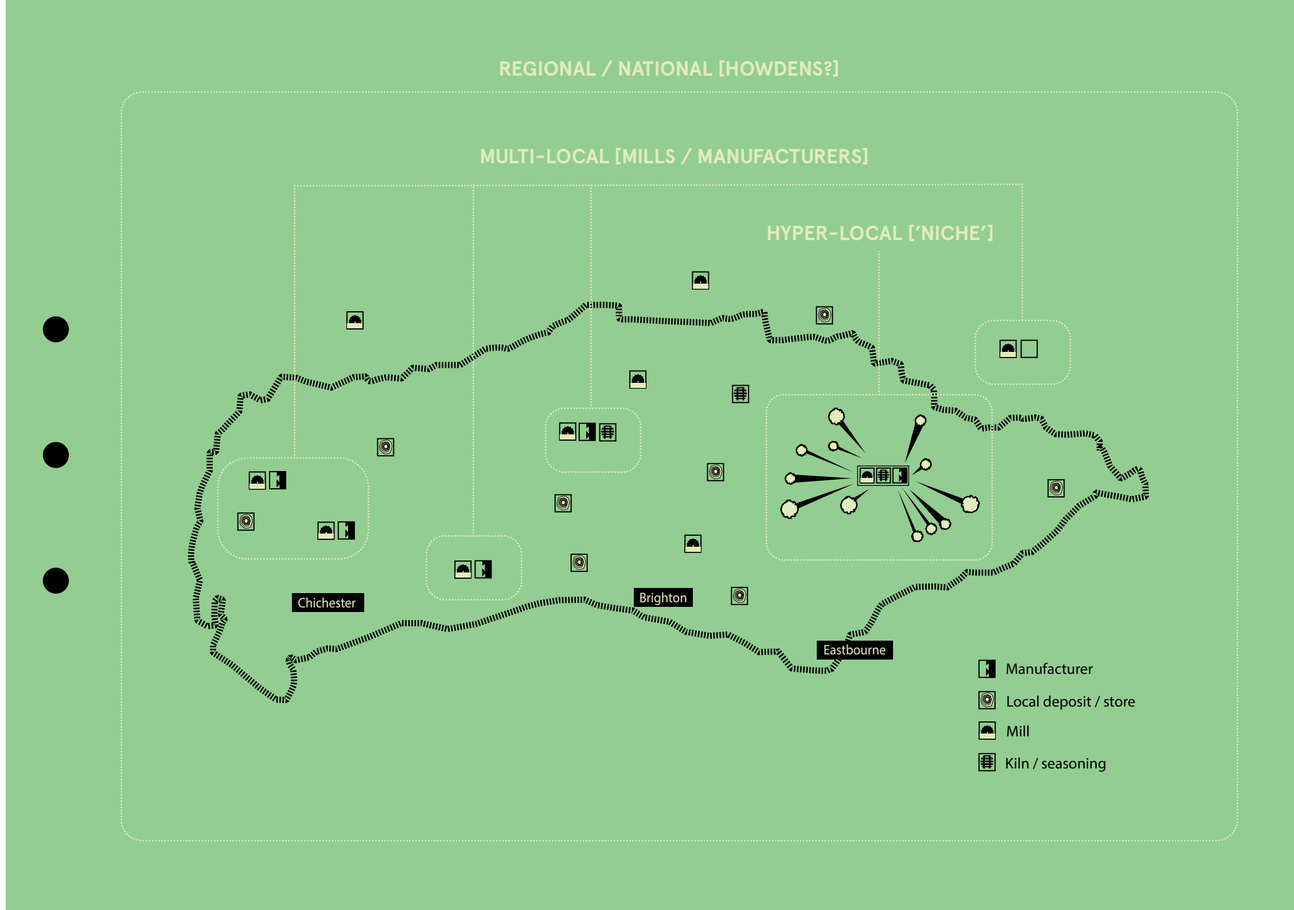
Scales

Notions, perceptions and actualities related to scale feed into sustainability theory and practice as a means to address collective and composite concerns for viability and (positive) impact planning and change.

The project itself considers some of its hypothetical potential and agency for change being that social housing 'churn' and continuous demand across thousands of houses is in itself a market (at scale) – And therefore may provide a basis for disruption in the supply chain / industry within the current status quo.

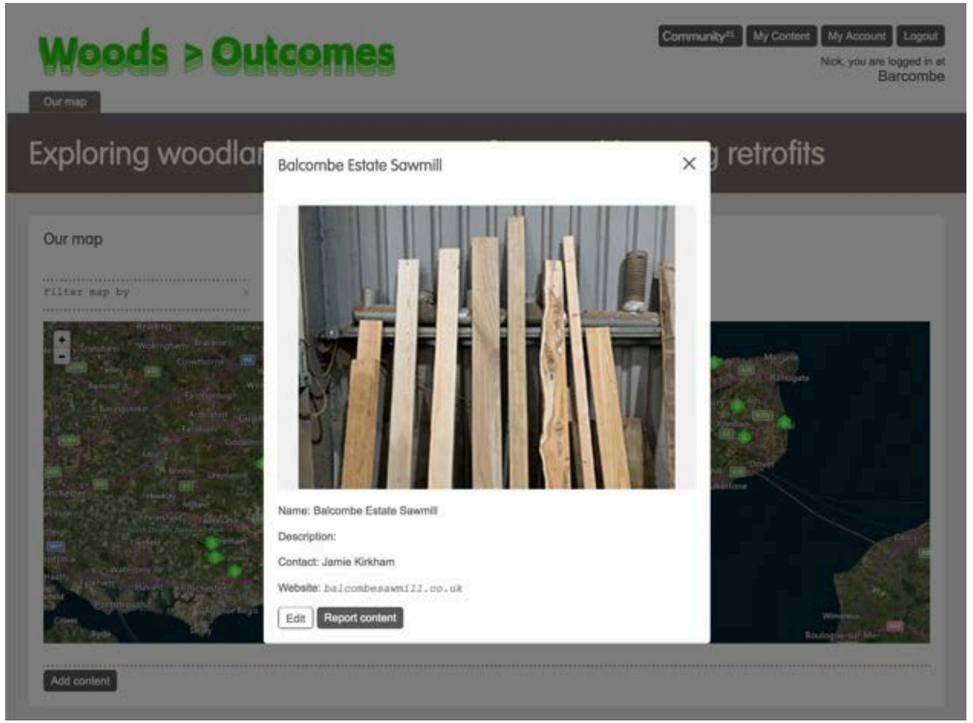
The project design and emergent aspects of the design process identified a layering of scales in terms of geography and production potential to unlock opportunities and design decisions relative to notions of 'local' and 'sustainable' supply.

Hyper-local ('niche') scale: This assumes a local alliance between landowners / managers that co-operate in the assessment and planning of resource supply chain. Here common understanding of the collective value of collaboration, common values and knowledge help support metrics of 'social good' and can sustain a consistent and resilient approach to delivering for the (local) market. The project asserted the notion of the 'Sussex 15' being 15 (or so) local woodland sites that can generate an immediate resource, can co-design and co-create a local resource management plan and can enact a sustainable model that motivates on going, very local investment in the operation (and landscape). Initial conversations with large and smaller local mills and stakeholders suggested a 'niche' potential to collaborate in team-like co-operative resourcing model. This would acknowledge / respond to frustrations associated with current the 'piece-meal' approach to resource production and the growing routine for what is perceived as 'usable' timber being incinerated for energy production in the absence of other 'realistic alternatives'. A local mill and / or mobile mill would



Left page: *Mobile mill*.
Image: Nick Gant, 2023

Balcombe Estate mill.
Image: Nick Gant, 2022



Interactive map and project micro-site.
Image: Nick Gant, 2022

form part of the hyper-local model, perhaps being a shared resource across land managers – In theory, woodland surveys (resource and / or ecology), evaluations and assessments for nature recovery and biodiversity, local economic growth and sustainable development, landscape master-planning and even product designs could be reconciled and co-defined through 'meaningful' collaboration.

Multi-local scale: is the strategic capacity to connect up multiple, hyper-local co-operations forming (in effect) a *community-of-communities* that links the 'knots in a network' across a region. This recognises the immediate value of retaining the tangible, 'meaning making' and value adding potential at the hyper-local scale, whilst enabling a larger interaction to address composite concerns – e.g. bigger data development and exchange, disease management and head-line economic investment (for example).

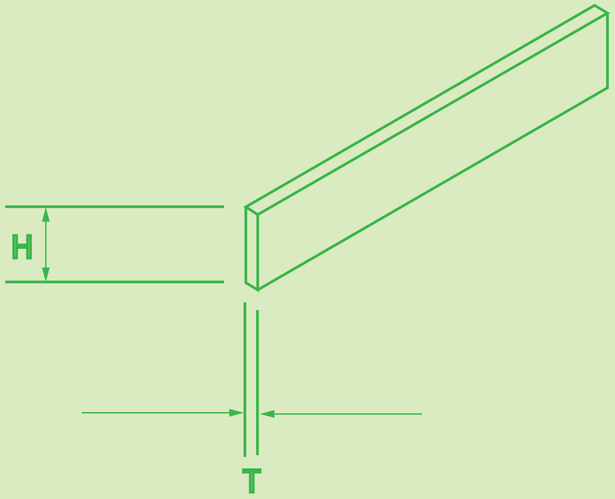
Our interactive map developed for the project uses software developed to enact such a multi-local collaboration. The team's mapping of mills across the southeast, arguably demonstrates a relatively even distribution of mills within localities that through the development and creation of an overarching strategy and market could theoretically provide for a joined-up regional demand.

This concurs with values associated with distributed manufacture [1] that seeks to define value(s) and benefits and champion diversity and idiosyncrasy at the local level, whilst also corralling the collective economy and / or 'ecology of scale'. Materials, and their social, cultural, economics and environmental meanings, stay local > market and production intelligence and knowledge is shared and connected beyond and between the local.

An emerging possibility within the project is the potential for regional (semi-centralised) wood hubs that provide an amenity for accessible storage, drying and perhaps a degree of processing (see 'The Sussex Plank') that could feed into the social housing supply chain (and others). The hubs occupy unused local authority buildings and land at strategic locations that reduce a proliferation of vehicle journeys that could pick up on 'responsive' mode opportunities for tree surgeons etc to 'dispose' of timber that may have some value – subject to agreed grading standards (to be defined).

Regional and national: Social housing is distributed across regions and represents a significant demand for products and services nationwide. Likewise national / international suppliers functioning across and beyond regional boundaries may provide a level of 'competitiveness' when utilising 'economies of scale' and accumulate viability through smaller margins but much higher volumes. This may also be true in terms of production processes that operate at scale, where centralisation affords efficiencies that impact on the 'cost' (financial) of products and services – but may or may not account so well against other metrics. One current supplier to social housing in our case study region (Howden's) has explicit ambitions for supply chain efficiency and 'sustainability' and UK priorities with fibreboard manufacture.

[1] Tooze, J., & Diez, T. (2017). Mass Distribution – A conceptual framework for imagining futures of retail.



Sussex Shape?

[standardisation]

Scale of the market

As mentioned above local authority / social housing provision is a regional concern and acts at a scale that is significant in its contribution to the built environment. Local authority budget managers may therefore seek, or expect to enact *an economy of scale* by virtue of in effect generating a 'new market'. This market may in part be 'designed' on the basis that design development may make use of material that is currently low / undervalued, which, if specified, may offer new opportunities for land owners, processors and fabricators. Local authority service providers may create the market that addresses current blockages that appear to broadly polarise timber between low value wood fuel and high-grade / value timber for use in more established markets.

The 'Sussex plank'

The Sussex plank is to some degree a rhetorical (research) question from the project to local mills / 'the industry' asking what would be the optimal size / shape of timber that could be produced from the equipment and common species and sizes that come through for processing in any given context. It is born from a notion that 'as designers' it is assumed we will want to specify prescribed dimensions of timber and locally mills cannot predict or speculate on such low volume, inconsistent demands. Therefore timber is generally rationalised and polarised as a commodity that is relatively high value due (in part) to patchy demand or fire wood / biomass. However if, as designers, we were to design out of common, or a limited number of 'shapes' then mills could use down time and unplanned, 'responsive mode' supplies and prepare stocks of 'the plank' with an expectation that there will at some point be a demand for social housing supply. A 'Sussex shape' or 'Sussex plank' would best be co-defined and determined by collaborative assessment of efficiency and optimisation at hyper-local and correlated at the multi-local scale.

Some stakeholders and mills did suggest that the Sussex plank concept and a level of 'standardisation' could be a useful proposition – if, in effect, all timber regardless of species or volumes could be converted to 'Sussex planks' then this could provide a new common market place and use for unplanned / responsive modes of supply as well as more planned, survey modes. However, the rhetorical nature of this question was not met with immediate, obvious or definitive answers and requires further research and perhaps an on-going determination of what constitutes 'optimal'. Regardless of no one single answer the design team and discussions with small and larger mills have rationalised and assessed that a 4x1inch / 100 x 25mm (or thereabouts) shape could provide a starting point for common types – and subsequently our designs for a range of products have sought to embrace this. Indeed, specifications if defined by the local authority could adapt and respond, within practical reason, to again sustain a distinct market and supply demand for planks of some variability at scale. Example *'What's in a skirting board?'* – there are differences in notions of standardisation of common products and should, could a skirting be of variable specification (species, size etc) when applied at scale beyond an individual house (?).

'Could mills make it all?' – Many mills are going beyond simply taking timber and developing lumber

‘What’s in a skirting board?’

Mixed species milling of planks. Image: Nick Gant, 2023

‘Could mills make it all?’

and if the design of 'products' can rationalise and optimise the machining necessary for production of more standardised types of product, then it may be possible to shorten supply chain handling. Some mills demonstrate potential to produce complex wood products including laminate flooring, thermo modified cladding and small buildings etc – although there were robust reports of industry and supply issues associated with local timber to underpin routine production, there is undoubtedly potential to correlate and co-design products to optimise programmes of simple 'types'.

Mill mapping

We developed a microsite for the project using our Community21 community planning software devised for such purposes where multi-stakeholder data inputs and geographic asset mapping could support collaboration and knowledge exchange. The team collaborated in mapping mills that provide an overview and insight as to the geographic spread in support of potential 'multi-local' initiatives, stock and resources that this interface could potentially further support and help manage. Current limitations on collaboration, data access and availability and reluctance of landowners to share WMP / data / reports etc means this would require greater investment to support the co-design of an appropriate model that encourages engagement and sustained use. Some level of digital interface and connectivity could be an asset in addressing and supporting better collaboration and encourage new stakeholders and investors into the market.

The project demonstrated the need for systems thinking between manufacturing, design and business collaboration and ecological understanding of the interrelationship between useable material production and more diverse species and habitat provision. Therefore, use of multiple species standardisation that also makes use of 'the wood lying waiting to be processed' and / or a range of dynamic designs that can accommodate variability could disrupt the current hiatus. This would offer landowners (public and private) and tree surgeons to add to windfall and unplanned felling to build stocks in centralised storage hubs ready to standardise the processing of Sussex planks. This could accommodate the multiplicity of valued, small and medium sized enterprises that characterise the sector (DEFRA, 2023) distributed across a region.

Wildlife status and motivations drivers

Public and private drivers associated with broad notions of individual and collective contributions to nature (implicit perceptions of conservation, recovery, biodiversity and habitat provision for diverse species and ideas of 'rewilding'). We referred to this 'the Knepp effect' and 'eco-ego' status of landowners driven also by a wider cultural appreciation of the 'state of nature' and potential status of / for woodland owners when contributing to wildlife amenity. This could be supported by processes that can help form authentic 'nature narratives' and identities around their land with resulting species diversity. This is a demonstrable driver for management and engagement that concurs with the design team's sustained engagement with a 'Making Nature' approach to product development (Gant, 2020) that where resource development demonstrably correlates with the discernible and promotable improvement of landscapes and habitats

Interactive map of mills.
Image: Nick Gant, 2023

for wildlife. Woodland owners and managers articulate ambitions to contribute to regional nature recovery and (anecdotally) have widely welcomed early proposals for accessible wildlife monitoring methods and accessible interfaces that could monitor (and motivate) management plans with an ecological bent – whilst allowing managed felling / coppicing to 'wipe the financial face' of operations associated with woodland ownership.

The design team see this as an already motivating force in the management of woods in the region with large and small private and public estate managers and owners seeing different incentives and narratives for nature recovery in accordance with government policy and metrics for Local Nature Recovery Strategies (LNRS) and Biodiversity Net-Gain (BNG) and the 'status' of nature recovery in the cultural narrative and perceptions and ideas around notions of 'rewilding' (see pilot monitoring and augmented experiences below).

There is *roadmap* recognition of the value in diversifying the products and their source species may support resilience biodiversity in the landscape and eco-system services at the source of the supply chain, which interconnects with the need to increase investment in demand and consumer respect for home-grown resources .

This fed into the design prototyping that embodies the need to (positively) accommodate variability in species and size of woods, advantages of both fast-growing coppicing of (for example) sweet-chestnut on routine rotational management and a range of ages of hardwood stock. Whilst somewhat symbolic, the realisation of these drivers is represented through the design and production of 'nature prioritising' prototypes. It is proposed that knowledge of the provenance and association with 'wood-for-good' supply chains can directly or vicariously motivate management and engagement of woodland managers / owners seeking to contribute to a regional culture of (more) sustainable development. Moreover, design has demonstrable agency in supporting, stimulating and driving these agendas / motivations and the potential for collaboration around 'branded' association with tangible, local / regional values for human / nature *homes and habitat* improvement.

Timber in construction roadmap, Department for Environment, Food and Rural Affairs, 2023.

Coppice coups at Stanmer Park.
Image: Nick Gant, 2023

Main prototype product case study

The aims for the prototyping stage of the project were to ascertain the viability of producing interior FF&E (furniture, fittings, and equipment) products, from the timber sourced from local woodland, for use in social housing in the SouthEast region of the UK.

The work has taken a Research through Design approach (RtD), using practices of ideation, iteration and prototyping to allow for the emergence of new insights. According to Stappers, et al, 2017, this approach can be seen as a struggle "with opportunities and constraints, with implications of theoretical goals/constructs ... and the empirical realities in the world[1]." The aim being to strike a good (acceptable) but not necessarily perfect balance between often competing factors of desirability, feasibility, and viability[2]. Common in RtD projects is the use of domain specific knowledge and experience to inform the design process. In the case of this report, the principal designer has over 25 years' experience in designing and producing timber products, covering joinery, cabinetry, and furniture.

A concept critical to shaping the development process is the notion of a standardised plank of sawn timber, which will be referred to as the 'Sussex Plank'. The premise being that this Sussex Plank could be produced by local mills from a range of timber species, and sizes of tree, and be suitable to make a wide range of products. In designing the doors, it was important to be mindful of how components could be standardised so that the same timber plank could be used for other joinery products.

Within the FF&E category the research team decided to focus on three products: skirting boards, kitchen worktops and kitchen doors. The rationale for this being that all are traditionally made from timber, can be made from similar, if not the same, stock size of sawn timber, can be made from a wide range of species, and each product offers different levels of complexity in their design and production. This report will primarily cover the design of a kitchen door, being the most complex of the three products, however the findings from the work undertaken can be extrapolated to assess the viability of producing skirting boards and other timber products.

The prototyping report details the design and prototyping process, covering design requirements of kitchen cupboard doors within the context of social housing. It details how those requirements, alongside considerations of the optimum Sussex Plank dimensions, and production cost drivers, have shaped the design of multiple prototype variations. To gain a real-world industry perspective on the potential production time and associated costs of each variant a joinery company was employed to make each of the samples and following that, to provide a breakdown of each step in the production process, its associated costs, and an estimate for the production of 3000 doors per year for each variant. These estimated costs were then fed into a costing model that incorporates cost drivers from the timber supply chain, from felling through to seasoning/drying and planning to size. The costing model was created to plug-in variables, such as labour or transport costs to see what range of costs might be likely. The outputs from the costing model as well as assessment from an evaluation matrix of key design requirements was used to determine the 'best fit' design option. The costing model for the doors was then modified to make estimates for the skirting board and worktop. The report concludes with a discussion of the viability of using timber for FF&E products and identifies non-financial factors that may support the case for localised production and timber use, as opposed to mass produced chipboard and laminate products.

[1] Stappers, P. J., & Giaccardi, E. (2017). Research through Design. In M. Soegaard, & R. Friis-Dam (Eds.), The Encyclopedia of Human-Computer Interaction (2nd ed., pp. 1-94). The Interaction Design Foundation.

[2] IDEO, "Design Thinking," retrieved from https://designthinking.ideo.com/

The 'Sussex plank'

Conversations with mills, timber suppliers and others in the timber supply chain identified the potential of a single standard dimension of sawn timber that could allow smaller woodland owners to better estimate the value of the timber stock they hold. And if a range of products were designed to utilise this plank size, especially for those with longer-term procurement plans (such as a local authority) there could be relatively predictable demand in the future, and therefore more confidence of a yield of greater value than that of biomass.

This plank, therefore, needs to be appropriate for a wide range of joinery applications (doors, cabinets, skirting boards, flooring, cladding, etc) that mills can produce from logs, secure in the knowledge that there would be significant demand once the timber was sufficiently dry (10 - 14% moisture content)[3]. The primary dimension being thickness, as this is critical to the seasoning time (both kiln drying and air drying). A standard plank dimension (Sussex Plank #1) which fit common dimensions for both skirting boards and cabinet door frames was 1" x 4" (imperial) or 25mm x 100mm (metric). Once dried and planed this can consistently achieve 18mm thick and up to 90mm wide. This plank size strikes a reasonably good balance between quick (air or kiln) drying and low dimensional deformation and splitting. This plank size is most suited to the production of skirting boards and architraves from softwood at the dimensions given above.

This plank size acted as a starting point, to inform possible design choices, however through the design of the doors it became apparent that two plank sizes would be needed to offer greater utility and to minimise wastage. A second plank size (Sussex Plank 2) was specified at 40mm x 100mm to achieve a greater range of finished sizes suitable for doors and worktops, from hardwoods. Illustrations 01 and 02 show how the two plank sizes can be machined to achieve 6mm, 18mm and 32mm planed boards. They can of course be machined to other dimensions, however for the purpose of this project the aim was to limit the variables in order to fit to the prototype constraints. Illustration 03 shows how log diameter (at the narrowest point) can be used to assess the number of planks in a given log. Planks would be cut as full width and then seasoned before sawing into individual planks. These Sussex Planks could be sold/identified under the brand of Sussex Timber.

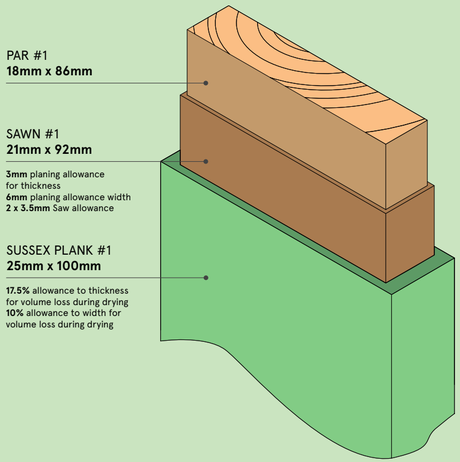
Timber species

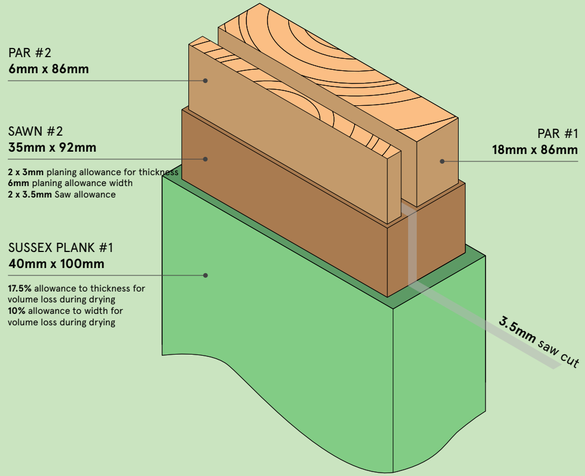
In addition to its sawn dimension, the Sussex Plank, would be characterised by the species of tree grown in the region, that are suitable for interior joinery and have a predicted yield that would enable felling for production. This includes softwoods such as scots pine, douglas fir, hemlock and larch and hardwoods such as english oak, common beech, ash, sycamore, sweet

[3] BS EN 942:2007 'Timber in joinery – General requirements: European Committee for Standardization. (2007). Timber in joinery – General requirements (BS EN 942:2007). CEN.

Sussex Plank 1

25mm x 100mm
Suitable for 18mm thick PAR for skirting and door frames

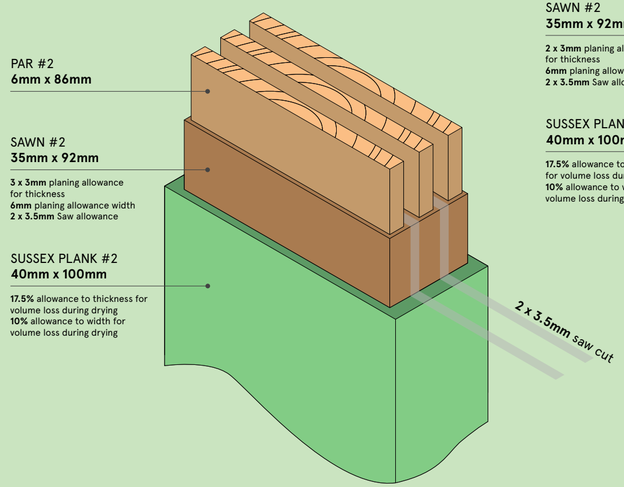


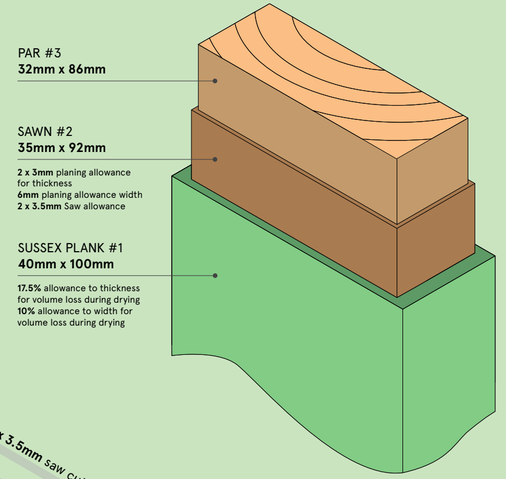


Sussex Plank 2

40mm x 100mm
Suitable for 6mm thick PAR for laminate strips, 18mm thick PAR for skirting and door frames, and 29mm PAR for worktops.

Sussex Plank 2





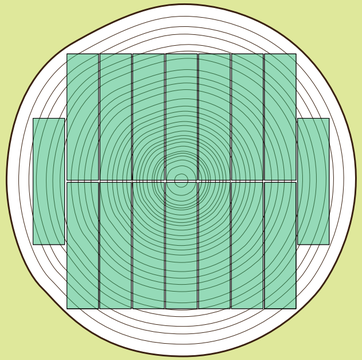
Green Timber – recently felled and sawn into planks for seasoning (drying) – approx. 100% moisture content.

Sawn Timber – dried to 10 to 14% (air or kiln dried). Cut to approx. dimesions to allow planed timber to be achieved.

PAR Timber – planed all round (PAR) this is machied from sawn timber to achieve exact dimentions with all edges at 90°

Sussex Plank 1

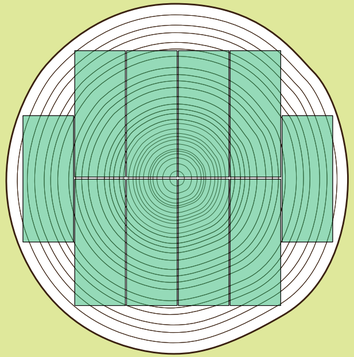
25mm x 100mm x 2500mm - Live Sawn
Minimum Log diameter of 275mm
to produce 16 x Planks



Log diameter (after bark removal)	Number of Planks
275 mm	10 planks
325 mm	14 planks
355 mm	18 planks
400 mm	20 planks
420 mm	24 planks
450 mm	28 planks
470 mm	32 planks
520 mm	38 planks

Sussex Plank 2

40mm x 100mm x 2500mm - Live Sawn
Minimum Log diameter of 270mm
to produce 10 x Planks



Log diameter (after bark removal)	Number of Planks
275 mm	10 planks
325 mm	14 planks
355 mm	18 planks
400 mm	20 planks
420 mm	24 planks
450 mm	28 planks
470 mm	32 planks
520 mm	38 planks

chestnut, hornbeam and silver birch. While feasible to use softwood planks to produce skirting boards, hardwood is more suitable for both worktops and doors. Hardwoods due to their small, tightly packed cell structure exhibit greater dimensional stability and resistance to moisture-related changes than softwoods, especially in environments like kitchens with fluctuating humidity levels. Where skirting boards may be fixed in place and painted over, both serving to protect them from absorbing moisture from the surrounding air, and to limit their movement, they are also singular planks, meaning that slight changes in dimension (±2mm) will likely go unnoticed. This is not the same for complex assemblies such doors, where dimensional changes to components can be immediately visible and impact on the functionality, by twisting or swelling.

Why sweet chestnut

Sweet chestnut (Castanea sativa) was selected to be the primary timber for the prototypes as it is a fairly abundant hardwood in the SouthEast of the UK, with an established supply chain. It has properties that make it suitable for interior joinery and is priced lower than comparable hardwoods. Current estimates suggest there are approx. 30,000 hectares, or about (2% of woodland cover) in the UK, with the majority in the south of England[1]. Alongside oak and ash, sweet chestnut is a principal tree species for the UK, already widely used or in increasing usage, where existing silvicultural knowledge can aid deployment and will continue to be important unless adversely affected by climate change, new pests or disease[2]. In fact, predicted scenarios for climate warming over the 21st century indicate that conditions favouring chestnut

1. Forest Research. (n.d.). Tree Species Database, Sweet Chestnut. Retrieved from https://www.forestresearch.gov.uk/tools-and-resources/tree-species-database/131550-sweet-chestnut-sc-2/ (Accessed 8th March 2024).
2. Forest Research. (n.d.). Tree Species Database, Sweet Chestnut. Retrieved from https://www.forestresearch.gov.uk/tools-and-resources/fthr/tree-species-and-provenance/ (Accessed 8th March 2024).

will be enhanced, and in particular for the South East. Work undertaken in 2014 by the Forestry Commission indicates that over the following 50 years, sweet chestnut has the greatest potential for growth and productivity of any broadleaf tree in the UK. Grown in Britain WoodStock 2016 report indicates there is scope for sweet chestnut to increase in yield by 55x from 2015 figures (1000m3 to 55000m3) in a scenario where hardwood species, other than oak were promoted. However, anecdotal reports during this project from various points in the timber supply chain suggest that increasing demand for sweet chestnut is leading to uncertainties in availability, the guarantee of local sourcing and price increases.

As a hardwood it is relatively easy to work with hand and machine tools (very similar to ash and oak), although when dry it is prone to splitting. Sweet chestnut for external cladding is often finger-jointed (see illustration) to create longer lengths from shorter coppiced logs, making for more efficient use of material. It sands easily and produces a smooth surface, and takes a wide range of finishes (oil, varnish, paint etc well). For both manual handling of components and finished products it is relatively light in comparison to other similar hardwoods. It is less dense than ash or oak at the same moisture content level (c560kg/m2 at 15% MC vs c715kg/m2 for ash and oak). Especially important in joinery, it has low dimensional (moisture related) movement, meaning that there is lower risk of components shrinking or expanding and therefore impacting the structural or aesthetic characteristics of a product, when exposed to changes in air moisture content. One factor that needs consideration is the tannin content of sweet chestnut that can accelerate metal corrosion, particularly iron compounds, causing blue-black discolourations.

Grade timber for prototypes

Timber for furniture is graded into different categories based on the visual appearance of the wood (knots, streaks, shakes, staining, resin, wane, etc). The four principal grades for furniture are:

A / Prime or Clear Grade: Highest quality timber with minimal defects. Virtually free from knots, splits, and other imperfections. Often used for high-end applications where a flawless finish is desired, such as fine furniture and architectural detailing

B / Standard or Select Grade: High-quality timber with few visible defects. Contains some natural imperfections such as small knots and colour variations. Suitable for a wide range of applications including interior trim, furniture making, and general construction.

C / Common Grade: Quality timber with more visible defects and irregularities. Contains knots, shakes, and other natural markings that may affect appearance but not structural integrity. Used for general construction, framing, and rough carpentry where appearance is less critical.

D / Character Grade: Timber intentionally selected for its unique and distinctive visual characteristics. Includes knots, cracks, splits, and other natural features that add to its rustic charm and aesthetic appeal.

Buckley, P., & Howell, R. (2004). The ecological impact of sweet chestnut coppice silviculture on former ancient, broadleaved woodland sites in south-east England. English Nature Research Reports, Number 627. Imperial College, Wye College, Ashford, Kent.

Forest Research. (n.d.). Regional Changes in England in Tree Species Suitability Resulting from Climate Change.

National Forest Inventory. (April 2014). 50-year forecast of hardwood timber availability. Forestry Commission.

Grown in Britain. (2016). WoodStock—Final Report. Retrieved from https://www.growninbritain.org/wp-content/uploads/2020/04/GiB-WoodStock-Report.pdf (Accessed on 11th March 2024).

British Standards Institution. (2007). BS EN 942:2007 Timber in joinery – General requirements.

Vastern Timber. (n.d.). Sweet chestnut data sheet. Retrieved from https://www.vincenttimber.co.uk/products/sweetchestnut/Sweet_Chestnut_Data_Sheet.pdf (Accessed 5th March 2024).

Kitchen door preparation.
Image: James Tooze, 2023

For the prototypes character grade was chosen as it is the lowest cost (approx. 65% of the cost of prime grade) while still being suitable quality, with the additional surface marks of character grade being considered a feature rather than a defect.

Manufacture

In addition to the local sourcing of the primary raw material another intention of the project was to manufacture locally, within the region of the local authority and the social housing they manage. Two possible scenarios that influenced the design were to a) put the production of the doors out to tender, to local joinery companies with existing manufacturing capacity or b) to set up a dedicated enterprise to manufacture the doors and potentially other joinery (skirting, etc). Both scenarios leverage the knowledge and expertise already in the region, with the SouthEast having 11.7% of the UKs furniture manufacturing sector, mainly in the form of small specialist manufacturers .

Designing the prototypes

The aim was not to design a new style of solid timber door, rather to design doors that balance 1) efficient material use and 2) minimal labour costs, while meeting the design specification points. All doors were designed to be visually appealing, with the assumption that all would be of equal desirability to potential users. Five door versions were designed, each characterised by the way they are manufactured. Four of the versions use 6mm planed strips that are cross laminated to result in an 18mm thick door frame (or overall thickness panel). The use of 6mm strips and cross-lamination was chosen as it utilises a single size of timber. It also affords simpler (less skilled) assembly and machining, although producing this thickness material creates more wastage as more material is lost due to sawing and planing to size. The fifth version is a standard shaker style door, made from an 18mm frame and 6mm panel, designed as a 'control' version to compare others to. This version is still fairly simple in construction but does require more skill and precision to accurately machine joints and rebates. This can be seen in the illustrations of each version below.

Ariyo, M. (2023, August). C31.020 – Kitchen Furniture Manufacturing in the UK. IBISWorld Report Number. Retrieved from IBISWorld database.

Kitchen door preparation.
Image: James Tooze, 2023

Kitchen cabinet door design requirements

The specification points are for a cabinet door to fit a standard 720mm tall x 600mm wide cabinet (base or wall unit).

Material specifications:

- Material: Hardwood native to SouthEast UK
- Stability: Low dimensional movement (shrinkage, expansion, splitting, twisting, etc)
- Integrity: Allow for drilling of hinge mounting holes and secure fitting of hinges
- Durability: impact resistant to damage from manual handling (daily use)

Dimensions and sizes:

- Width: 596mm – to fit standard cabinet
- Height: 715mm – to fit standard cabinet
- Thickness: 16mm to 20mm – to fit standard cabinet hinges

Construction considerations:

- Assembly: Low to medium skill level – with accuracy and speed of construction enabled by jigs and guides.
- Structurally sound: rigid and durable construction, with strong, long-lasting glue bonds and joints connecting all parts.
- Easy-to-clean surface for low maintenance.

Finishes and coatings:

- Surface coating: Hard wearing and moisture-resistant coating for increased longevity.
- Recoatable: finish can be reapplied in situ to allow for renovation and to allow for redeployment.

Door prototypes

Sample construction version #1
Designed to be made from 6mm slats (PAR #2), laid up in an internal and external frame, and an exterior panel, and cross laminated to make up a total thickness of 18mm. The main aspect of this version is that it can be used/offered in two styles, a frame and panel or full panel door. This version was produced in 3 types.

- V1A – made from sweet chestnut with component edges chamfered (1mm) prior to assembly. Chamfers at the joints between frame components and panel are used to minimise notice of discrepancy between adjacent panel thicknesses, caused by moisture related swelling or contraction. All contact points are glued with PVA wood adhesive. Door trimmed square and to exact size after construction.

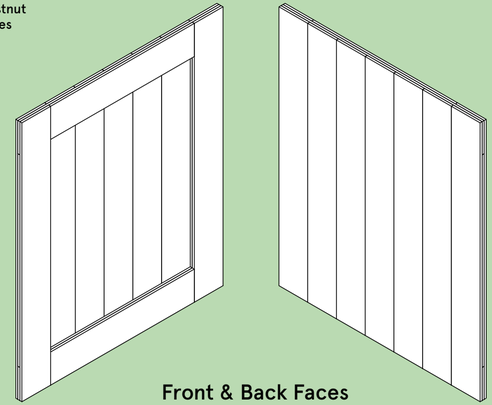
- V1B – made from sweet chestnut with components assembled as above, and with all external edges chamfered after assembly.

- V1C – as V1B but using a mix of timber species sourced from local woodland including hornbeam, oak and sweet chesnut.

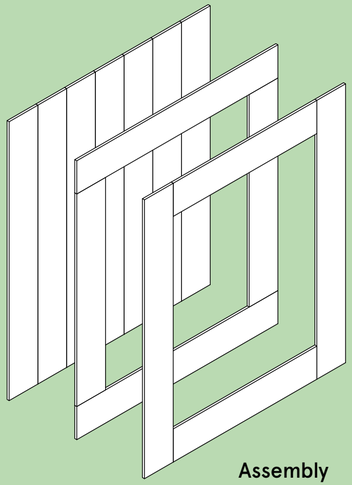
A risk with this version is that the full-length panel is only glued onto the frame from one side. If the timber expands or contracts significantly it would cause visible warping or splitting.

Sussex Door – Version 1

Made from cross-laminated 6mm x 86mm
V1A- Sweet Chestnut
V1B - Sweet Chestnut
V1C - Multi Species



Front & Back Faces

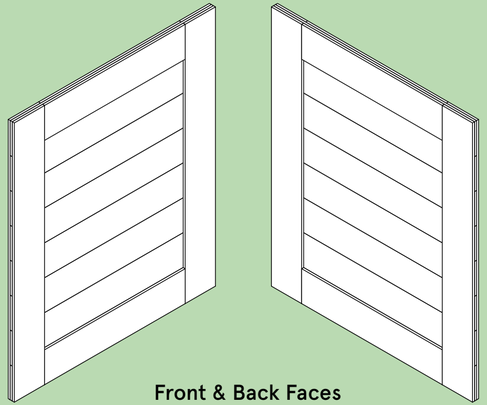


Assembly

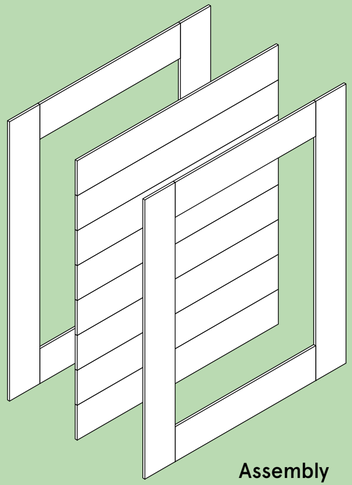
Cutting list x 1 door = 450 of Sussex Plank #2 needed to make 300 doors

Sussex Door – Version 2

Made from cross-laminated 6mm x 86mm
Sweet Chestnut



Front & Back Faces



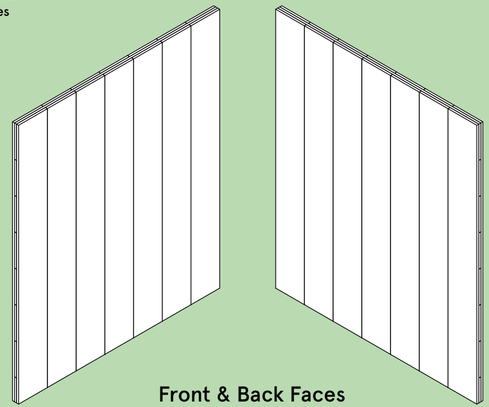
Assembly

Cutting list x 1 door = 434 of Sussex Plank #2 needed to make 300 doors

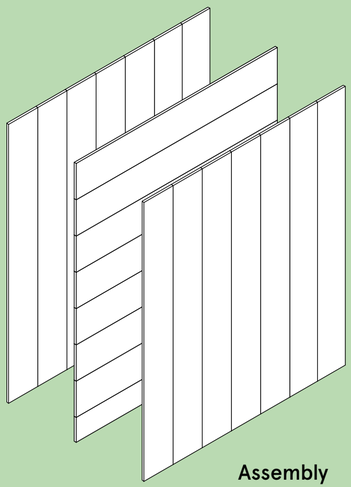
4 of 2.4m lengths @ 86mm x 6mm	715mm	596mm	596mm	426mm
1 of 80mm length @ 86mm x 6mm	596mm			

Sussex Door – Version 3

Made from cross-laminated 6mm x 86mm
V3A- Sweet Chestnut
V3B - Multi Species



Front & Back Faces



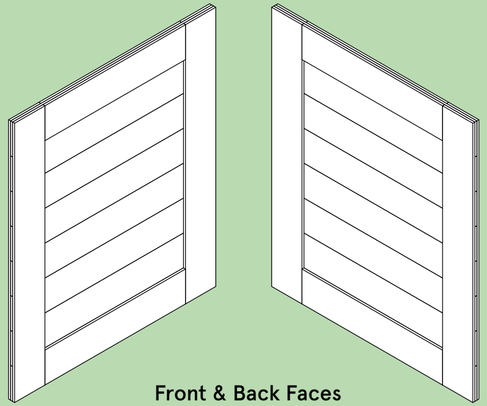
Assembly

Cutting list x 1 door = 700 of Sussex Plank #2 needed to make 300 doors

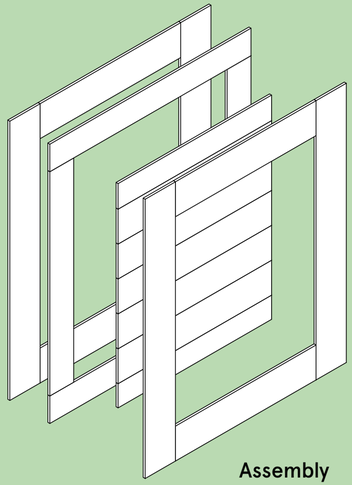
4 of 2.4m lengths @ 86mm x 6mm	715mm	715mm	715mm	
2 of 2.4m length @ 86mm x 6mm	596mm	596mm	596mm	596mm
1 of 2.4m length @ 86mm x 6mm	715mm	715mm	596mm	

Sussex Door – Version 4

Made from cross-laminated 6mm x 86mm
Sweet Chestnut



Front & Back Faces



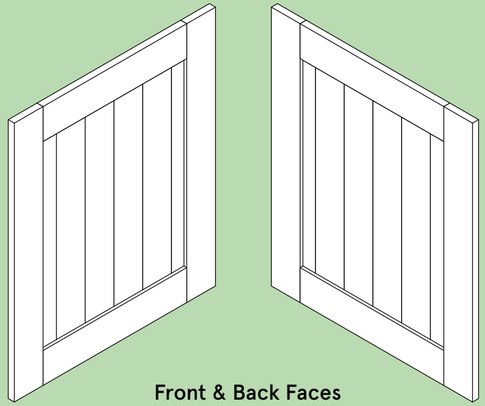
Assembly

Cutting list x 1 door = 450 of Sussex Plank #2 needed to make 300 doors

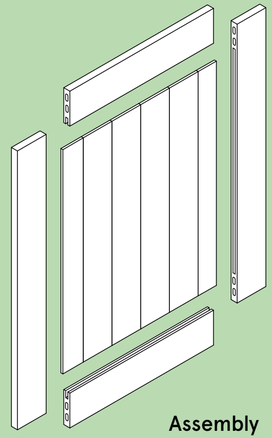
2 of 2.4m lengths @ 86mm x 6mm	715mm	715mm	426mm	426mm
1 of 2.4m length @ 86mm x 6mm	596mm	596mm	563mm	563mm
1 of 2.4m length @ 86mm x 6mm	446mm	446mm	446mm	446mm	446mm
1 of 1.2m length @ 86mm x 6mm	446mm	446mm		

Sussex Door – Version 5

Made from cross-laminated 6mm x 86mm
Sweet Chestnut



Front & Back Faces



Assembly

Cutting list x 1 door = 350 of Sussex Plank #2 needed to make 300 doors

3 of 2.4m lengths @ 86mm x 18mm	715mm	715mm	425mm	425mm
1 of 2.4m length @ 86mm x 6mm	563mm	563mm	563mm	563mm
1 of 1.2m length @ 86mm x 6mm	563mm	563mm		

Sample construction version #2
Designed to be made from 6mm slats (PAR #2), slats are laid up in a central panel, with a frame glued to each face creating the effect of a shaker-style panel door. Made from sweet chestnut with components assembled as above, and with all external edges chamfered after assembly. All contact points are glued with PVA wood adhesive. Similar to V1, there is a risk with this version that the full length expands or contracts significantly causing visible warping or splitting. This is limited by being sandwiched between two frames but still possible.

Sample construction version #3
Designed to be made from 6mm slats (PAR #2), this version is constructed as a 3-layer cross-laminated panel. It can be produced as a single door but more likely it would be produced as a larger panel and cut to produce multiple doors. The main aspect of this version is that the production of panels offers greater flexibility, they can be made in volume, and then cut to size for doors, drawer fronts, side panels etc. As the middle layer of the panel is not visible, it could be lower grade timber. Thicker panels can be created for use as worktops by using thicker stock for the mid panel.

- V3A – made from sweet chestnut, laid up as 3 cross-laminated panels. All contact points are glued with PVA wood adhesive. Panel trimmed square to door size with all external edges chamfered after assembly.

- V3B – as above but using a mix of sweet chestnut, oak and ash.

The cross lamination of the panel greatly limits the risk of moisture related movement as the panels (and glue between) act to limit potential for the timber cells to 1) take on moisture and 2) expand or contract. One trade-off is that this version requires approx. 50% more material than versions 1, 2 and 4. Another aspect to consider is that this version would require the use of multiple laminating presses for medium to high volume production.

Sample construction version #4
Designed to be made from 6mm slats (PAR #2), slats are laid up in three cross-laminated frames, with a central 'floating' panel. With the central frame being cut to a narrower width to create a rebate that the floating panel can sit in. All contact points on the frames and edges of the central panel are glued with PVA wood adhesive. The central panel is not glued to the frame (therefore - floating) but is sandwiched in place to create the effect of a shaker-style panel door. Made from sweet chestnut, trimmed to size after assembly, with all external edges chamfered. This version accounts for the potential moisture related movement of the central panel but sitting it within a rebate (channel) that is 2mm wider, any expansion or contraction would not be visible as it would be hidden by the exterior frames.

Sample construction version #5
Designed to be made from 18mm boards (PAR #1) for the door frame and 6mm slats (PAR #2) for the internal panel, this is a standard shaker style door. With fewer components this version requires the least materials and least components and within the prototypes acted as a 'control' version. In comparison to the other versions this door requires greater skill and experience as a joiner and machinist, routing rebates for the mid panel and mortices for the loose tenons (Dominos). All contact points on the frames and edges of the central panel are glued with PVA wood adhesive. Similar to version #4 the mid panel 'floats' in the frame, located as the frame is assembled. Made from sweet chestnut, trimmed to size after assembly, with all external edges chamfered.

Finishing of all door versions
All surfaces and edges are sanded to 180 grit (fine) and finished coated with a product that is food safe (EN 1186), safe for children (EN 71.3), water repellent, durable and hard wearing, resistant to common liquid spillages and which does not crack, peel or flake [1].

Version comparison: construction considerations

In table 1 each of the prototype versions are assessed against key criteria. It shows that version 3 offers the greatest versatility for making a wide range of products and the lowest maintenance, however it may require a more specialist set up for manufacture. Version 4 and 5 offer versatility for various door and drawer sizes and easy maintenance, with version 4 being more suited to lower skilled manufacture.

Version comparison: costing

To assess potential total cost for each door version a cost model was created (see appendix), that contains data from project partners, Forestry Commission timber conversion factors and volume production estimates from the joinery company involved in the prototype production. The model allowed the project team to use the inputs from the Woodland Enterprises Ltd and the joinery company involved in the prototypes to establish some baseline costs. The model also allowed the project team to stress test some of the commercial data and assumptions to see how the final price and viability was affected. While considerable effort has been made to achieve robust estimates, the projections for the joinery in particular remain well considered guesses. All costs exclude VAT and profit so these would need to be added in any future revisions. Estimates are based on making 3000 doors per year. This would cover approx 300 kitchens. For the purpose of estimating and comparison, the doors are taken to all be the same size (as the prototypes), however we acknowledge that kitchens will likely need a number of different sizes. The costing model uses batch sizes of 300 doors for each production run and where capital expenditure (CapX) for machinery has been identified over and above that found in smaller joinery workshops, such as 4-sided planers, sander thicknessers and laminate presses, these costs have been spread over 3-years or 9000 doors. Table 2 shows the cost estimates for each of the door versions. Version 5 is clearly the cheapest, based on the assumption that all labour costs are equal. All door version estimates come out at between 2.5 to 3.5 times the cost of a comparative size door (made from polypropylene and PET faced chipboard) currently used in social housing.

Conclusion and discussion

Is it possible to make timber FF&E products for social housing, possibly. Production and milling costs are still too high to make the products competitive for social housing construction. For doors, the price of timber

[1] https://osmouk.com/downloads/topoil-product-information-0423.pdf

Version Comparison: Construction Considerations

Version	Production				Maintenance		
	Adaptability of process for other doors	Adaptability of process for other products	Skill level	Suitability for local joinery SME	Structural Stability	Ease of recoating in situ	Easy-to-clean surface for low maintenance.
1 (A, B + C)	High	Low	Low / Med	High	Med / Low	Med	Med
2	High	Low	Low / Med	High	Med / Low	Med	Med
3 (A + B)	High	High	Low / Med	Med	High	High	High
4	High	Low	Low / Med	High	High	Med	Med
5	High	Low	Med /High	High	High	Med	Med

Version Comparison: Costing

Version	Green timber	Logistics	Milling	Joinery	Total per door	Primary Cost Drivers	Focus for cost reduction
1A	£1.58	£1.43	£14.71	£53.97	£71.68	Machining of timber (labour + equipment) Number of parts / handling	Lower (production) cost if lower skills needed. Spread of CapX over longer period
1B	£1.58	£1.43	£14.71	£53.63	£71.35		
1C	£1.58	£1.43	£14.71	£55.17	£72.88		
2	£1.52	£1.38	£14.27	£50.26	£67.43	Machining of timber (labour + equipment) Number of parts / handling	Lower (production) cost if lower skills needed. Spread of CapX over longer period
3A	£2.45	£2.23	£22.58	£59.48	£86.74	Materials Machining of timber (labour + equipment) Number of parts / handling	Lower (production) cost if lower skills needed. Spread of CapX over longer period
3B	£2.45	£2.23	£22.58	£59.48	£86.74		
4	£1.58	£1.43	£14.71	£56.30	£74.02	Machining of timber (labour + equipment) Number of parts / handling	Lower (production) cost if lower skills needed. Spread of CapX over longer period
5	£1.23	£1.12	£11.63	£46.90	£60.88	Machining of timber (labour + equipment)	Spread of CapX over longer period

makes up a small proportion of the final cost so if these doors were sold in the private market then it would be a route for landowners to significantly increase their income. For the doors the highest cost component is the joinery. While door version 5 can be taken to be the best option, in terms of cost, production viability and maintenance, it still remains a factor of 2.5 times more costly than products currently specified. However, if joinery costs were reduced by a quarter then version 4 would be comparable to version 5. Simpler products like skirting boards have the best chance to succeed in social housing as they require machining, rather than joinery and there could be further cost refinement and negotiation with the supply chain.

Even though the costs are higher than a social landlord might expect to pay, there are non-financial and indirect benefits that could fall within their remit and would therefore prove cost effective or worth at least the investment. Long-term commitment to source from local woodland owners and mills may help to create the financial security needed for them to establish longer-term and forward-thinking woodland management plans that integrate commercial objectives and invest in regeneration goals. Joinery could be contracted to organisations that support those marginalised from the workforce through mental health problems, homelessness, alcohol, or drug related issues such as the Brighton & Hove Wood Recycling Project [https://www.woodrecycling.org.uk]. Solid timber doors are likely to last a significant period of time, potentially 20+ years with appropriate care. With opportunities of having a second life in another location. Solid timber, in comparison to laminated chipboard doors, offers the potential for breaking down for reworking and re-use. In addition to solid wood having an aesthetic appeal, a literature review of research indicates that the presence of wood in interior environments may improve both occupant satisfaction, their sense of wellbeing and cognitive performance. Non-cost benefits are hard to sign up to when budgets are limited so if Sussex Timber is to succeed as a brand it may require some upfront subsidies at various points in the supply chain to make the product cost competitive, and therefore financially viable.

Final kitchen doors.
Image: Nick Gant, 2024

Final kitchen doors.
Image: Nick Gant, 2024

Mixed species cladding.
Image: Nick Gant, 2024

The ‘Sussex chair’

In addition to the more ‘standard’ products provided by / for social housing providers the design team complimented the process (outside of project funding) by engaging with a design for a ‘Sussex Chair’ as a means to further respond to demands to address ‘what’s actually out there’. Reports suggest relatively low levels of active forest management in Sussex, which has a negative impact on nature and economic development [1], [2]. These ‘waste(d) opportunities were investigated by The University of Brighton / Commuity21 research group via a *research-through-design* process and development of a proposed local chair type. This arose through engagement with local landowners and their landscape management plans and aspirations, in particular Stanmer Park. On the outskirts of Brighton Stanmer is the largest wood within Brighton and grade 2 parkland in council ownership. It is faced with not uncommon issues associated with constrained public sector finances, disease ingress (in particular serious levels of ash-dieback) and policy and public expectations to address social, cultural, economic and environmental demands.

The University have been helping with coppicing areas of wood much of which was destroyed and re-established after the 1986 storm. These areas we have defined as being of interest and perhaps being of a type common in Sussex that have been left to grow from a range of different reasons. In Stanmer we have been removing timber, creating coupes and a ‘mosaic’ of habitats. The resulting timber is generally small diameter from twigs to longer branches up to 6 / 7 meters long and mostly between 5-20cm in diameter. Three main species have colonised these areas ash and sycamore and hazel from historic coppicing that has lapsed from routine cycles due to competing demands. Thus, our designs have sought to engage with common, ‘low value’, limited use timber that would result if this and other woodlands (re)engage coppicing and WMPs in areas that have been unmanaged for similar time frames and not managed with timber product production in mind.

The developing proposals engaged with collectively felled green wood and green-wood-working skills to, where possible, remove need for storage or drying. Sycamore is prolific, considered by some as a ‘weed tree’ and undervalued as a furniture-making material, offering a pale, attractive wood that may be ‘easy to live with’ and workable timber. The nuance critique of different prototypes are explained / explored through the associated diagrams.

It is hoped ‘The Sussex S.E.E Chair’ could have value within local circular-economy and communal maker-space initiatives in support of health and well-being of the community adopting composite values for Society, Economy and Environment (S.E.E) borrowing from Elkington’s notion of the triple bottom line [3]. The approach references ‘eco-socialist’ William Morris Company Sussex Chair [4] as a successful product and type in line with company values and also more recently Curtis Buchanan’s ‘Democratic Chair’ [5] developed to only be produced from greenwood with limited tools and accessible to less skilled makers.

Staff with expertise in 3D Design and Craft department, and recognised greenwood chair maker (bodger) and 3D Design and Craft students developed prototypes that rationalise and respond

Greenslade, C., Murphy, R. J., Morse, S., & Griffiths, G. H. (2021). Breaking Down the Barriers: Exploring the Role of Collaboration in the Forestry Sector of South East England. *Sustainability, 13*(18), 10258.

Hardiman, B.S.; Gough, C.M.; Halperin, A.; Hofmeister, K.L.; Nave, L.E.; Bohrer, G.; Curtis, P.S. Maintaining high rates of carbon storage in old forests: A mechanism linking canopy structure to forest function. For. Ecol. Manag. 2013, 298, 111–119.

Elkington, J. (1997). The triple bottom line. *Environmental management: Readings and cases, 2*, 49-66.

https://collections.vam.ac.uk/item/O7883/sussex-chair-armchair-webb-philip-speakman/

https://www.curtisbuchananchairmaker.com/store/p31/Full-Scale_Drawings%3A_How_to_Make_a_democratic_Side_Chair.html

Sussex S.E.E Chair fabrication workshop.
Image: Nick Gant, 2023

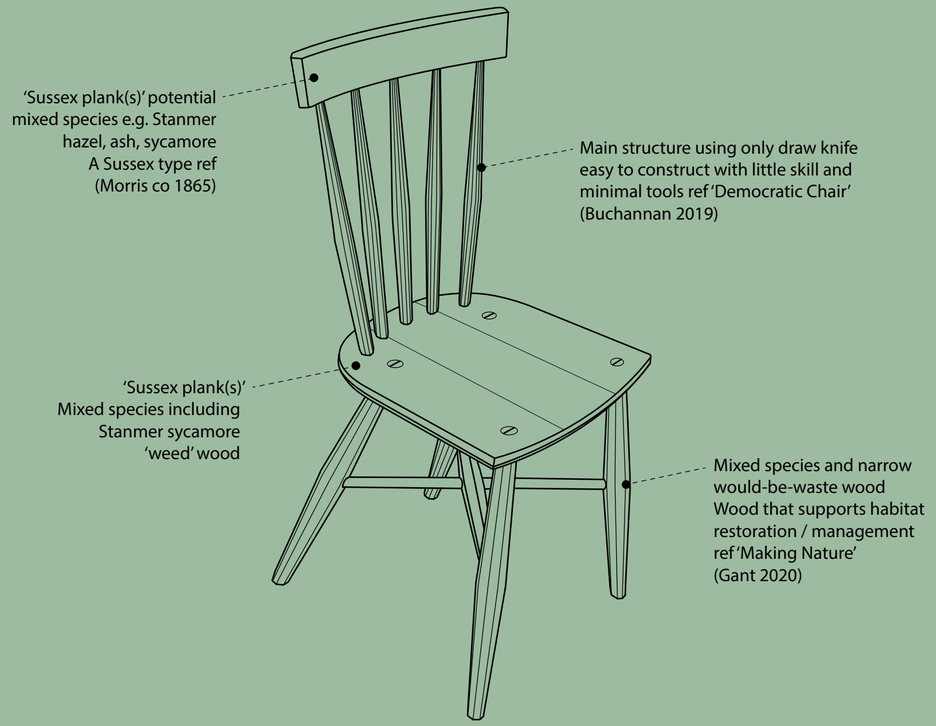
Standing timber with Ash dieback.
Image: Nick Gant, 2023

What would be waste weed wood.
Image: Nick Gant, 2023

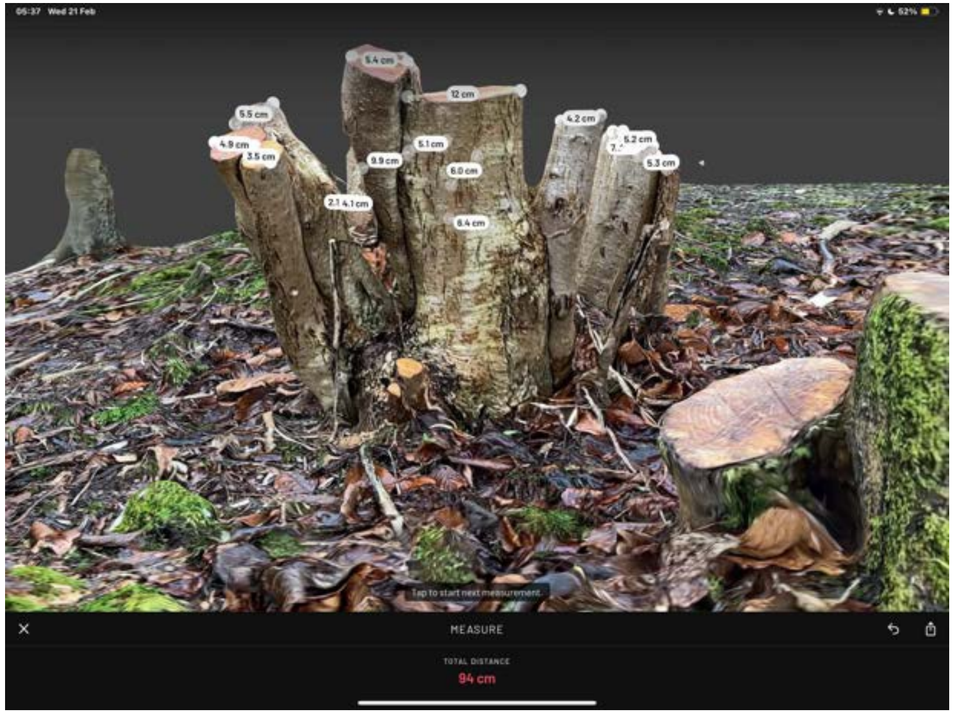
Chipboard made from waste from door prototype waste and pine resin.
Image: Nick Gant, 2023

Sussex S.E.E Chair fabrication process.
Image: Nick Gant, 2023

S.E.E chair fabrication.
Image: Nick Gant, 2024


'Sussex plank(s)' potential
mixed species e.g. Stanmer
hazel, ash, sycamore
A Sussex type ref
(Morris co 1865)
Main structure using only draw knife
easy to construct with little skill and
minimal tools ref 'Democratic Chair'
(Buchannan 2019)
'Sussex plank(s)'
Mixed species including
Stanmer sycamore
'weed' wood
Mixed species and narrow
would-be-waste wood
Wood that supports habitat
restoration / management
ref 'Making Nature'
(Gant 2020)

S.E.E chair V3.
Image: Nick Gant, 2024



3D scan of coppiced stool using iPhone.
Image: Nick Gant, 2024

to the context provided by the low value and otherwise waste, but large volumes of wood and notions of local socially-economic and environmental value through production.

Lidar measurement and monitoring

The team used ubiquitous, accessible phone and iPad technology to do quick 3d scans of coppice stools that can enable detailed record keeping and quick measurements and yield estimates as well as provide digital experiences of the resource site and landscape (see augmented experiences).

Logosol kiln drying experiment

Our experience in using the relatively inexpensive Logosol kiln were noted as advantages and disadvantages – and compared with airdrying Kiln drying produces a controlled environment (temperature, humidity, steam levels) to dry batches of timber. All constituent pieces dried to exact suitable moisture content. Kiln drying can remove 9/10th of moisture, decreasing fungal growth and killing insects and larvae. The fan for the forced air movement must pass over the board surfaces in all areas of the kiln. It was found that the stacking of the wood as it goes into the kiln is essential and that an experience operator is key.

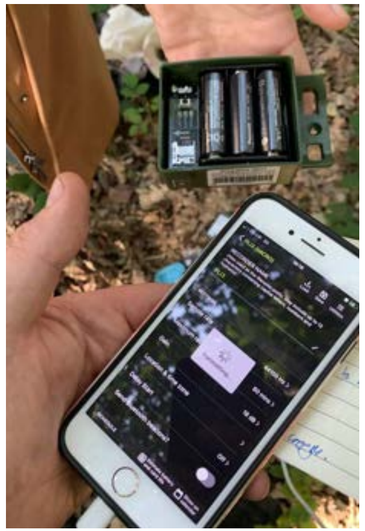
Findings:

	Air Seasoning to 20%	Then kiln dry to 6%	Kiln drying only
Oak	240-360 days	6 – 16 days	20 – 30 days
Beech	150 – 200 days	5 – 8 days	12 – 15 days
Spruces	45 – 90 days	3 – 5 days	4 – 7 days

- Air-drying timber is at the mercy of the elements and with increased rainfall in autumn, winter and spring months this will extend drying times.
- Kiln drying is costly – increasing power costs.
- Logosol requires manual administration, constant checking of the moisture content and changing to the next schedule stages as necessary – time consuming.
- Free Water = Liquid water in cavities within the timber
- Bound Water = Water within the structure of cell walls within the timber.
- There are huge variations in moisture content between species and heartwood and sapwood. This also varies with the time of year that the timber is felled. Same species only should be loaded into the Logosol for optimum results.

Pilot: acoustic monitoring for woodland management

In order to explore potential cost-effective methods for small-scale woodland management by non-experts, we worked with researchers at the University of



Acoustic monitoring pilot installation.
Image: Nick Gant, 2023

Sussex to explore passive acoustic monitoring (PAM). Having been pioneered in marine environments, PAM is gaining popularity as an ecological monitoring tool because it is non-invasive, applicable across (vocalising) taxa (including nocturnal species) and relatively cost-effective.

Methodology

Data collection: To test whether affordable acoustic sensors could be used to detect changes in woodland biodiversity under different woodland management regimes, a paired replicate design was adopted. In each of two woodlands in Sussex (matched for age, weather conditions, altitude and approximate topography and management history), control and intervention sites were selected. Intervention sites had planned extraction/ thinning in winter 2023/2024.

Three acoustic sensors were set up at each site to enable future analysis of inter-site variability. Each was affixed to a tree with non-invasive methods. Each was programmed to record for 1 minute of audio every 15 min around the clock, following UK best practice UK guidelines[1], [2]. Unit cost inc batteries and SD cards £250 inc vat.

Data analysis: The resulting audio data can be analysed in two ways. Under a bioacoustic method, to gain estimates of avian species presence and approximations of abundance, AI applications such as BirdNET [3], [4] can be used. Accuracy for Sussex Woodlands has yet to be determined, but this technology is developing rapidly and will increase in accuracy as more and more users adopt digital species ID apps that grow the databases.

Under an Ecoacoustic approach, to gain insight into changes in community dynamics and the overall soundscape (including unidentified species, dense dawn choruses, invertebrate and weather patterns) acoustic indices can be calculated. The University of Sussex is developing a dashboard to enable rapid visualisation of long-term acoustic monitoring.

Challenges and mitigation strategies

Availability: Global chip shortages in 2022/2023 significantly delayed the start of the field season and highlight the downside of technological solutions.

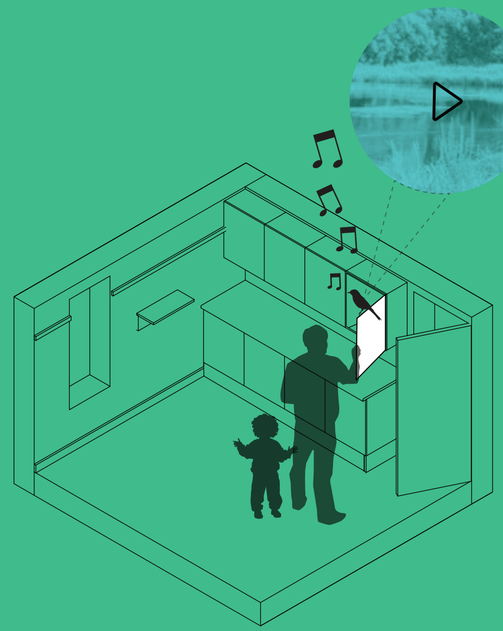
Accessibility: One team found the interface challenging and were not able to complete the data collection. This is an important insight. However, the field is moving fast and products that carry out species ID in situ and send species lists over wireless networks may prove useful in this market (e.g.https://www.birdweather.com/).

Reliability: Variations in battery life meant an average 10% data loss per month. This can be mitigated by changing batteries more frequently.

Augmenting experiences

The project revealed emerging opportunities to develop a level of interface through the prototype products that could use connective technologies and conscious development of the material language and communicative capacity of the products. This could reconcile aspects associated with engaging landowners with the social and wildlife value and provenance status of local resources with owners not necessarily

1. Each recorded at a sample rate of 44,100Hz, covering the range of human hearing, all avian, mammal and significant invertebrate vocalisations. Set to 18dB gain at 16 bit.
2. Metcalf, O., Abrahams, C., Ashington, B., Baker, E., Bradfer-Lawrence, T., Browning, E., Carruthers-Jones, J., Darby, J., Dick, J., Eldridge, A. and Elliott, D., 2023. Good practice guidelines for long-term ecoacoustic monitoring in the UK.
3. https://birdnet.cornell.edu/
4. Kahl, S., Wood, C.M., Eibl, M. and Klinck, H., 2021. BirdNET: A deep learning solution for avian diversity monitoring. Ecological Informatics, 61, p.101236.



wanting to encourage visitors to private woods and potential limited mobility and accessibility to social housing users. Moreover, it could help facilitate better material and eco-literacy within the user community and elevate the values associated with local resource models and products. Examples include live-streaming woodland birdsong from the wood where resources are derived generating direct links to the (benefitting) landscape and deliberate use of wood with more natural aesthetics combined with 3D digital experiences that augment the products with animal, bird and plant species or provide a virtual woodland rug / carpet.

Insights

Availability of hardware: Global chip shortages in 2022/2023 significantly delayed the start of the field season and highlight the downside of technological solutions.

Accessibility and ease of use: One team found the device challenging to use due to the need to pair with a smartphone application and were not able to complete the data collection. This is an important insight for private woodland owners, as a moderately high level of technological competence is required.

Analysis: Currently data has to be collected from the devices and then analysed remotely to identify species present or overall acoustic community dynamics. These analyses would be achievable by ecologists with programming skills in Python, but not lay woodland owners. However, the field is moving fast and products that carry out species ID in situ and send species lists over wireless networks may prove useful in this market (e.g.https://www.birdweather.com/), although their fidelity is yet to be fully examined.

Reliability: Variations in battery life meant an average 10% data loss per month. This can be mitigated by changing batteries more frequently. The reliability of future AI-driven products remains to be established but is improving rapidly.

Recommendations: Passive Acoustic Monitoring is developing rapidly and offers a cost-effective solution for long term monitoring of avian species presence and diversity. Next steps would be to i) ascertain optimal sampling density ii) establish sampling regularity (e.g. breeding season only vs year-round) and iii) compare emerging fully automated products with parameterisable analysis methods off-line. Comparisons with human accuracy (eg via point count) are favourable; this approach merits serious consideration for monitoring of small woodlands.

Chapter six:

- Key Findings
- and
- What Next

Overall, the project has evolved due to some of the initial assumptions either being incorrect or misplaced. A common misconception was that the forestry supply chain is in a ready state to gear up to something if there was the right incentive, however this is simply not the case and has been echoed by other studies into local timber. If the Forestry Commission, DEFRA and the Department for Business & Trade would like UK timber (Indigenous or new species) to have a greater role in construction and the UK economy, it needs to engage more in long term planning and less in wishful short-term fixes.

This said, this project did allow us to see the potential opportunities for Sussex Timber. These are:

- It would be possible to create a large 'commodity bank' of hardwood from unmanaged woodland if it was planned in good time – instead of the just in time business model. This commodity bank could act as a long-term wood resource for joiners and be the platform for the Sussex Timber brand to establish itself.

- Planed Sussex Timber could be competitive to hardwood imports – including America Oak.

- Timber production and improved biodiversity can go hand in hand and if these additional societal benefits were given a value, then Sussex Timber based products can potentially be competitive in the harshest of commercial environments.

- If a Sussex Timber top-up grant was introduced, then social housing could act as a starter market to drive the increased use of Sussex Timber; in the same way Government offers top-up grants to social landlords to improve the energy efficiency of people's homes.

- Standardisation, common language and transparency will improve efficiency. The creation of a 'Sussex Plank' could help to significantly reduce the handling costs as no matter what the species, timber would always be felled and milled to the same dimensions making it easier for millers to produce and stockpile streamlined competitive timber at volume. When dealing with timber it is sticking to simple and a short list of units e.g. metric tonnes, and having an open platform where the supply chain has full visibility on the costs will allow competitiveness to control pricing as opposed to it being a 'who you know' approach.

The following sections go into more detail, but Sussex Timber could have a future if there was a willingness to invest.

The state of our wood

The project was developed on policy documents and industry commentary that suggested that there is usable timber currently standing in woodland, which will likely be felled as part of ongoing woodland management activities. The assumption being that this resource could be better utilised for a range of applications within sustainable local housing, for a range of benefits. Collective first-hand experience, literature, and stakeholder insight and feedback demonstrates that the current situation is complex, with many factors hampering the formation of a coherent supply chain for small-scale woodland products, with the underlying concern that 'we need to grow better wood'. A significant limitation for the project was the lack of transparency of woodland management plan data, as without this it is not possible to test assumptions of a commercial Sussex Timber business model and adapt to much variability in supply. Despite this we have re-evaluated some of the objectives and approach and are able to provide valuable insights.

Woodland is being presented as a key mitigator of climate related emissions – literature suggests that older stands, coppicing, and hardwood and softwood species need to form part of an effective mix of timber resources, and the greater use of diverse timber products will be necessary to realise these ambitions [1]. Despite such positive messaging and potential contribution to Net Zero targets that should bolster longer-term coordination and cooperation in the sector, the team found there to be very limited exchange of data and knowledge, and collaboration between relevant actors in the current supply chain, limiting the potential for it to meet the demand and requirements within the social housing sector.

Prototypes

The team developed a range of prototypes that included focused investment in the development of a range of hardwood kitchen doors. These demonstrated that a multi-species approach was possible and could make for desirable products – the value of which may be realised when presented alongside accompanying resourcing narratives associated with their provenance and role within local social, economic, and environmental value chains. These we trailed using a range of integrated technology solutions. There is a potential market, or at least market value in products where such metrics are robustly evidenced. Further research is needed to determine the viability of providing reliable and meaningful information to customers and users, as well as the potential impacts and implications. Other prototypes included softwood (pine) skirting boards, and a currently speculative hardwood worktop, that utilises some of the waste generated through the production of hardwood products. Versions of a Sussex S.E.E Chair has demonstrated the direct use of low-grade timber prevalent after storms and unmanaged woods. Each prototype embodies principles and aesthetic sensibilities that are relevant, authentic and (therefore) potentially valuable – but they will likely require alternate costing and value models and potential cross subsidies to be 'competitive'.

Cost model and value

As referenced in the prototype section, a comprehensive cost-model was produced to understand what the key cost components of the construction products were and within this where were the costs the highest so that we could focus on making the product as cost-effective as possible. This is based on best availability of data and better and / or different data may enhance or provide more specific, relevant outcomes.

The four key cost areas are:

1. Extracting and purchasing the raw green timber
2. Milling the green timber into the required sawn dimensions

[1] Burton, V., Moseley, D., Brown, C., Metzger, M. J., & Bellamy, P. (2018). Reviewing the evidence base for the effects of woodland expansion on biodiversity and ecosystem services in the United Kingdom. *Forest Ecology and Management, 430,* 366-379.

3. Transporting the timber to and from the mill
4. Joinery – the skilled person making the product from sawn wood

Appendix XX explains the cost model and includes copies of outcomes with selected inputs.

Key points from the cost model are:

- The raw material (i.e. green timber) has very little impact on the overall cost of a finished product so a higher price could be paid to landowners to incentivise them to manage and farm hardwood.

- It could be possible to produce hardwood timber that is as commercially competitive as American Oak and tropical forest species.

- The highest costs are producing the finished product i.e. joinery, and overall the products were too expensive for social housing.

- Even though the final cost could be too expensive for social housing the University of Brighton has created a design that is cost effective and efficient for a hardwood door and as a result has the potential to be competitive on the private market i.e. kitchen upgrade companies.

- Simpler products like skirting boards have the best chance to succeed in social housing as they do not require a specialist joiner and there could be with further cost refinement and negotiation with the supply chain.

- Non-cost benefits are hard to sign up to when budget is limited so if Sussex Timber is to succeed as a brand it may require some upfront subsidy to try and get it on a level playing field

The Forestry Commission timber conversion factors underpinned this model.

The financial 'cost' of products going into social housing is an obvious concern – The project design team engaged with the need to be highly attune to how to minimise cost and the prototypes considered this in detail at every stage. Products currently used in social housing include MDF skirting boards and kitchen cupboard doors with laminate coatings of various type made using processes and source material that are broadly incompatible with the notion of a locally sourced, woodland as a resource ambition or aspiration. It is therefore evidently not a *like-for-like* comparison but more an establishment of a model that seeks to actually test assumptions about the *true viability* of local wood products.

If minimal, financial cost is the primary factor or metric then this exercise has exorcised the assumption that local timber products can compete on price alone – it cannot. On timber alone comparing like-for-like the cost model suggest circa £20 per 'Sussex Plank' and major UK timber retailer is quoting circa £19 for a similar sized American Oak. There are multiple metrics associated with sustainable development levelled at all sectors and there are inevitably different kinds of 'cost' that timber products may offer 'value' to. In fact, our social housing suppliers do not currently stock / supply UK supplied hardwood kitchen doors or any regional products and therefore a more comparable

https://www.kitchendoorworkshop.co.uk/kitchen-doors/

https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/sources/timber-2/conversion-factors/

https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/glossary/

cost evaluation cannot be made. Initial comparative and projected costings for the Sussex plank suggest that in relation to overall local authority expenditure budgets across a 30-year period the additional expense of specifying locally sourced timber may be very small (circa 0.5%) – however, the significance of opportunities to work towards multiple metrics for sustainable development, at regional scale may represent significant 'value' for money. If we want to enact these wider values a 'top-fund' could support the delivery of the social, environmental and (local) economic benefits.

The model allowed the project team to use the inputs from the University of Brighton design team and Woodland Enterprises Ltd to establish some baseline costings, but the model also allowed stress testing some of the commercial data and assumptions to see how the final price and viability was affected.

All costs exclude VAT and profit so these would need to be added in any future revisions.

Total value accounting in product development

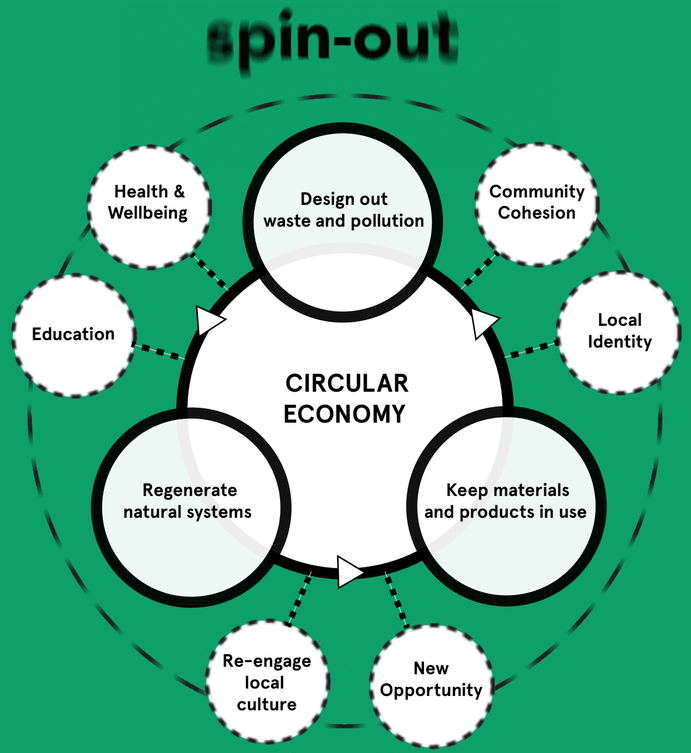
With each product we encountered the need and opportunity to consider for 'total value accounting' as what may in principle be 'cheaper' financially may have other forms of negative 'cost' within the supply chain. Locally sourced timber could enact models for more *virtuous circular economies* within the region that seek to acknowledge the contribution woodland, resource and product management can facilitate against a range of potential benefits within a circular economy model. Borrowing from concepts of Total Societal Accounting there are evident social 'values' that could be delivered through the use of a local sustainable, timber supply chain and products. Our prototypes have indicated need for collaboration to overcome the many inhibiting factors – but this can lead to higher levels of value in developing 'multi-local' systems for social, cultural, environmental, and economic sustainability and improvement enacted by developing the current model(s). Our ledger concept that forms a communication channel through the products helps to ensure users are included in the narratives associated with their everyday products. These integrate messaging within the products themselves about wider positive values enabled through local resourcing (see augmented experiences). *Tree-to-table* value mapping could be further enhanced through 'well-making' initiatives with charitable and social value partners engaged in making as a means to improve mental health and well-being in vulnerable groups (for example). Robust scientific underpinnings for claims associated with carbon reduction, biodiversity benefit as well as social values within this (local) context all need greater scrutiny and modelling.

Collaboration:
Issues and opportunities associated with sustainable development often require significant collaboration to change the 'status quo' - The development of even simple timber supply chains that can realistically utilise 'what's actually out there' require greater collaboration. Our experiences concur with other commentators that "levels of collaboration are low and use predominantly horizontal mechanisms, focusing on information sharing rather than joint operation. This is despite a positive market opportunity and a growth aspiration".

Gant, N. 2020, https://community21.org/casestudies/18772_virtuous_circular_economies

Retolaza, J. L., San-Jose, L., & Ruíz-Roqueñi, M. (2016). *Social accounting for sustainability: Monetizing the social value* (pp. 53-55). Cham: Springer.

Greenslade, C., Murphy, R. J., Morse, S., & Griffiths, G. H. (2021). Breaking Down the Barriers: Exploring the Role of Collaboration in the Forestry Sector of South East England. *Sustainability, 13*(18), 10258.



Storage:
The project demonstrated a need for locally centralised storage and drying facilities that could stockpile and hedge timber investment for use in the social housing market. These would support optimisation of mixed species stocks of 'planks' that can translate into the range of products, helping to diversify the market opportunity away from more polarised low value biomass / firewood and higher graded lumber inaccessible for social housing procurement. The lack of movement in the industry may require new inward investment and / or social sector to develop demonstrators to disrupt the current channels for accessing timber today.

Biodiversity drivers:
Nature preservation and improvement appears to be a multi stakeholder concern that may present an opportunity to unite interests of landowners (public and private), social housing suppliers and service users. Landowners suggest nature is a key driver for large public sector and privately owned estates as well as with smaller private owners – Our social housing supply chain can help 'wipe the face' (economically) of nature-first operations. Moreover if our initiatives that support land owner understanding and engagement with timber development processes that champion 'making nature' and the growth of 'productive habitats' this could motivate better management practices through a mutual value chain. This may counteract / unlock limiting factors and perceptions such as *moat-making* around properties towards felling as part of a tangible, well mediated biodiversity gain. New opportunities could concur with the principle (if not the specific means, metrics and measures) for policy initiatives such as Biodiversity Net-Gain (BNG) and Local Nature Recovery Strategies (LNRS) generated through utilisation of nature prioritising or benefiting supply chain processes and design. Presumptions re what social housing tenants would aspire to and engage with need further research but we are confident the current prototypes represent a quality outcome, with valuable narratives attached. We have modelled initial devices for connecting users to the landscape through digital and physical material interactions that manifest through an *ecology-of-things* that can enhance experience, understanding and appreciation of the stuff that surrounds them.

Data:
A sustainable production process feeding reliable resource stocks will require more accessible data related to (for example):

- Access to possible yields associated with felling licences when approved.
- An open trading system where costs are visible, in particular the price of hardwood which despite being traded in reasonable volumes has no commercial data unless you talk to specialties brokers.
- Open and collaborative model that uses mapping and management software could support a localised market and management system useful for the supply chain.
- Development of practical, applied ecological data to underpin value systems associated with nature-recovery / benefit through timber supply chain management.
- Social housing user assessment evaluation

https://community21.org/partners/makingnature/

Greenslade, C., Murphy, R., Morse, S., & Griffiths, G. H. (2020). Seeing the Wood for the Trees: Factors Limiting Woodland Management and Sustainable Local Wood Product Use in the South East of England. *Sustainability, 12*(23), 10071.

What next

- Invite stakeholders to review prototypes and ‘show home’ social house set up at The Waste House University of Brighton to disseminate outcomes and see what further progress and initiatives can be developed from the project and its findings.

- Seek opportunities to test assumptions about social housing users’ aspirations and preferences for more regenerative and localised materials, objects and spaces.

- Develop and test opportunities for an actual workable woodland cooperative based on the production of commercial timber, recreation space, ecosystems and managed woodlands.

- Develop methods for woodland owners to use accessible technology for wildlife monitoring and evaluation in support of motivated wood management for nature (and timber). This requires further scientific protocols and demonstrators and design solutions to support authentic data development alongside rewarding and user-friendly interfaces.

- Further develop collaboration with Forestry Commission Grant recipients and stakeholders in the development of more sustainable supplies of furniture+ products that integrate some of the alternate approaches and initiatives developed through the project – including development of multi-local, regional hubs for supply, storage, standardisations (plank approach) and socially valuable supply and manufacture, benefit branding and biodiversity connectivity.

- Assess manufacturing options that develop TVA and making-well opportunities for local charities and new economic and ‘making-well’ initiatives that can unlock new ‘branding’, social value and identity aspects through partner organisations.
- Explore opportunities and co-design of pilot wood-hub storage and drying model with collaborative suppliers.

- Further explore interest in local social service and charitable and industrial sectors of regional design types and collaborations in the manufacture of branded regional product types that embody a range of social, environmental, cultural and economic opportunities.

Acknowledgements

We want to thank the many landowners, business and mill owners and managers who took time to talk to us to critically and candidly, explore ideas and helped in addressing our challenge. We would especially like to thank the extended project team and wider interest from staff at the University of Brighton including James McAdam, Luna Stephens, Duncan Baker-Brown, Jim Wilson, Tanya Dean, Jem Ryan, Kerenza Bloomfield, Jason Moserri with thanks to the wood department technical team for their input and patience including Malcolm Jordan and Evan Reinhold.

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A note on the footnotes

The footnote numbers in this report are typeset in artist Katie Holten’s *Irish Trees* typeface. Each number is represented by the number of leaves present on a tree branch. Hotlen’s *Irish Tree Alphabet* project finds roots and inspiration in Ogham, a medieval alphabet used primarily to write the early Irish language, in which the characters or letters were called feda ‘trees’, or nin ‘forking branches’ due to their shape.

Luna Stephens, Graphic Designer