Towards Ecological Citizenship in social housing through Making Nature Principles and an Ecology-of-Things

Dr Nick Gant, James Tooze and **Alice Eldridge**

Keywords: Regenerative, Making, Nature, Biodiversity, Housing

Introduction

This research was undertaken through an inter-disciplinary and cross-sectorial collaboration for practical insight and understanding between arts and science researchers, local government and industry stakeholders and land managers. This paper documents part of a process of funded research that seeks to apply *Making Nature Principles* (Gant, 2020) to the creation of regenerative objects and products for social housing in Sussex, UK. The products are developed to provide sustainable alternatives in a local authority-housing sector facing policy demands for net-zero targets, Local Nature Recovery Strategy (LNRS) and Biodiversity Net Gain (BNG) whilst also needing to ensure cost effective and practical value to diverse range of citizens and stakeholders. We approach the research with the hypothesis that Sussex (a highly wooded county) could / should be able to contribute to sustainable, local timber resources for social housing with potential cascading benefits for society, economy and the environment.

The research also sits within wider, emergent and proliferating notions that craft has its roots in nature (Niedderer & Townsend 2022), seeing designers and makers as having agency as 'cultivators', co-working with natural systems (Collet 2020). Researchers suggest design and craft being in *partnership* with nature (Fletcher et al 2019) with an 'essential' need for collaboration between science and design, going beyond *bio-mimicry* as means to form *new hybrid typologies*. It is asserted that *regenerative* and *circular design* can benefit nature (Ellen McArthur Foundation 2016), *bio-design* (Myers 2012) and *'nature-first'* perspectives (Cox 2019) can contribute to both human productivity and nature recovery as part of meeting *sustainable development goals e.g.* UNSDG 12 - Ensure sustainable consumption and production patterns. UNSDG 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. Making Nature Principles (MNP) attempt to support greater *material literacy* (Gant 2017) through engagement and approaches that seek to ensure making and nature associations are more directly defined by makers, in collaboration with other disciplines to enact the profound change to design practice and theory that is required (Fletcher et al 2019).

Ecological science calls for "a place-based, use-inspired science of understanding and improving the dynamic relationship between ecosystem services and human well-being with spatially explicit methods" (Gibbons 2018, Wu 2013). In social housing currently, circular economy innovation is limited to technical advances mostly weighted to waste management (Marchesi & Tweed 2021). Our work responds to calls for greater engagement with socially focused, multi-local innovation (Srivarathan 2023, Manzini 2009). It responds to calls for definitive methodological approaches and sharable metrics that can help to measure success in regenerative housing development (Hes & Bush 2018) and progress knowledge in the application of landscape monitoring approaches and technologies that support 'eco-space' accessibility and the usability of ecological science (Brunbjerg et al 2017). Therefore our research design aims to address both the need for practical regenerative approaches in real communities whilst seeking methodological insights for *making research* that utilises accessible, applied ecology relevant to the maker community.

A more speculative component explored in the *Wild House* project aims to use networked creative technologies to augment natural products with audio and visual information in the

creation of an Ecology-of-Things. Using sensory networks to playfully connect between products and the originating habitats of the materials they are derived from. Connecting people and nature-based making via technology, may seem jarring, but has a solid evidence-base and chimes with our location in an urban UNESCO Biosphere – a designation that challenges experimentation in ways to live harmoniously with nature. As prescient environmentalist Rachel Carson wrote: Yet in the UK urban wildlife is so depleted that people lack opportunity, leading to nature deprivation in 1 in 5 households in the UK (Friends of the Earth). At the same time, technology is ubiquitous and presents itself as an enabling tool for reconnection. Nature apps such as iNaturalist, Merlin, PlantSpotter and eBIRD educate, inspire and reconnect by bolstering receptivity through supporting identification of species and gamification of sightings. Studies show that audio-visual 'nature surrogacies' confer some of the advantages of real-world messy nature, conferring reductions in psychological and physiological and self-report markers of stress and anxiety (Meuwese et al 2021; Aldoh et al 2024), improvements in self-reported stress, anxiety, happiness (Palanica 2019) and sociality (van Houwelingen-Snippe et al 2020). To our knowledge, the potential bolstering ecological literacy and nature connection via augmented products is novel terrain.

Key research questions relative to the research include:

- Can woodlands and timber products help deliver more sustainable supply chains and products for social housing in Sussex?
- How might these products be designed to mediate greater material literacy in users?
- How might these products be augmented with creative technologies to enhance greater ecological literacy, engagement or connection?
- What research and development processes can support hybrid arts / science collaborations for more robust research of the maker / ecology relationship?

Methodology: Methods, stages, and techniques

Micro - approaches engage with the idiosyncrasies of local landscape, social, cultural and material contexts and are intended to be repeatable by makers (with limited ecological knowledge). And fundamentally this must also be practically purposed to deliver outcomes for local authority partners and social housing users in the locality

Macro – methods in support of multi-localism consider a regional network of necessary connectivity and collaboration across the geography - stakeholder engagement and literature reviews acknowledge that local concerns and insights will often have regional and wider relevance within a healthy mosaic of diverse places and habitats for people and nature

Meta – research methods embrace and observe the role of *propositional* research (Walker 2013) and creation of *in-forming things* (Gant 2024) and the agency of making as a distinct methodological approach -this being where theory and practice are entwined, where making embodies the theoretical hypothesis within the practical apparatus of research. Resulting objects serve as both manifestations of enquiry and proposed 'solution' within a format relevant to the context and culture where the research is intended.

Stage 1: Mapping and surveying

1.1 Timber mills were mapped and applied to a wiki-GIS digital map (Knowne & Gant, 2023). It maps mills as potential hubs for multi-local, *knots-in-the-network* of distributed resource and possible manufacture activity – The emerging map demonstrates relatively evenly geographic distribution of mills regionally.

1.2 The project also approach demanded engagement with the systemic issues associated with the complexity of woodland resourcing - giga-mapping woodland resources and the associated social and cultural aspects impacting their accessibility and their natural and geographic relevance and provenance. An initial giga-map was devised following informal interactions between stakeholders that merged hypothetical expectations and evidence expressed through academic and policy literature and established resource management methods for surveying woodlands.

1.3 'Sight Surveys' and ecosystem drawings and collages (Gant and Luffiansyah 2022) enabled primary research engagements with our subject woodlands enabling makers (as well as ecologists and land managers) to really notice the environment and draw connections between different aspects of the resource landscape, formal woodland management plans including the removal of resources and any associated potentials for habitat improvement.

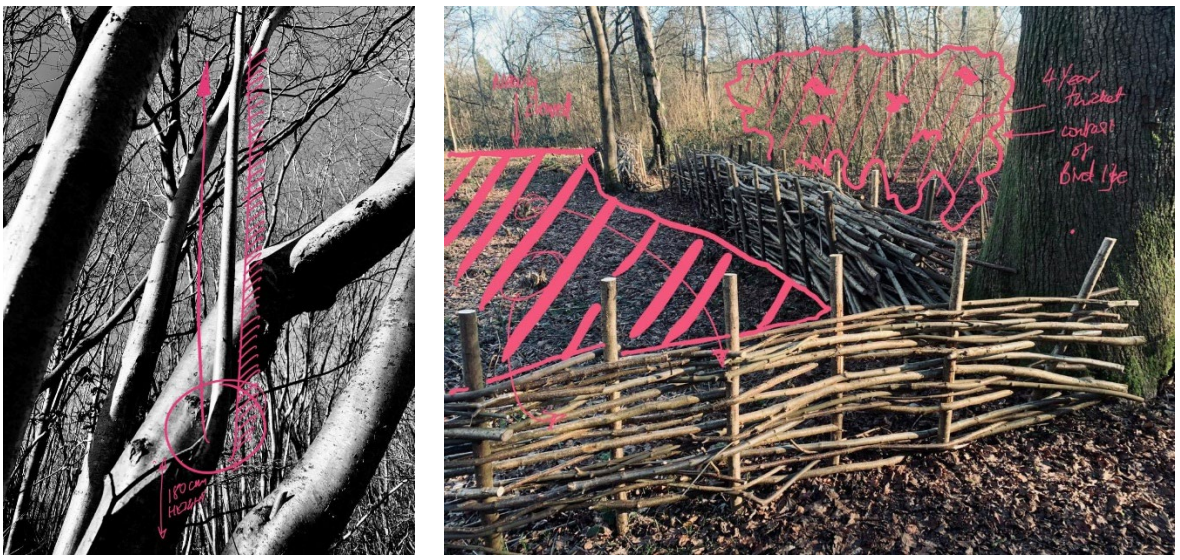

Fig 1. Nick Gant (no date) 'Sight-survey' identifying the lack of number and poor health of younger, straight / typically usable stems in the unmanaged woodland and variation in habitat / composition and variance of bird species of different stages of recently managed / coppiced areas.

1.4 Woodland acoustic monitoring

Fig 2. Nick Gant (no date) Monitoring variations in soundscapes between sites under differing woodland management strategies. Woodland management map (left) and autonomous recording unit (right)..

The Woods to Outcomes project provided space to investigate affordable methods to investigate biodiversity impacts within *Making Nature*. Whilst Biodiversity Net gain considers habitat alone, we know that birds and butterflies, along with other species are omitted. Acoustic monitoring is gaining popularity in the space as a citizen-science friendly approach to assessing changes in bird communities (for example using BirdNET) as well as whole soundscapes (see Sueur and Farina et al).

Within the constraints of practicality and funding these approaches seek to combine a range of disciplinary expertise and experience – This is undertaken as a means to reconcile the anxieties that 'non experts' (e.g. makers) have expressed in terms of the intimidating weight of ecological scientific knowledge when considering the adaptation and augmentation of their knowledge when trying to unlock progress towards genuinely regenerative actions (Gant and Luffiansyah, 2022). This whilst also acknowledging that ecological science itself needs to be applied and applicable to situations and communities where it is useful and can contribute to sustainable development.

Stage 2: Making prototypes

2.2. Kitchen Doors

To further explore how timber products from local woodlands can help deliver more sustainable supply chains and products for social housing in Sussex, prototype kitchen cabinet doors were designed and made. These have been installed in the Waste House, as

part of the *Wild House* project to test their desirability, dimensional stability, and durability. Kitchen doors were selected as the local authority has a schedule of works that includes the need to install circa 300 kitchens a year (approx. 3000 doors) for the next 25 years in council managed properties. In addition, many hundreds of metres of skirting board, architrave, door frames and other furniture, fittings and equipment products. An assumption in the project team was that with a local authority as the principal customer in the supply chain, it offers the opportunity to take a longer-term and strategic approach, better connecting procurement with other responsibilities and targets the authority has. By sourcing from local woodland owners, this could encourage investment and longer-term planning that supports local woodland, mills, joiners, and others in the supply chain. The local authority has a stake in the viability of rural economies, as well as the resilience and biodiversity of the natural landscape. This longer-term approach fits well with woodland managers, who too need to take a medium to long-term view, both as custodians of the land they oversee but also of the economic viability of the stock they manage.

An example of how such longer-term thinking could impact the supply chain is the creation of a standard dimension (width and thickness) plank of sawn timber that could allow smaller woodland owners to better estimate the value of the timber stock they hold. The notion of this 'Sussex plank' came from conversations with mills, timber suppliers and others in the timber supply chain that posited that if a range of products were designed to utilise this plank size, especially for those with longer-term procurement plans the predictable demand in the future would encourage planting and management of suitable tree species and confidence of a financial yield of greater value than that of biomass. The design of the doors were informed using a standard plank, considering factors such as differing shrinkage and distortion rates as different timber species dried out. 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 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.

For the prototypes Sweet Chestnut, Ash and Oak were selected as they are key and fairly abundant hardwoods in the South East of the UK, with an established supply chain, and will continue to be important unless adversely affected by climate change, new pests or disease. In fact, predicted scenarios for climate warming over the 21st century indicate that conditions favouring chestnut will be enhanced, and in particular for the South East. Over the next 50 years, Sweet Chestnut has the greatest potential for growth and productivity of any broadleaf tree in the UK (Forestry Commission, 2014). The doors, in addition to ascertaining

their financial viability as products, were created to explore whether a responsive and multi-species approach could be taken to material sourcing that would be reflective of more (bio)diverse and resilient woodlands.

Fig 3. Nick Gant (no date) Multi-species kitchen cupboard (James Tooze and Nick Gant) door embracing healthier more diverse woodlands and utilising the 'Sussex Plank' standardisation of timber resources to increase affordability and efficiency of resources.

2.3. Sussex S.E.E chair

Our featured case study uses timber locally defined as 'weed-wood' relative to the restoration of formerly unmanaged woodlands, some of which have relative monocultures of overgrown species that colonised following the great 1986 storm and is seen as potentially representative of many under managed woodlands in Sussex (Gant et al, 2024).

The Sussex S.E.E chair represents an open design challenge to (re)engage with what was The William Morris company's most successful chair, which shares a geographic interest as well as other intrinsic principles and purposes. The chairs developed (so far) in this project approach the physicality and processing of the object through nuanced perspectives relative to proposed benefits to Society, Economy and Environment. Borrowing from Elkington's notion of the *triple-bottom-line* (Elkington,1999) iterations of the Sussex S.E.E chair dial in aspects of social (S), environmental (E) and economic (E) value manifest through the making process. This embodying process affords opportunities to develop a user / object interaction mediated through a defined material language within an everyday product.

Fig 4. Nick Gant (no date) Sussex S.E.E chair v1.1 and v1.2 (Nick Gant and Jason Mosseri).

The team included design and craft academics and students and a respected traditional chair maker. We explored chair types where the underlying design / making direction is conceived through the structuring of the making principles and in response to the possibility of how makers of differing skill levels may access engage. Different interactions combine primary inputs driven by the species and size of timber (considered of little or no value due to the lack of management). For example, Sycamore in particular, as a pioneer species (Szwagrzyk et al, 2018), is invasive and useful and provides a very flat-white finish. Hazel was left in with bark attached and by only using a draw knife, very basic versions of the chair are easy to access in terms of skill and use of abundant material felled at a size with little application - even for firewood. Unlike Morris' originals, our chairs are simpler in structure and refer to the kinds of construction and making principles similar to Curtis Buchanan's 'Democratic Chair' (Buchanan).

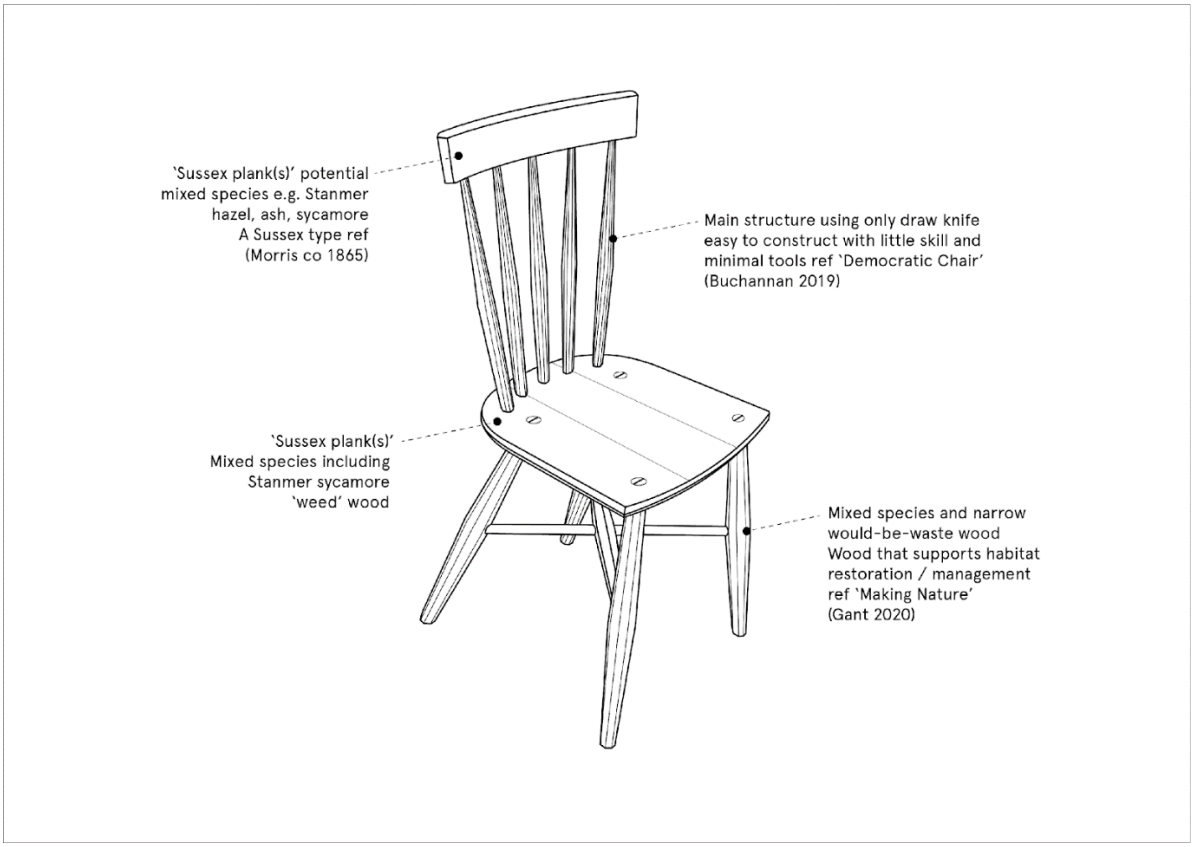

Fig 5. Nick Gant (no date) Critical framework of version 1.1 of Sussex S.E.E. chair (Nick Gant) composing visual / material and making language and using the easiest, most accessible making techniques for future production by charities that utilise making for health and well being.

2.3 Ecology of Things – this borrows from the established notion of Internet of Things (Ashton, 1999) where internet enabled or 'smart' objects and products are able to sense, interact and share information as part of a connected network. In our case objects that use digital and / or material interactions and communication media to highlight their part in a landscape resourcing and natural habitat eco-system. Example being our multi-species timber kitchen units that play sounds derived from sonic sensors that are in inaccessible natural environments this includes bird song from private woodlands where the timber resourcing is improving habitats for these species or augmented reality used to beam users into the resource woodland using the cupboard as a portal.

Fig 6. Nick Gant (no date) Multi-species kitchen cupboard uses augmented reality to beam users into the resourcing woodland via a panoramic video and binocular interface (Nick Gant and James McAdam).

Results: Key findings or expected results

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 technically possible with different configurations providing better results against shrinkage and movement. The mixed species approach could make for desirable products (following user testing) that are better reflective of the healthier, more diverse and resilient woodlands that we need within a sustainable, mosaic landscape. Moreover, the notion of a 'Sussex plank' was devised to reverse the *designer as specifier* orthodoxy in favour of mills developing standardised planks from a much broader range of species, with designs being versatile in accommodating this. The run, mix and range of materials are, in reality, unlikely to lead to much mixture within one door / kitchen but could become a desirable method for optimisation. The value of such products may also benefit from being presented as products alongside accompanying resourcing narratives associated with their provenance and role within local social, economic and environmental value chains. To this end we have generated integrated technologies that form an Ecology of Things (EoT). These provide material and immaterial, direct and indirect interactions with the landscape that may surface the connectivity between humans and other species mediated by the material things that surround us.

The Sussex S.E.E chair emerged out of a programmatic response to a set of both criteria defined by the context and more open aesthetic opportunities to explore what wilder-wood objects might look like and convey through the material language of the object. 'Wonky, weed, woods' in this case small diameter sycamore, hazel and ash provide specific starting points and outcomes with idiosyncrasies that we embrace and exploit, seeking to enhance their contribution and values through the object narrative. Versions of a Sussex S.E.E Chair have demonstrated the direct use of low-grade timber prevalent after storms and unmanaged woods. It is often left standing and / or extracted and left onsite or burned limiting the potential to improve and diversify habitats and the woodland health.

The state of our wood(s)

The project was developed on assumptions, policy documents and industry commentary that suggest that, in effect, there are woods out there nearby (in Sussex) and we should be using them in sustainable local housing for a range of reasons. Collective first hand experience, literature and stakeholder insight and feedback demonstrates that the situation is complex and in reality we need better woodland management to enable a coherent supply chain in the future. Woodland is being presented as a key mediator of climate related emissions – literature suggests that older stands, coppicing and hardwood as well as softwood species need to form part of an effective mix and the greater use of different timber products will be necessary to realise these ambitions (Burton et al, 2018). We were often frustrated by a lack of exchange of data and knowledge and of the collaboration that is necessary between actors to generate an efficient and productive supply chain at scale that will meet the multiple metrics for social housing. Mapping mills provided an overview of how their relatively even distribution throughout the region that might support multi-local hubs for storage and possibly manufacture of standardised products from simple skirting boards and in some case more complex products – however greater collaboration would be required to ensure optimisation of different timbers within the supply chain.

Value(s) accounting in product development.

Within the evident and obvious economic constraints associated with the delivery of products for social housing sector we developed a very detailed costing model - not detailed for this paper (Gant, et al, 2024). However with each product we encountered the need and opportunity to consider for value accounting as what may in principle be 'cheaper' financially may have other forms of 'cost' within the supply chain. Locally sourced timber could enact more *virtuous-circular-economies* (Gant, 2020) within the region that seek to acknowledge the contribution woodland, resource and product management can facilitate against a range of potential benefits. Engaging value(s) 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 models. A ledger concept that forms part of digital augmentation and communication channel delivered 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 research.

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 researcher's published assessment 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" (Greenslade, et al, 2020).

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.

Data

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

- the currency and efficacy of woodland management planning in the region and possible yields associated with felling licences when approved.
- 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

Biodiversity drivers

Nature preservation and improvement appears to be a multi stakeholder concern that may present an opportunity to unite interests of both public and private landowners, social housing suppliers and service users. Landowners suggest nature and biodiversity is presented as a key driver and aspiration 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-prioritising operations, particularly if it can (literally) *make the case* for products and resourcing models that have demonstrable and tangible, positive impacts on nature locally. 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' (Gant, 2022) this could, in turn, motivate better management practices through a mutual value chain. This may counteract and unlock limiting factors (Greenslade et al, 2020) and perceptions such as *moat-making* around private properties towards keenness for felling as part of 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 regarding 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 a 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 (Gant et al, 2024). Therefore through further research and testing can we lock-down this potential through the development of fully realised and marketable products that embody this complexity (?)

Discussion: Contribution and impact

Practical and speculative

The research has developed insights into the practical delivery of locally sourced timber products intended for social housing in Sussex and more emergent, speculative frameworks for research that are less tangible but are guiding the next phases of research. These are seen as mutually beneficial and interrelated in terms of developing understandings and meaningful connections throughout the supply chain - from the motivations to management more bio diverse landscapes through to the end-product / user interactions. Moreover we value the transformative act of making, and the made object, as a vehicle for both research and a key point of human and more-than-human connectivity and mediation. The criticality of the object transcends its practical purpose to embody a set of systemic issues and opportunities whilst attempting to mediate this complexity through the material language used in its 'making'.

Making research often provides methodological insight as a contribution and outcome in its own right. The project presents the making of objects as 'in-forming things' (Gant, 2024) - these typically integrate approach and insight, being both apparatus and artefact of research; they embody findings that delineate the direct nature-net-gain potentials of social housing products and ways in which this process might be enhanced through the material (and making) experience. We engage with the making of 'products' where the objectification of *research-through-making* ensures the practical apparatus of purposeful, practice-based-research also affords opportunities to deliver new insights into the wider social, cultural and environmental dynamic. Mixed method ecological and visual 'sight surveys' and acoustic monitoring of woodlands attempt to ascertain potential enhancements to nature as an integrated and user-centred approach to the development of an *ecology-of-things*. This

approach seeks to be deliberate in an attempt to map and define the interrelationship between the habitats of people as nature reconciled through everyday objects as a form of *Ecological Citizenship*. Moreover it places 'the maker' as the facilitator, custodian and curator within these connections. The Making Nature principles methodology applied attempt to make (literally and materially) direct correlations between specific and identifiable habitat improvement and biodiversity as a direct result of the making process. Moreover these interconnections are enhanced to reconcile the product users (in this case social housing tenants) and the landscape, flora and fauna to enact a tangible experience of co-existence mediated by materials. The research agenda now is to map the longer-term impact of the intervention – ecological surveys / on going sight surveys to increase maker engagement with the state of change enacted through the resourcing model. Other limitations of the research necessitate inviting stakeholders to review prototypes through a 'show home' social house set up at The Waste House University of Brighton - this to test assumptions about social housing users aspirations and preferences for more regenerative and localised materials, objects and spaces. We seek to further develop methods for woodland owners to use and benefit from accessible technology for wildlife monitoring and evaluation in support of motivated wood management for nature (and timber). This requires further hybrid scientific protocols, demonstrators and design solutions to support authentic data development alongside rewarding and user-friendly interfaces for engagement with research. Moreover we ultimately aim to curate and test opportunities to more explicitly promote the parallels between the *making of things* with *bio-diversity net gain* and to elevate the value of Making Nature Principles through EoT enabled Sussex S.E.E. Chairs that mediate this biodiversity connectivity. We hope to assess manufacturing options that develop opportunities for local charities and new economic and 'making-well' (Hackney et al, 2023) initiatives that can unlock new 'branding', social value and identity aspects through partner organisations. 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.

The research findings demonstrate the probability and practical implications of nature-based approaches to the making of social housing products and experiences. The resulting objects materialise hybrid ecological and generative making methods via a combination of material and digitally augmented objects, experiences and interfaces that reveal and embody the inter-connectivity of human, plant and animal ecology. These approaches and outcomes provide a basis for discussing notions of co-authorship in the creative, generative development of things: They are dictated by the 'nature-of-making' demonstrating and testing the application of Making Nature Methods and revealing insights into the ways in which wider challenges of sustainable development meet the practical reality of social and industrial sectors and the habitats of humans and other forms of nature.

Acknowledgments

This research is supported by funding from The British Council, Forestry Commission Innovation Grant, EPSRC / and Royal College of Art's Ecological Citizenship Fund and 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 especially thank Nick Adlam of Lewes and Eastbourne District Council and Bill Maynard and Frankie Nowne of Woodland Enterprise Ltd, Will Furse at Stanmer Park, the extended project team including (not exhaustive) Duncan Baker-Brown, Jason Moserri, James McAdam, Luna Stephens, Tanya Dean, Miles Hobden, Jeremy Ryan, Maureen Berg, Kerenza Bloomfield and Jim Wilson with thanks to the wood department at The University of Brighton and the technical team for their input and patience including Evan Reinhold, Craig Issac and Malcolm Jordan and wider interest from staff and students at the University of Brighton.

References:

Aldoh, A., Ungureanu, R., Popescu, S., Eldridge, A., Sandom, C.J. and Rae, C., 2023. How Does a Multi-Sensory Experience of Nature Interact With Wellbeing? Effects of Visual and Auditory Nature Presence on Affect.

Ashton, Kevin. "That 'internet of things' thing." *RFID journal* 22, no. 7 (2009): 97-114.

Blythe, R. and Stamm, M., 2017. Doctoral Training for Practitioners: ADAPTr (Architecture, Design and Art Practice Research) a European Commission Marie Curie Initial Training Network. In *Practice-Based Design Research* (No. 6, pp. 53-63). Bloomsbury Publishing.

Brunbjerg, A.K., Bruun, H.H., Moeslund, J.E., Sadler, J.P., Svenning, J.C. and Ejrnæs, R., 2017. Ecospace: A unified framework for understanding variation in terrestrial biodiversity. *Basic and Applied Ecology*, *18*, pp.86-94.

Buchanan, C. 'Democratic Chair'
https://www.curtisbuchananchairmaker.com/store/p31/Full-Scale_Drawings%3A_How_to_Make_a_democratic_Side_Chair.html

Burton, V., Moseley, D., Brown, C., Metzger, M.J. and 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*, pp.366-379.

Collet, C., 2021. Designing our future bio-materiality. *AI & SOCIETY*, *36*, pp.1331-1342.

Cox, S., 2019. Modern life from wilder land, our manifesto on nature-first land & resource use

Elkington, J. and Rowlands, I.H., 1999. Cannibals with forks: The triple bottom line of 21st century business. *Alternatives Journal*, *25*(4), p.42.

Gibbons, L.V., Cloutier, S.A., Coseo, P.J. and Barakat, A., 2018. Regenerative development as an integrative paradigm and methodology for landscape sustainability. *Sustainability*, *10*(6), p.1910.

Friends of the Earth
https://friendsoftheearth.uk/nature/access-green-space-england-are-you-missing-out

Fletcher, K., Pierre, L.S. and Tham, M., 2019. Design and, Nature: A Partnership. *New York: Rout*.

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

Gant, N., 2017. Mediating matters. In *Routledge Handbook of Sustainable Product Design* (pp. 222-235). Routledge.

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

Gant, N and Luffiansyah, P. (2022) 'Making Nature'
https://community21.org/partners/makingnature/

Greenslade, C., Murphy, R., Morse, S. and 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), p.10071.

Harrap, S., 1996. *Tits, nuthatches & treecreepers*. A&C Black.

Hes, D. and Bush, J., 2020. Designing for living environments using regenerative development: A case study of The Paddock. In *Ecologies Design* (pp. 26-33). Routledge.

Jönsson, L. and Lenskjold, T.U., 2019. Hybrids. Others/Selfies: Poem:'Zoology'by Neil Bennun. In *Design and Nature* (pp. 53-58). Routledge.

Myers, W., 2012. *Bio design*. Museum of Modern Art.

Manzini, E., 2009 in (eds) Chapman, J & Gant, N. *Designers Visionaries and Other Stories: A Collection of Sustainable Design Essays*. Routledge.

Meuwese, D., Dijkstra, K., Maas, J. and Koole, S.L., 2021. Beating the blues by viewing Green: Depressive symptoms predict greater restoration from stress and negative affect after viewing a nature video. *Journal of environmental psychology*, *75*, p.101594.

Marchesi, M. and Tweed, C., 2021. Social innovation for a circular economy in social housing. *Sustainable Cities and Society*, *71*, p.102925.

Niedderer, K. and Townsend, K., 2022. Nature as source and inspiration for materials and making. *Craft Research Journal*, *13*(1), pp.3-8.

Palanica, A., Lyons, A., Cooper, M., Lee, A. and Fossat, Y., 2019. A comparison of nature and urban environments on creative thinking across different levels of reality. *Journal of Environmental Psychology*, *63*, pp.44-51.

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

Sangiorgi, D. and Scott, K., 2014. Conducting design research in and for a complex world. *The Routledge companion to design research*, pp.114-131.

Stamm, M., 2013. Reflecting reflection (s)-epistemologies of creativity in creative practice

research. In *Knowing (by) Designing* (pp. 33-39). LUCA, Sint-Lucas School of Architecture, KU Leuven, Faculty of Architecture.

Srivarathan, A., Jørgensen, T.S.H., Lund, R., Nygaard, S.S. and Kristiansen, M., 2023. 'They are breaking us into pieces': A longitudinal multi-method study on urban regeneration and place-based social relations among social housing residents in Denmark. *Health & Place*, *79*, p.102965.

Szwagrzyk, J., Maciejewski, Z., Maciejewska, E., Tomski, A., & Gazda, A. (2018). Forest recovery in set-aside windthrow is facilitated by fast growth of advance regeneration. *Annals of forest science*, *75*, 1-12.

Thierfelder, J., 2019. Thick description through visualisations towards new representations of nature. In *Design and Nature* (pp. 65-71). Routledge.

van Houwelingen-Snippe, J., van Rompay, T.J. and Ben Allouch, S., 2020. Feeling connected after experiencing digital nature: A survey study. *International journal of environmental research and public health*, *17*(18), p.6879.

Walker, S., 2013. Imagination's promise: Practice-based design research for sustainability. *The handbook of design for sustainability*, pp.446-465.

Wu, J., 2013. Landscape sustainability science: ecosystem services and human well-being in changing landscapes. *Landscape ecology*, *28*, pp.999-1023.