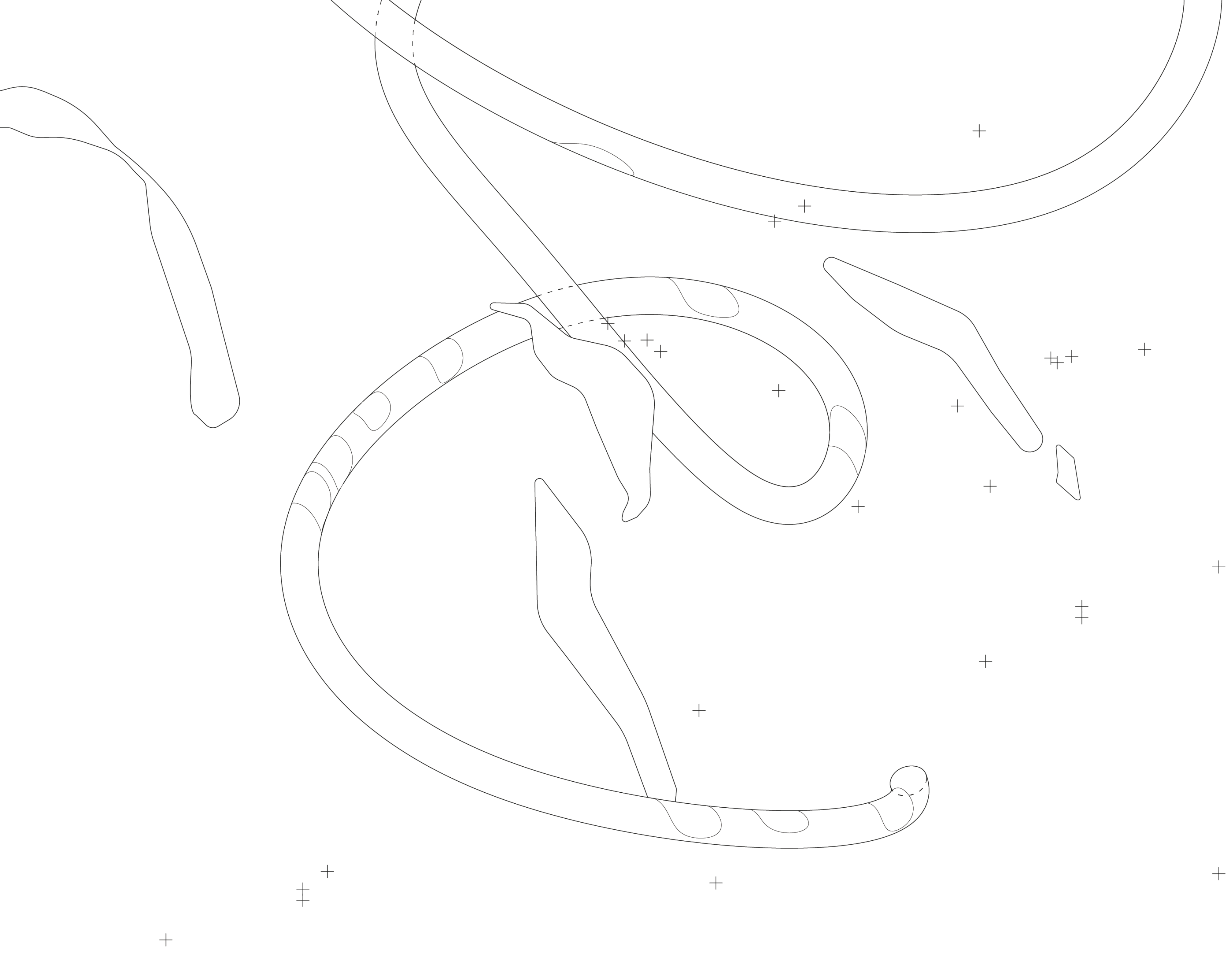
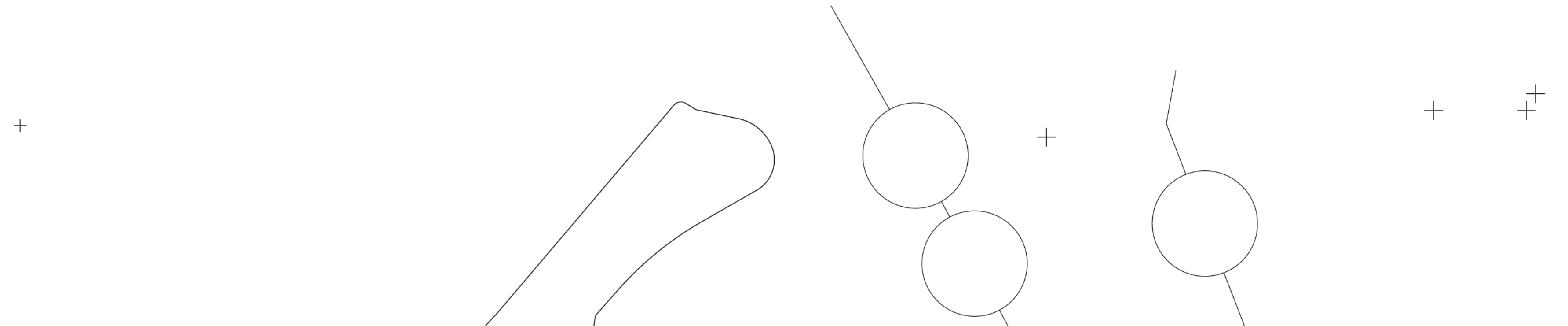
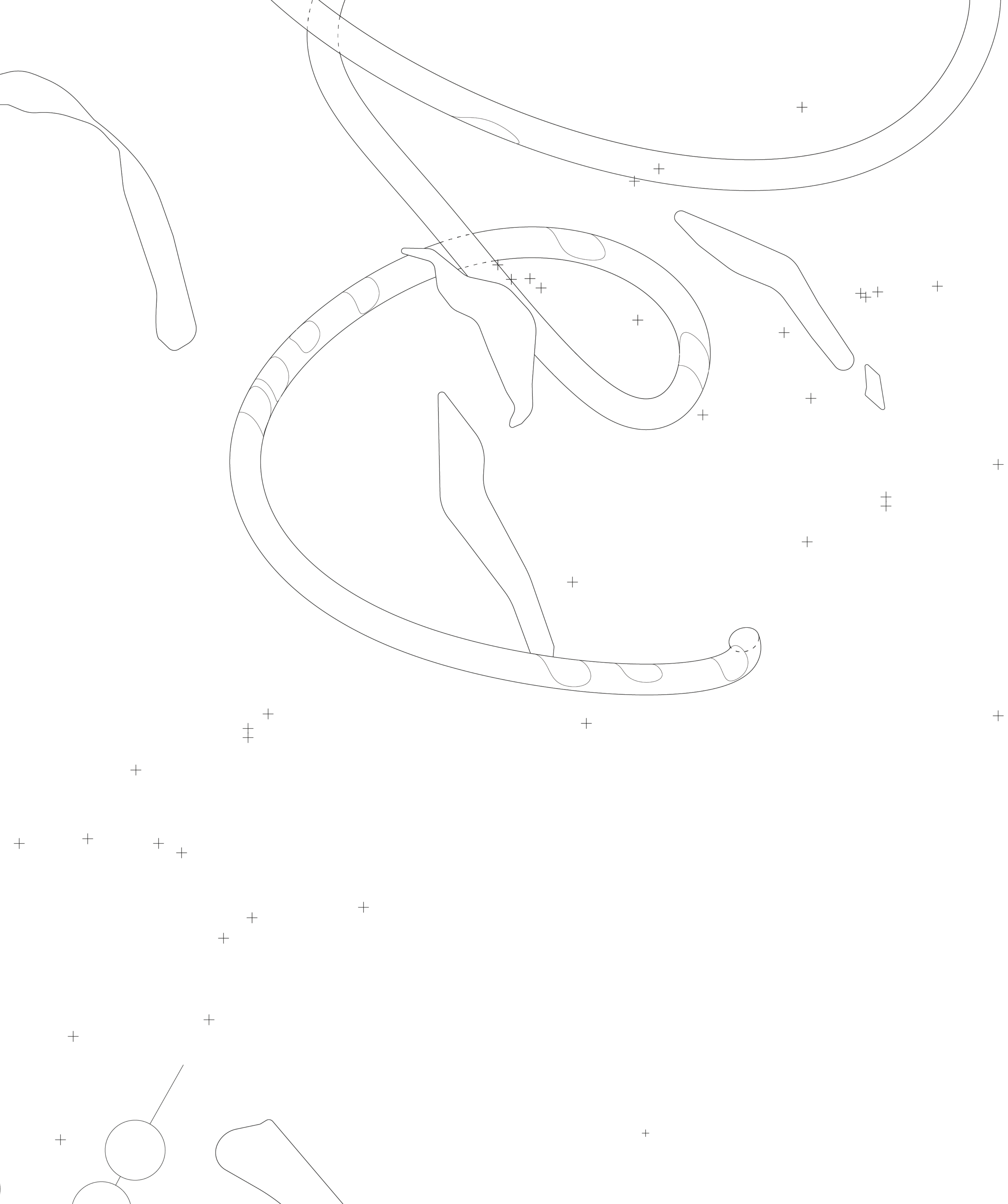


ARUP

Future of Making

Reimagining our material culture





“Be ten times bolder than you think you need to be.”

- Mary Robinson,
former president of Ireland and UN High Commissioner for Human Rights, on the topic of companies’ approach to the climate crisis.

Contents

Can we realise a regenerative future through transforming our systems and cultures of making?

Click to navigate:
remain in web view for interactivity
Uncover insights in each chapter

Let's collaborate to shape better futures and cultures of making.

Connect with Arup's global foresight team:
foresight@arup.com

Connect with Arup's Materials specialists:
materials@arup.com

How are we transforming our relationship to materials today?
Click to explore Arup's work

Introduction

Why Imagine a 'Future of Making?'

'Sustainability' – a system's ability to sustain itself – is often confused with carbon neutrality. Today, 'Net Zero' provides a shorthand for our desired future destination, but it is just a stepping stone towards something more. As explored in Arup's ***Regenerative Design report****, the goal must be the consistent regeneration of ecosystems via* ***'Total Design'.*** *What does this mean for our relationship with materials and our ways of making? A fundamental reshaping of the narratives and processes that underpin our systems of production and consumption are required.*

At Arup, we recognise that these are critical questions to ask. Arup designers and engineers are all engaged in 'making': places, spaces, systems and structures—and we are doing so at scale. Our work influences the use of resources and treatment of materials. In rethinking what 'good' design looks like, we can unlock new forms of value and realise safer, more resilient and regenerative futures with our clients and collaborators.

From the dawn of the Industrial Age until today, the quest of industry and enterprise has been one of relentless growth. Each evolutionary step along the way has accelerated production processes and increased output, from major breakthroughs in steel production, electricity, telecommunications, and transportation to the development of digital technologies, computers and the internet. A range of societal benefits have been realised as a result: millions of people have been lifted out of extreme poverty, life expectancy has increased significantly around the globe, diseases have been eradicated, living standards overall have improved. These outcomes are, of course, positive and welcome.

Yet, the inescapable fact is: much of our human 'progress' has been to the detriment of the ecosystems that underpin all life on Earth.

The human-centred economic model based on infinite growth[1] —and, in conjunction, the take-make-waste model that has dominated manufacturing processes—is built on the assumption that raw materials will always be freely available, and that they are there for us.

Our relationship to the materials around us is broken, and fundamentally unsustainable.

Our industrial model has long been depleting the planet's resources, degrading ecosystems, leading to biodiversity loss, and is now threatening the balance of the critical Earth systems that support life. As a global population, we currently require some 1.7 Earths per year; the way some societies live would require five, eight or even nine Earths if scaled up to the global population.[2]

In other words, we are on course to overshoot *every* planetary boundary—we will soon step outside the limits of the environmentally stable 'safe zone' necessary for human societies to prosper. This risks the collapse of the social foundations we acquired in our previous industrial evolutions.

If we are to avoid this, we must challenge our current definition of 'growth', prioritising the generation of new circular capabilities; decoupling economic and social advancement from finite resource consumption; accounting for planetary 'cost', and recognising the existing value in the methods and materials all around us.

Reimagining our material culture

If we fail to imagine what is possible tomorrow, we will be locked into what we see as probable today. The solutions to the problems created by extrapolative, extractive systems cannot come from those same systems.[3] Instead, the way we practice futures thinking, the way we anticipate and vision, must be transformative. This means being more conscious of our failings, more honest about our constraints and less tied to what we know.

—
1. Meadows, D. et al. (1972).
2. Earth Overshoot Day (2025)
3. Spencer, F. (2023).

Introduction

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*'**Total Design**' is one of Arup's core principles. It is a mindset that takes the broadest possible view of a problem and its context. It embraces rigour and technical excellence, refreshed by continuous learning. And most importantly, Total Design aims to bring together the widest range of specialisms through generous and confident collaboration to maximise our creativity.*

x

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2. Earth Overshoot Day (2025)
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Industrial 'revolutions' have traditionally been named 2.0, 3.0, 4.0 and so on. This numbering reflects the underlying quest for growth: the dream of a line that eternally trends up towards the top-right corner. Even the emerging industry 5.0,[4] while it seeks to introduce sustainability (understood here as decarbonising) and resilience, is still predicated on the same infinite growth.

Future of Making explores another way. It imagines what the world might look and feel like if we broke out of the infinite growth line and shifted towards circular thriving,[5] where 'value', 'cost' and 'growth' have a new meaning.

The six chapters of this report bring to life aspects of a possible circular system. We have outlined the 'why'; the case for change. But in these chapters, we begin to see 'how': in the work of designers and engineers around the world who are already realising pockets of the future, in the present. Our goal is to show that a regenerative future is not only possible but in many ways and in many places, it is already materialising.

Our ambitions for what comes next must not be limited by what is 'now'. Can we engage in 'radical optimism' together?

As we sketch out a world where heritage and foresight converge; where every product, space, and initiative is informed by regenerative design principles, we must accept that such fundamental shifts do not happen quickly. They are the result of collective, concerted action. We are all called to shape the future of making collaboratively.

To become regenerative designers, we must first imagine regenerative futures. Only then will we—as practictioners, as a firm, as an industry—see what new skills and capabilities we need to develop now; how we can design and create value for our clients differently; and, crucially, what we need to start 'ex-novating': fading out in a controlled way on the path to transformation.

So, what is changing and challenging your own relationship with materials? What might be your role in realising a more regenerative future of making? Can *you* imagine something different?

What if growth was synonymous with innovation, maximising the value of existing resources and rolling out circular capabilities far and wide?

What if we balanced innovation with ex-novation, discontinuing technologies and ways of doing things that consistently damage the planet?

What if we gave nature a central role? What would an industry look like that was inspired by, embedded in and respectful of nature? What do we need to become truly, fully circular?

—

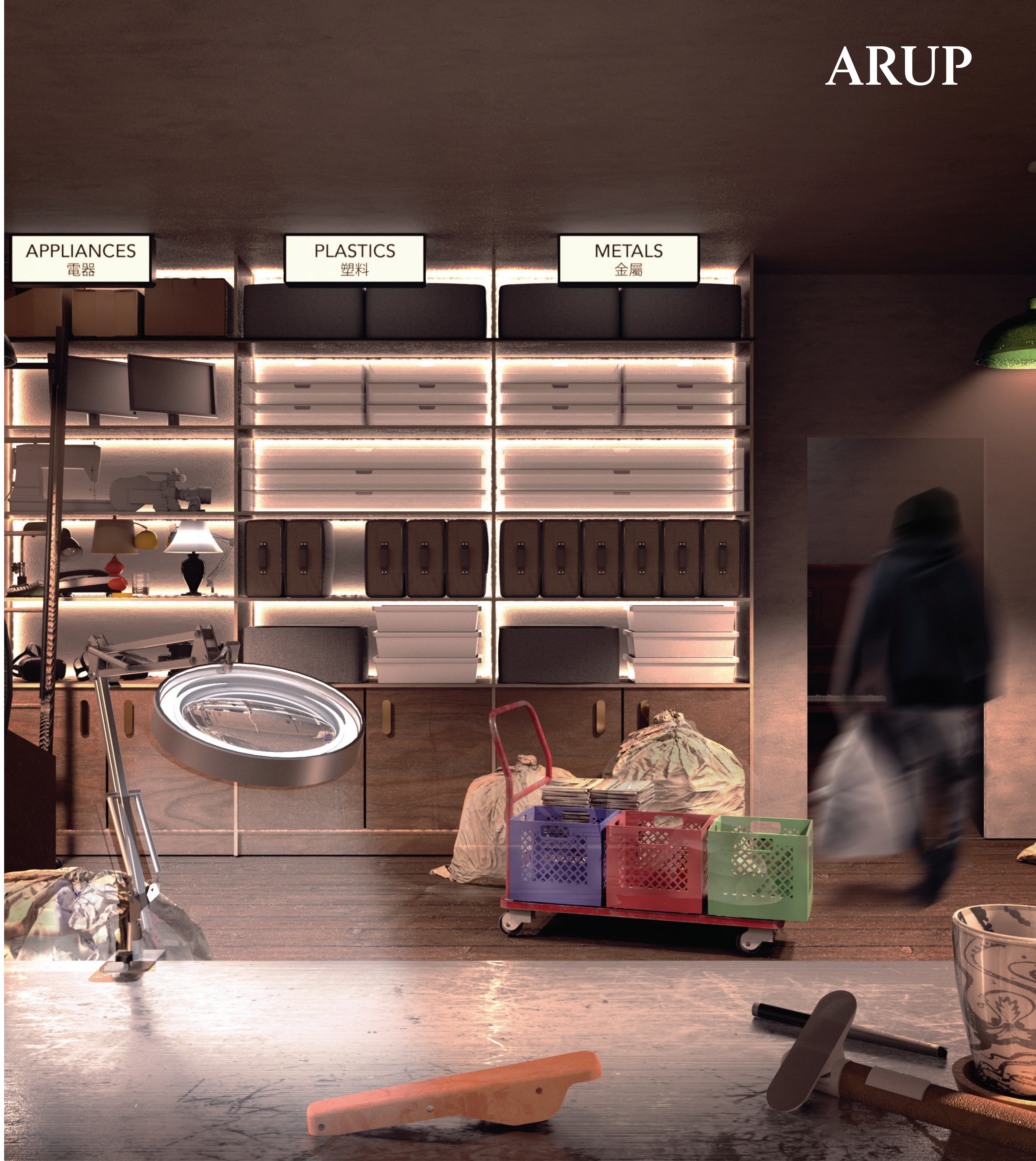
4. European Commission (2020).
5. Susskind, D. (2024).

Our role here is not to displace blame; we are all implicated in these present-day industrial norms and it will therefore take action from all of us to shift them. We must join together across materials value and processing chains with common goals and embrace the 'what if' of a radical optimism that believes change is within our power. We hope you will join us.

Recovery

Re-evaluating materials

Recovery challenges the notion of value currently ascribed to materials in their raw and transformed states. It highlights the real cost of material extraction and disposal as well as the opportunities for extending material lifespans, thus extending their use.



The climate is only one of the planetary boundaries that our use of materials negatively affects.[6] Pollution, the overuse of freshwater in mining, transformation processes and cooling, and the extractive practices that are necessary to obtain virgin materials cause huge damage to ecosystems and have had devastating consequences for biodiversity.

Despite this evidenced harm, our use of virgin materials continues to grow. The world still relies almost exclusively on newly extracted materials. Global circularity—the amount of materials cycled back into the global economy—*shrank* from 9.1% in 2018 to 7.2% in 2023.[7]

Yet, access to virgin materials is changing. Socio-cultural and geo-political pressures are limiting the availability of materials. Ores are dropping in quality and concentration, to the point where most electrical devices now have higher concentration of rare metals that many ores. The re-emergence of trade wars is threatening supply chains.

Seen under this light, materials that are already in circulation have tremendous value.

So-called 'waste' needs to be rethought. The 'end-of-life' must become a point of rebirth.

To become more regenerative, the materials stream requires a system-wide resources strategy.

This might include material banks, or hubs for recovering and re-circulating materials; a new understanding of landfills as repositories for future use; and material passports that enable us to trace and catalogue available materials.

"Waste is but a material without an identity."[8] Further to the environmental damage that it perpetrates, the indiscriminate dumping of materials is above all a huge loss of value and potential.

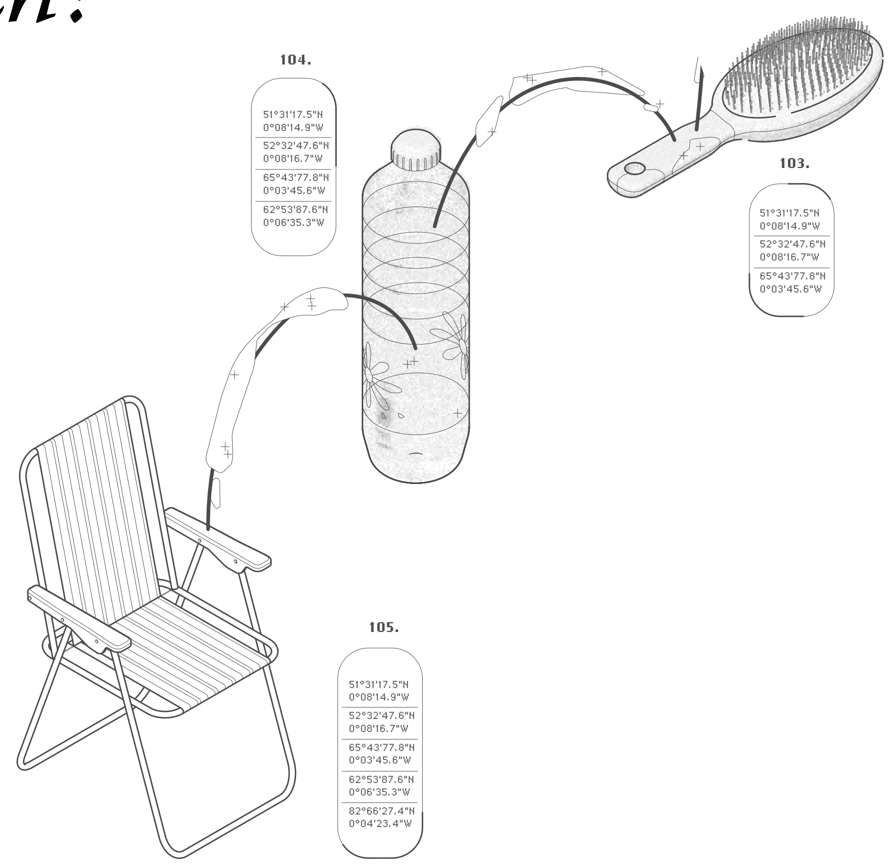
—

6. Stockholm Resilience Centre (2023).
7. Circle Economy (2024)
8. Rau, T. & S. Oberhuber (2022).

Click here to listen to story (web view only):
An Unconventional Detective

How can we recover more, if not all, the materials that are already in circulation?

How can we mine cities and goods instead of the Earth?



Case Study

Re-evaluating electronic waste in the circular economy

Only 17% of global electronic waste is documented as managed in an environmentally sound manner; the remaining 83% is unknown and likely to be disposed of illegally. Nigeria is one of the world's main destinations for the dumping of e-waste and, like many other countries paid to take waste, it does not have the infrastructure and facilities to process the waste safely. This causes damage to the local environment and results in an informal e-waste economy whereby 'pickers'—people who search waste for valuable materials—work at great risk to their health. It has also created an illegal market around data and identity theft the from old devices.

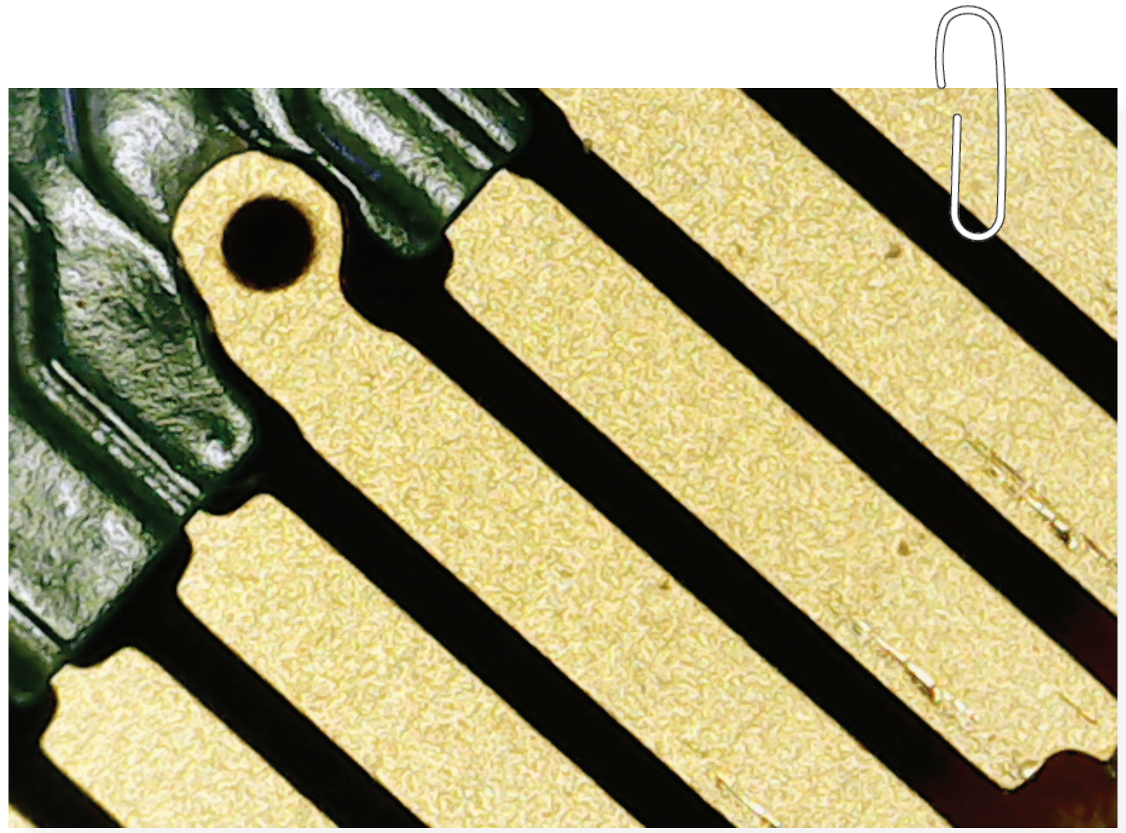
In 2019, the Nigerian government, the Global Environment Facility and the UN Environment Programme launched an initiative to establish a circular electronics system. It brings together government, private sector and civilians in a circular economy model for electronics with the goal of protecting the environment as well as providing safe employment.

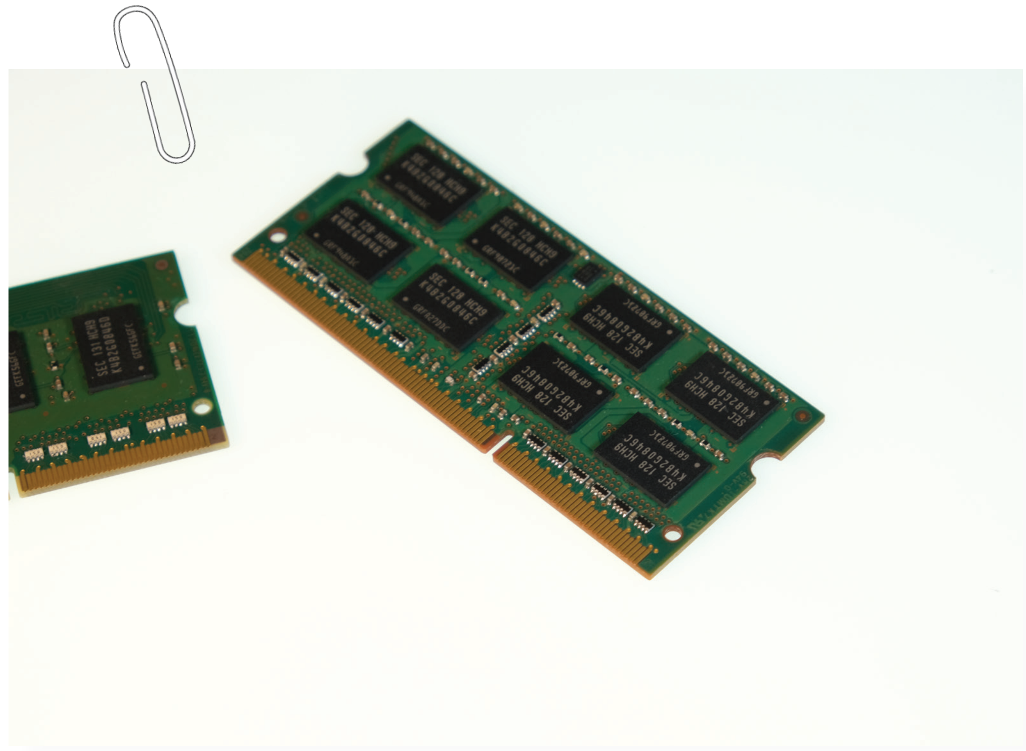
Though evidence of the project's impact on electronic waste re-use is yet to be published, it highlights dumped devices' economic potential as a valuable resource. Replicating such initiatives could help to tackle our growing piles of e-waste, predicted to reach 74.7 million tonnes globally by 2030.

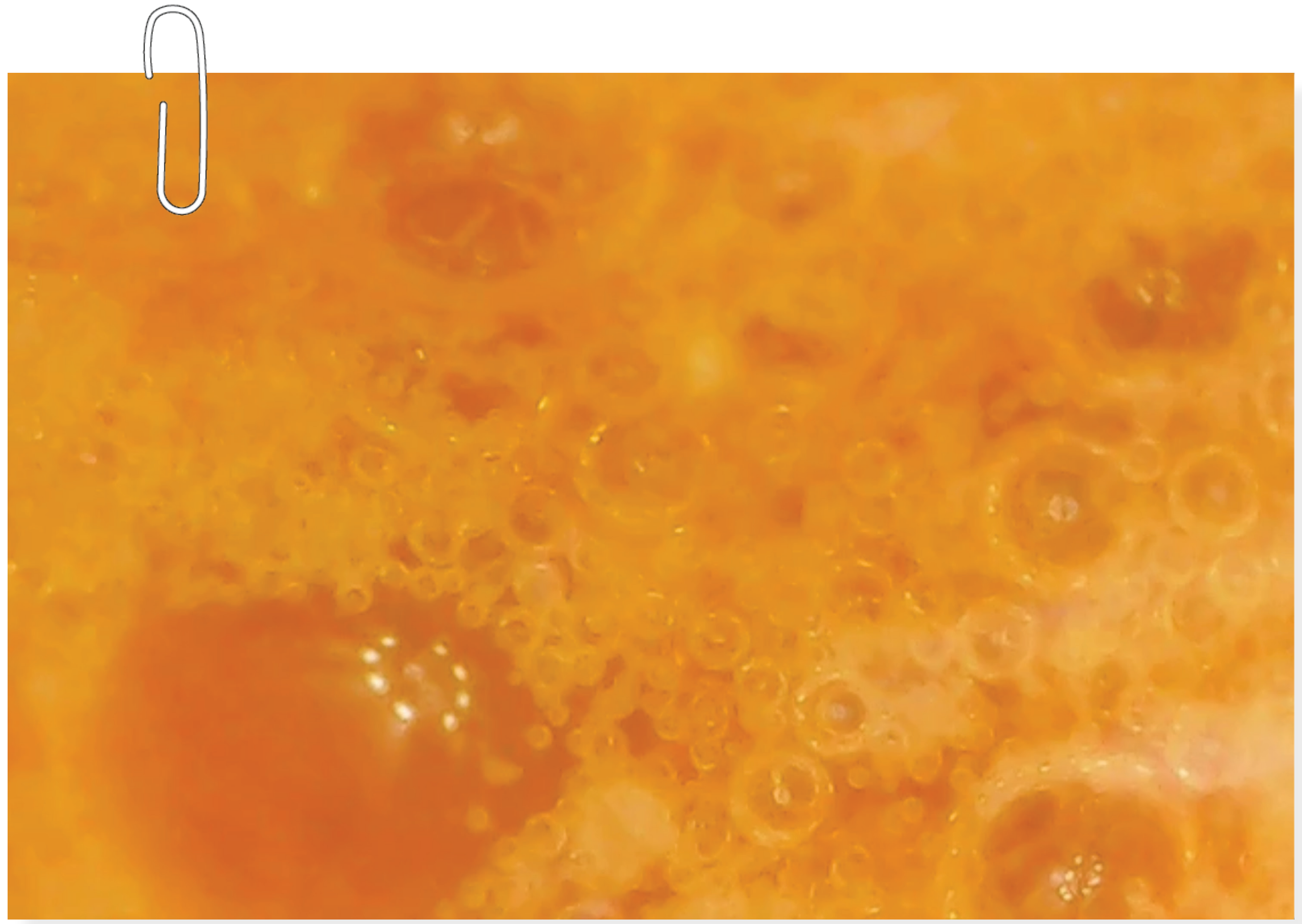
In 2023, the Nigerian government went further and revised environmental regulations to make producers accountable for the end of life of their products. If these were applied more widely and were enforced strictly, many Western countries would need to adapt to a new and less harmful system after relying for decades on offshoring consequences.

A global effort and strategy will be needed to change the infrastructure of electronic waste systems, mitigate their harm and shift the perception of e-waste from discardable devices at their 'end-of-life' to sources of metals and minerals with a high residual value.

What might a regenerative waste & resource management strategy look like on a national or global scale?







Case Study

Archiving waste for future generations

The Tellus Sandy Ridge facility in Western Australia is the first commercial geological repository for hazardous waste. It gives mining companies a safe and permanent storage space for their problematic by-products. This includes some materials that are needed for the transition to a greener economy. Using a multi-barrier safety case, the Tellus Repository also relies on various fail-safe mechanisms combining engineered and natural characteristics. Due to its location on dry, thick, flat, and stable salt or clay formations, the repository does not require ongoing maintenance or monitoring and is expected to remain passively safe through geological time.

Another objective of the facility is to conduct cutting-edge research on the re-use and recycling of strategic waste (waste that is difficult to avoid altogether or necessary for developing transition technology) as well as the permanent and safe disposal of intractable materials.

Working in partnership with the local government, Tellus takes a long-term view of strategic waste management. It has set up a trust structure to fund the post-closure monitoring for 100 years once the Western Australia government takes back ownership of the facility, reducing the burden on the tax payer.

The Tellus Repository is an example of what we can do today with hazardous, currently non-recyclable waste. It is essential to isolate such materials that risk contaminating the environment or damaging people's health, with an emphasis on safety. If managed correctly in the present day, repositories such as this could become archives of resources that will prove valuable to future populations, once the technology is developed to re-use or process them.

Could secure repositories for hazardous waste be the mines of the future?

2035

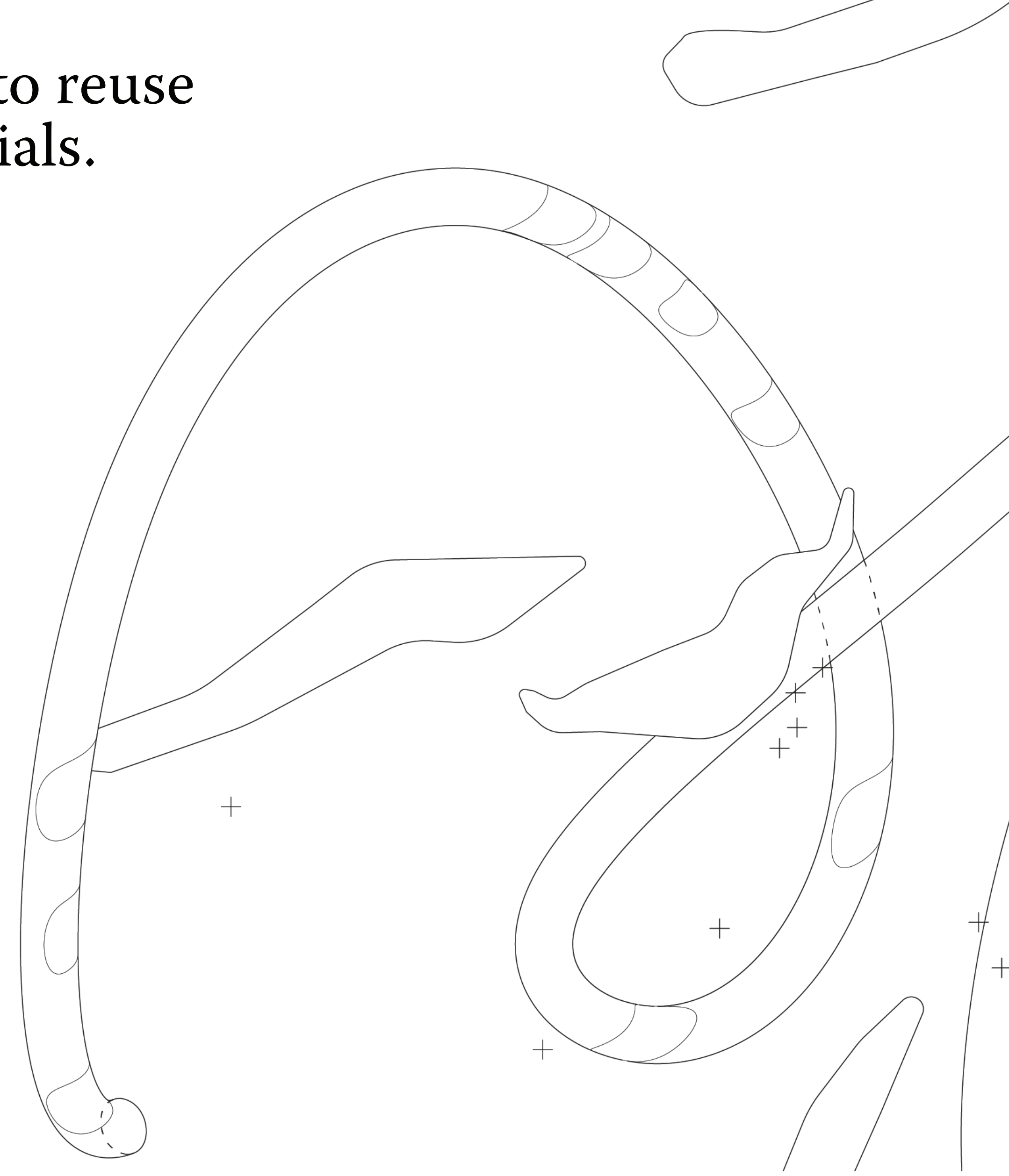
Material shortages and an escalating climate emergency push leading countries to the breaking point, with the G20 intergovernmental political forum unanimously signing the 'Renewable Resource Agreement', putting a 27% tax on all virgin materials.

2038

New environmental justice treaty makes producers of waste accountable for its safe treatment. Countries are no longer allowed to import or export waste, that is to move negative impact elsewhere.

What if all the materials we ever needed were already in circulation?

Accepting the challenge to reuse existing and waste materials.



Transformation

Obtaining and processing materials

Processes of material transformation and manufacturing follow an idea of industrial efficiency that does not factor in environmental costs. New technologies seek drastically to reduce energy requirements; new materials are being developed with minimal planetary impacts. Inspired by nature, the notion of efficiency is changing.

In natural systems, efficiency is understood differently. Organisms specialise to use mainly the resources that are abundant around them—often products of other organisms' processes—and to conserve those that are scarce. Rare nutrients are used sparingly, recycled rapidly, and included with weak bonds so that they can decompose without leaving by-products. Natural efficiency uses processes that require minimal energy; speed is, if at all, a secondary consideration because speed usually requires more energy.

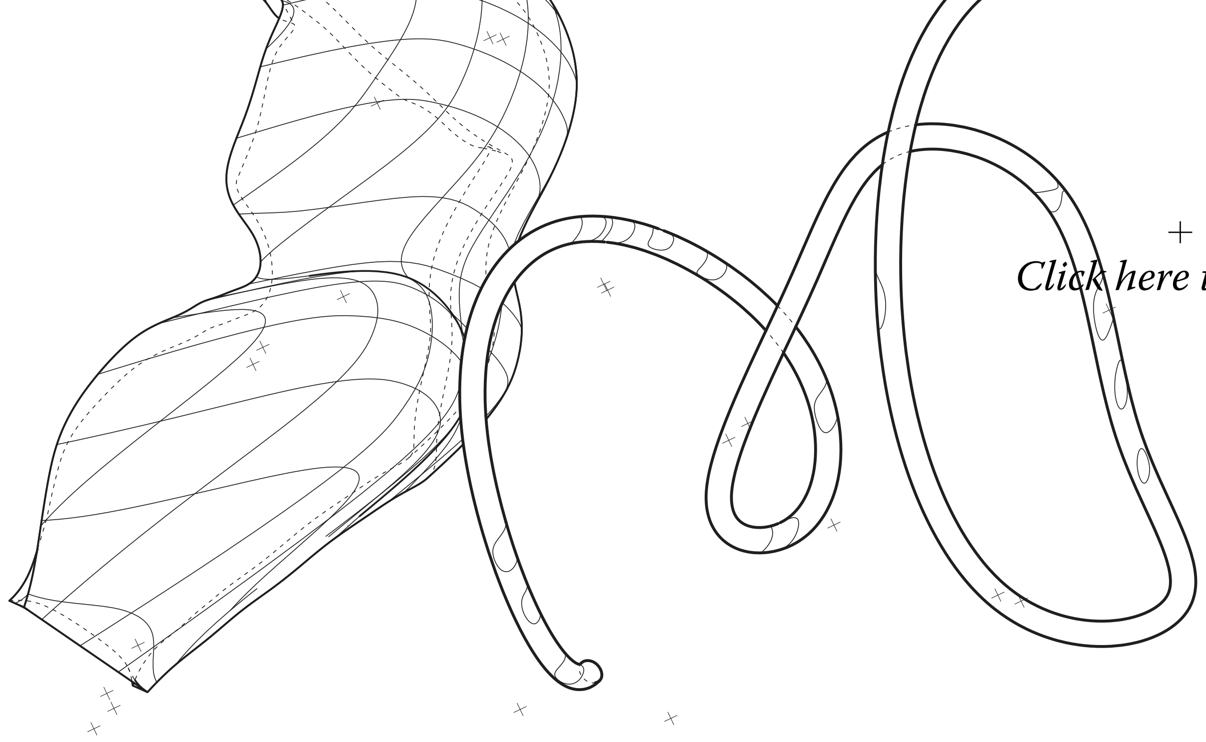
Through biomimicry and bio-utilisation, the regenerative mindset seeks to repurpose existing tools and skills to transform the way we work, rather than seek to develop new technologies that perpetuate a dysfunctional system of 'take-make-waste'.

This is shaping the transformation processes we use and the new materials we develop.

Our current industrial approach is largely driven by a central tenet: make for low maintenance. The consequence has been to use durable but very high-impact materials such as concrete and plastics. Flipping this on its head—that is, make with low-impact materials even if this requires high maintenance—has seen an increased growth in biological materials derived from plants and fungi. If they are to support a new, regenerative system, these materials must be embraced with their changed core properties rather than seek to replace 'old' materials.

It has also seen the development of new human-engineered materials that use alternative constituent ingredients—such as alternatives to Portland cement in concrete—and that are self-repairing.

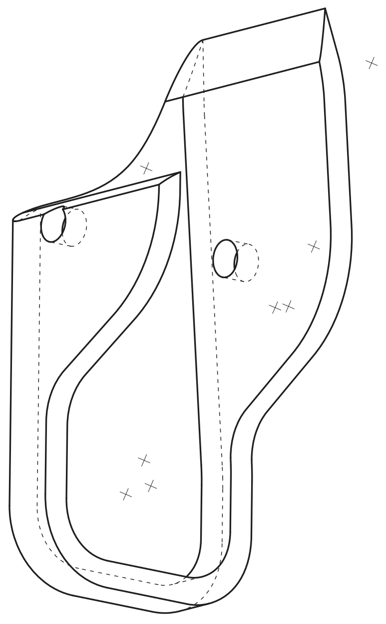
Many of these developments are still in their infancy, but they highlight an important shift. They reflect a growing acceptance of this new mission to build, make and design for low impact and for a seamless return at the end of life.



Click here to listen to story (web view only):
Metamorphoses

What more can we learn from nature's billions of years of R&D?

What new materials will emerge if we shift our understanding of efficiency and consider whole-life impact?



Case Study

Building with the Earth

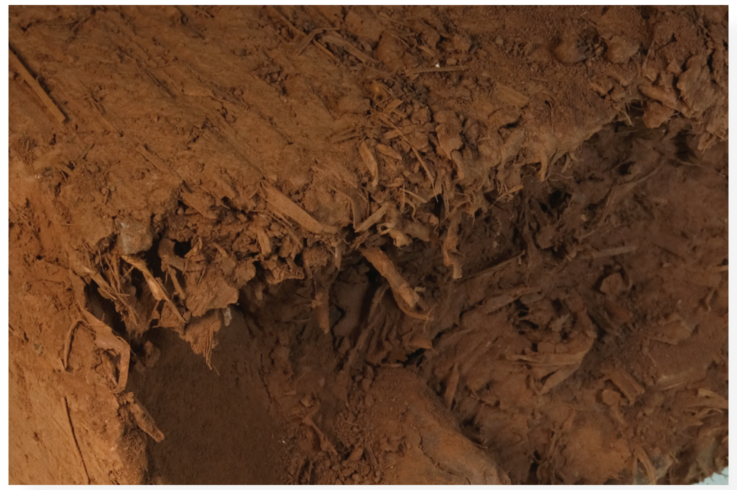
Rammed earth is an ancient construction technique which compacts natural raw elements including mud, chalk, lime and gravel into building materials. Rammed earth building materials had been used for thousands of years before their decline in the 20th century, and the techniques have recently come back into fashion thanks to their sustainability. Using what is local and abundant, rammed earth embodies low amounts of carbon and consumes less energy than steel or concrete in production, using pressure and moulds to replace high-heat processes. These materials can also be deconstructed and safely returned back to the Earth when no longer required.

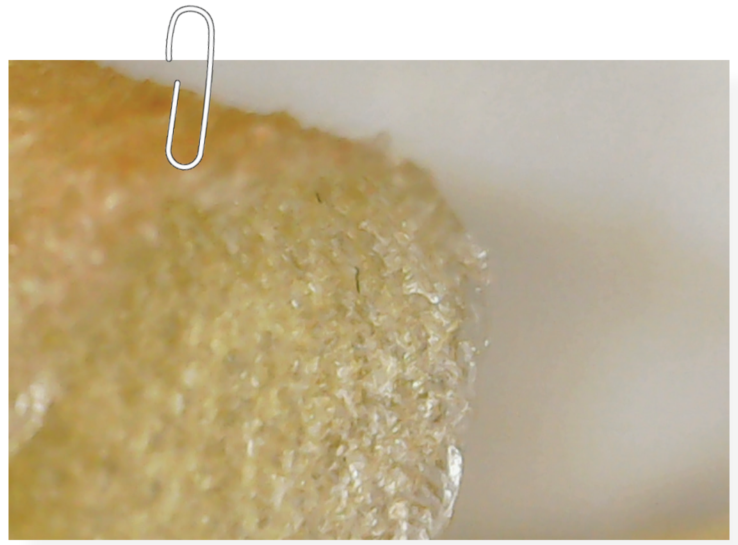
Start-up companies such as the Netherlands-based Terrestrial are evolving these construction techniques by using robotics that 'shoot' earth, building at low energy, directly in place and using already-present organic material —all of which contribute towards efficiency. Terrestrial used the shot-earth method to build a noise-absorbing wall alongside a motorway, a structure that would usually be made using energy consumptive concrete or timber.

Traditional ways are often unsuited to modern scales and needs, but they can serve as inspiration. MIT's Programmable Mud Initiative, for instance, developed a 3D-printing technique that uses mud to fashion moulds for concrete pourings on site. This reduces the need for a building to be 'built twice,' once through formwork, and once in concrete.

Rammed and shot earth may not be applicable to all uses and regions, but these (re-)emergent techniques signal a transformation of future construction that reinvigorates traditional methods and prefers sustainable, abundantly available materials—even if they require more maintenance.

What else could you build using locally abundant materials?





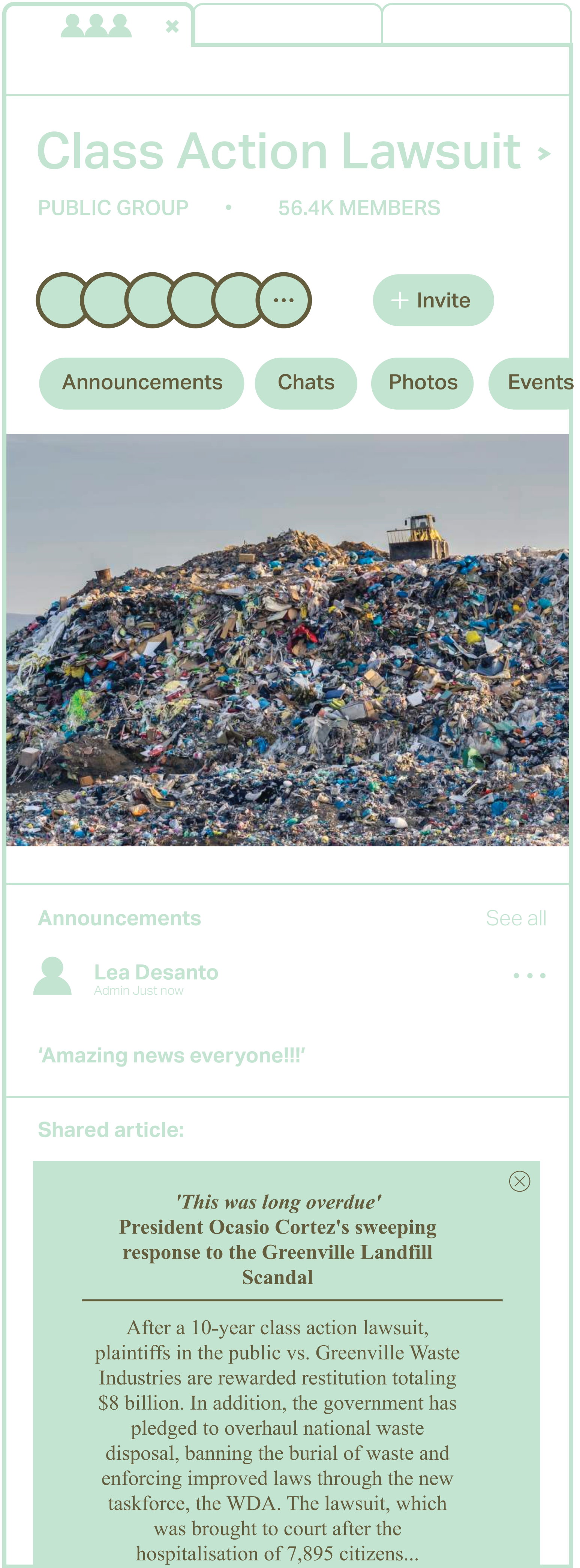
Case Study

Growing natural alternatives to plastic

Neri Oxman's Aguahoja collection offers alternatives to plastic that subvert the toxic waste-cycle through the creation of biopolymer composites. These materials are 'tuneable' with varied mechanical, optical, olfactory and even gustatory properties. The Aguahoja collection mimics natural systems (such as trees, crustaceans and apple skins), that use a limited palette of molecular components, including cellulose, chitin and pectin to construct a functional material. These renewable and biocompatible polymers leverage the power of natural resource cycles and can be materially 'programmed' to decay as they return to the Earth, for purposes of fuelling new growth.

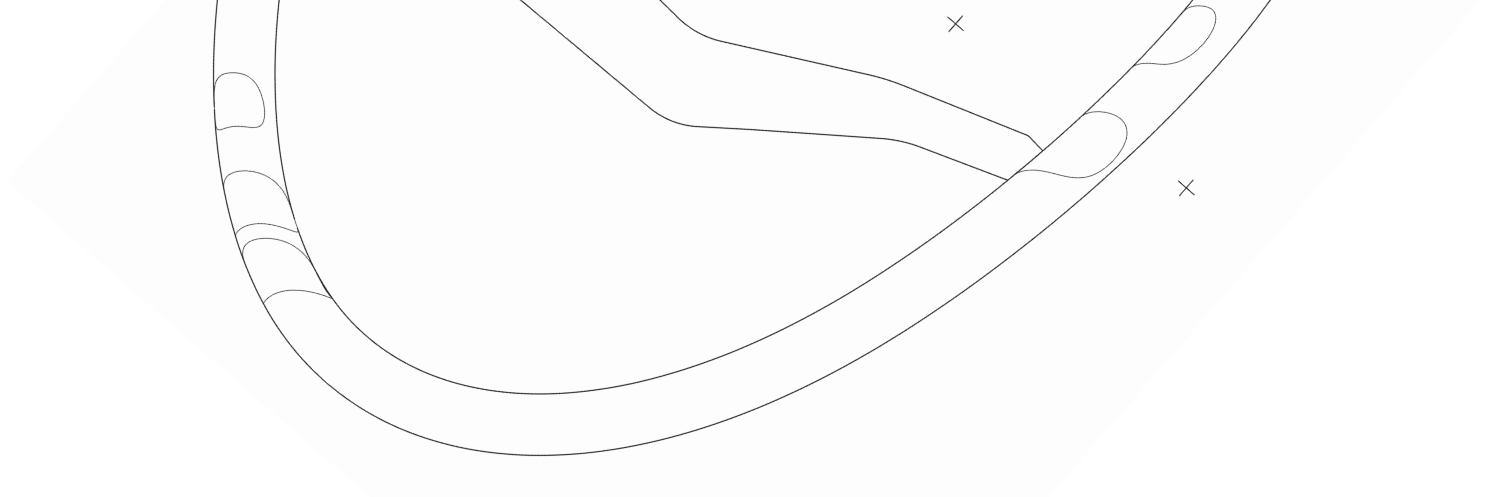
Aguahoja is an exploration that stretches our understanding of what's possible when we mimic natural, circular systems. It opens the doors to creative thinking focused on solving an enormous problem in our making ecosystems and consumption streams: namely, the over-use of plastics and other materials dependent on finite resources. Aguahoja reminds us that nature uses just four building blocks for almost all matter, and it shows us that even by using fewer, more abundantly available elements, we can make functional and beautiful materials.

How else can nature's billion-year R&D help you to develop new materials that don't cost the Earth?



2029

Social media article reporting on the inception of the USWDA (United States Waste Disposal Agency), the government task force created in response to the Greenville Landfill water contamination scandal, in which Greenville Waste Industries buried waste amongst water stores for over 50 years, contaminating drinking water and hospitalising over 7,000 people.



What if there really was no such thing as waste?

Formalising the recirculation of waste, reducing or even eliminating the amount we dispose of.

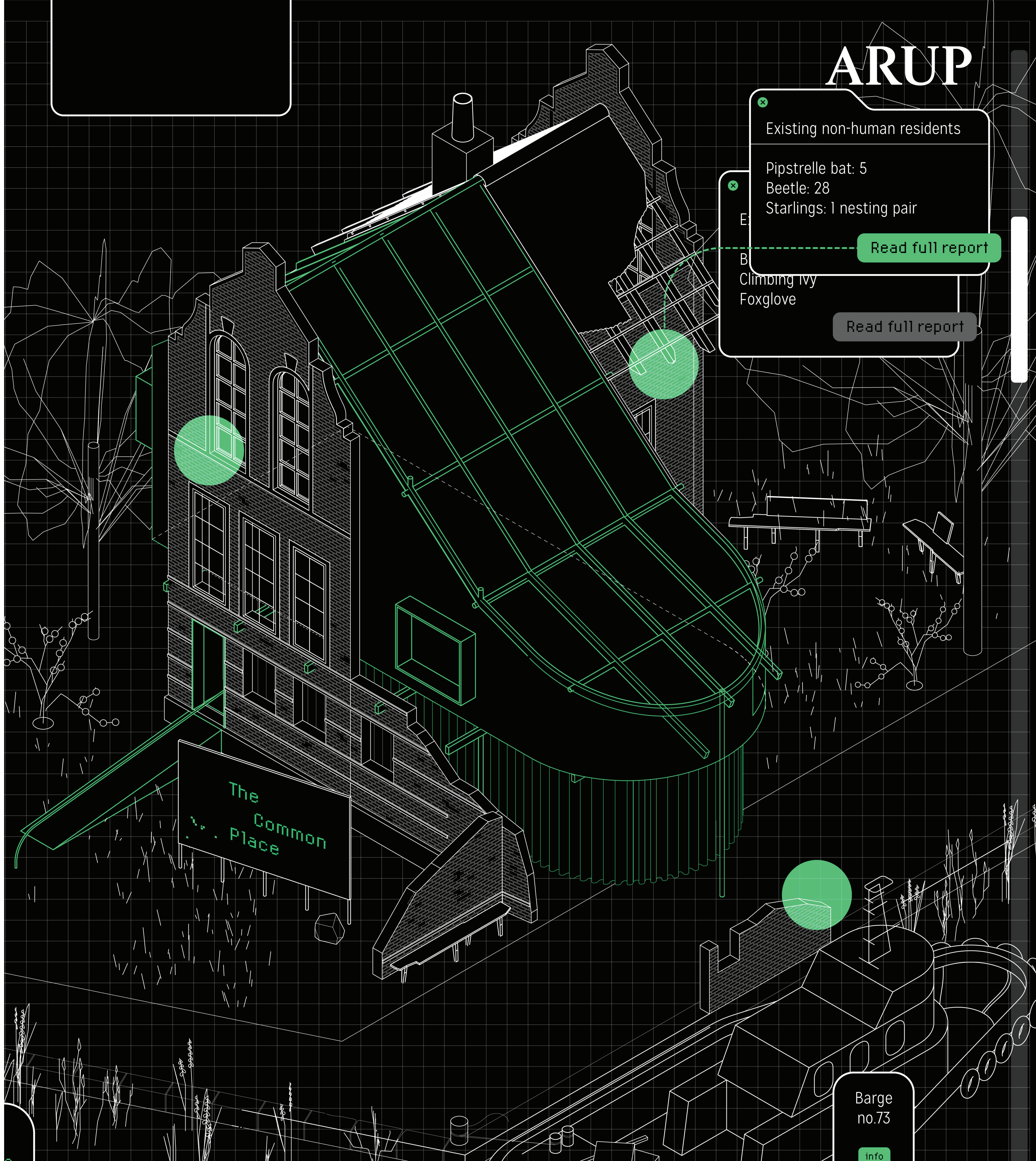
What if we no longer asked the Earth to swallow our poison?

Preserving our waste safely for future generations to repurpose.

Design

Building in circularity

The design stage is arguably where most of a building's or product's impact can be changed: it defines the materials that are used, the impact of operations, and the suitability for disassembly and re-circulation. The principal topic here is the dark matter that props up design structures, and what might happen if nature became a rightsholder as well as a collaborator in our decision-making.



To bring in nature as a stakeholder or rightsholder asks designers—of all denominations and specialisms—to consider how their outputs might have positive outcomes on the world and leave it in a better place. In other words, to move from *ap*plication to *im*plication: the implications of chosen materials, of production scaling and construction, of disassembly, of longevity, and so on.

Design and the designers' responsibilities, then, do not end with 'completion' but with the stage after a planned 'end-of-life'.

The result is that linearity is then designed out, and circularity designed in. Often, this translates into a 'simplification' of designs, in the sense of using building blocks that can be exchanged more easily for repair and maintenance as well as for disassembly. Complex designs and complex materials are much more difficult, if not impossible, to recirculate.

This sense of responsibility for implications is also reminiscent of the 'seventh generation' mentality of many Indigenous cultures, and accordingly the design disciplines can learn much from Indigenous practices. Lo-TEK—which stands for local traditional ecological knowledge—highlights the importance of place-based approaches at the same time as it challenges our over-reliance on technological advancements to solve our problems.[9] Lo-TEK suggests that we already have the tools and skills we need; we need to shift our mindset and parameters instead.

The planetary boundaries offer a new set of parameters for design briefs that goes beyond 'net zero.' They demarcate humanity's safe operating context on Earth: the Earth systems that have enabled the human species to thrive. Six of the nine have already been transgressed.[10]

Reframing our design briefs away from 'linear growth' to a 'thriving' within the planetary boundaries—as for instance the Doughnut Economics framework[11] does—is a promising way to achieve a circular economy.

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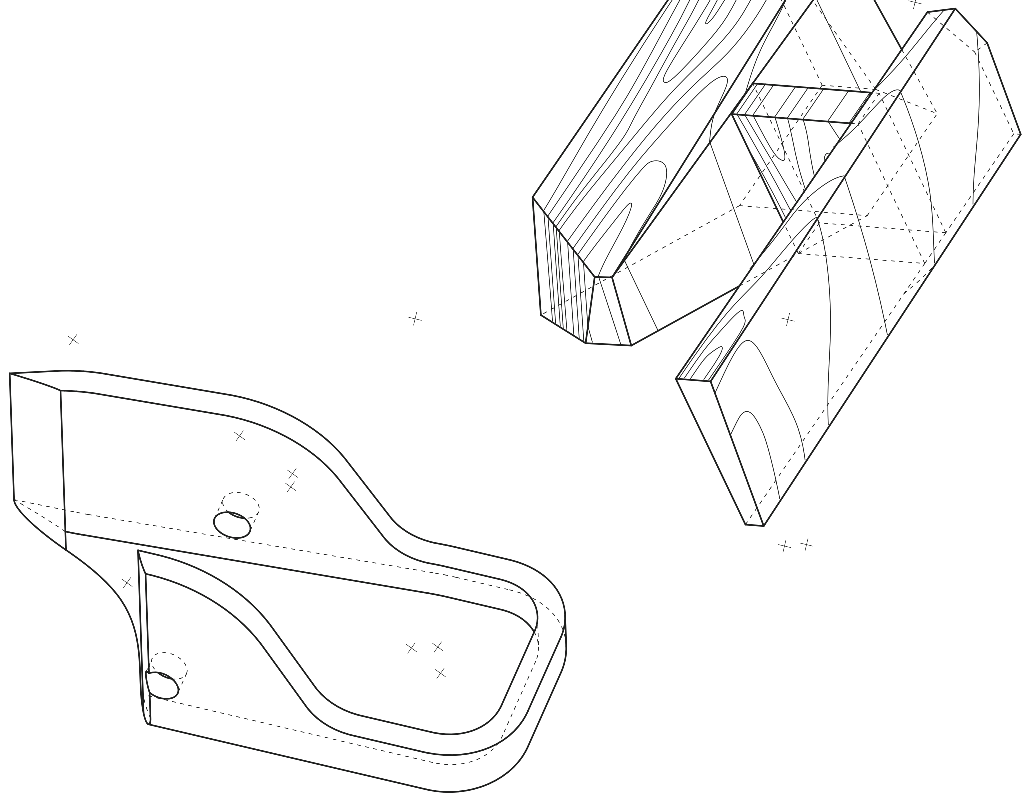
9. Watson, J. (2022).
10. Stockholm Resilience Centre (2023).
11. Raworth, K. (2017).



Click here to listen to story (web view only):
The Voices at the Table

How can we reframe the problems we solve through design thinking?

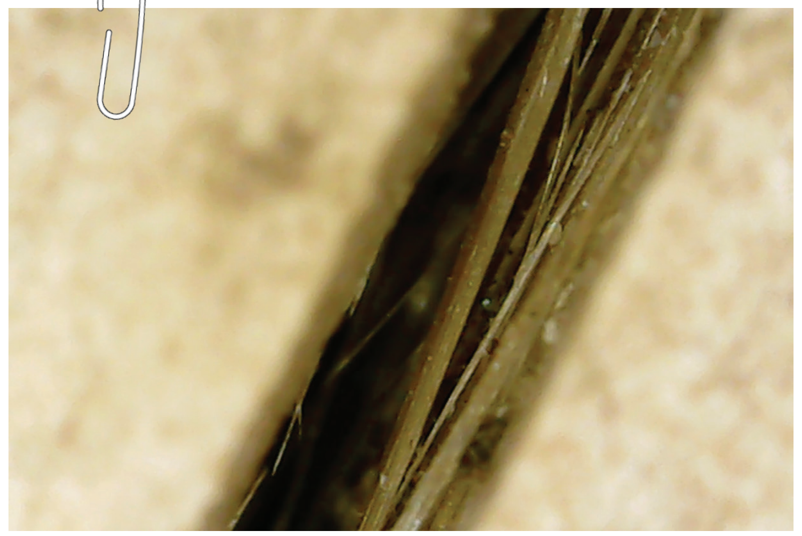
What parameters can we set to ensure circularity is always the best solution?

Case Study

Learning from local styles

In the Kutch region of Gujarat, a region that experiences earthquakes, cyclones, and sandstorms, the traditional Bhunga housing style is naturally weather-responsive. The structure has low wooden windows for natural cross-ventilation, low thatched roofs that provide natural insulation and heat absorption, and circular clay walls which are more likely to resist seismic shocks than walls around square or rectangular floor plans.

While Bhunga huts require regular maintenance, they are made of renewable materials like clay, bamboo, and timber, all of which are abundant in the area. This makes them a continuously sustainable housing option for those in the region. They are a prime example of vernacular styles that respond to place-based needs.



The suggestion cannot be a return to 'pre-modern' architectures. However, looking to local Indigenous building practices for inspiration and implementing them into refurbishments and new developments could provide a more scalable solution to the many climate issues facing buildings today and in the future. Earthquakes, floods, wildfires and extreme temperatures are all becoming more frequent, and this trend is predicted to continue.

As Indigenous building practices traditionally work with readily available, local materials, the need for importing materials also decreases with their uptake. Such buildings have the potential to be more resilient to threats while also making the most of the surrounding natural materials, creating a sustainable built environment.

Above all, Indigenous techniques and associated vernacular styles are a codification of responses to very place-specific needs. They can teach us a lot about the place. They are the counterpoint to a kind of standardisation that tries to make the place fit the design, rather than the reverse.

What material and structural lessons from Indigenous practices can you apply to your local interventions?

Case Study

Setting the levers to focus ingenuity

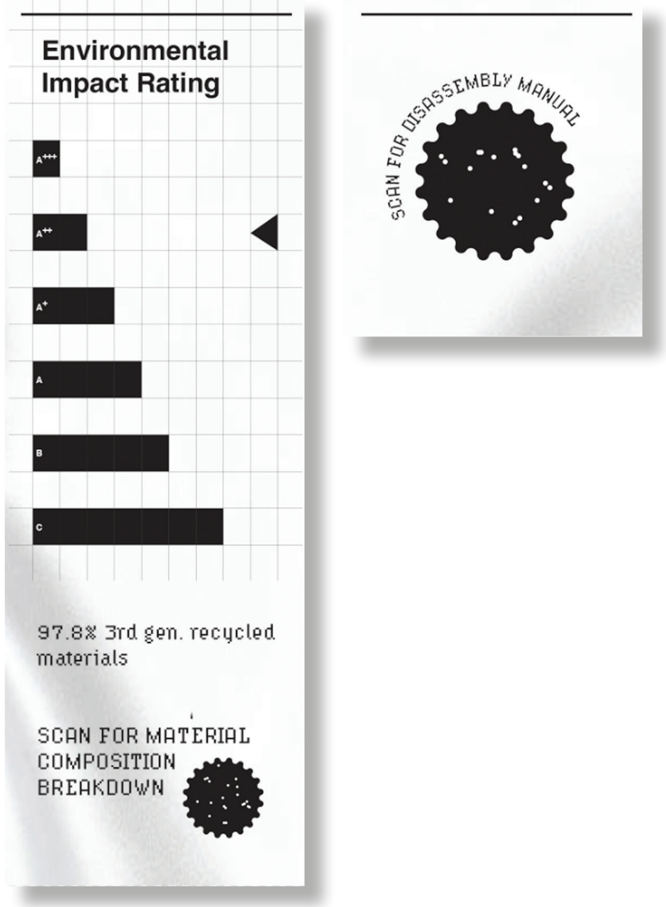
The Earthshot Prize, now an independent charity, was launched in 2020 by the Royal Foundation in the UK to meet an ambitious challenge: to repair and regenerate "the place we all call home". The Prize annually awards five winners a £1 million grant for their game-changing contribution to environmentalism and proposed environmental solutions. The award goes toward continuing and building upon the winner's work, and the Earthshot Prize supports winners and nominees by acting as an incubator.

The Prize chooses winners based on their contributions to one or multiple of five categories: 'the restoration and protection of nature', 'air cleanliness', 'ocean revival', 'waste-free living', and 'climate action'. The award ceremony is a prominent gala, with celebrities attending to give it international recognition and attractiveness, reiterating a focus on innovative environmental solutions.

Set up to be held annually for ten years, the Prize recalls J.F. Kennedy's ambitious 'Moonshot' speech. It seeks to focus global research and development efforts towards a long-term objective and vision. Focusing on the Earth rather than the Moon, highlights the importance of our planet. Yet Kennedy's words still echo: "because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too."

Such initiatives that combine a values-led approach with financial benefits — supported by high-profile influencers — have the power to generate a cultural shift. This mission-driven approach is one that governments and supra-national organisations can foster through the correct incentive, through legislation and, above all, through inspiring narrative.

What would you contribute to this global mission of repairing our home?

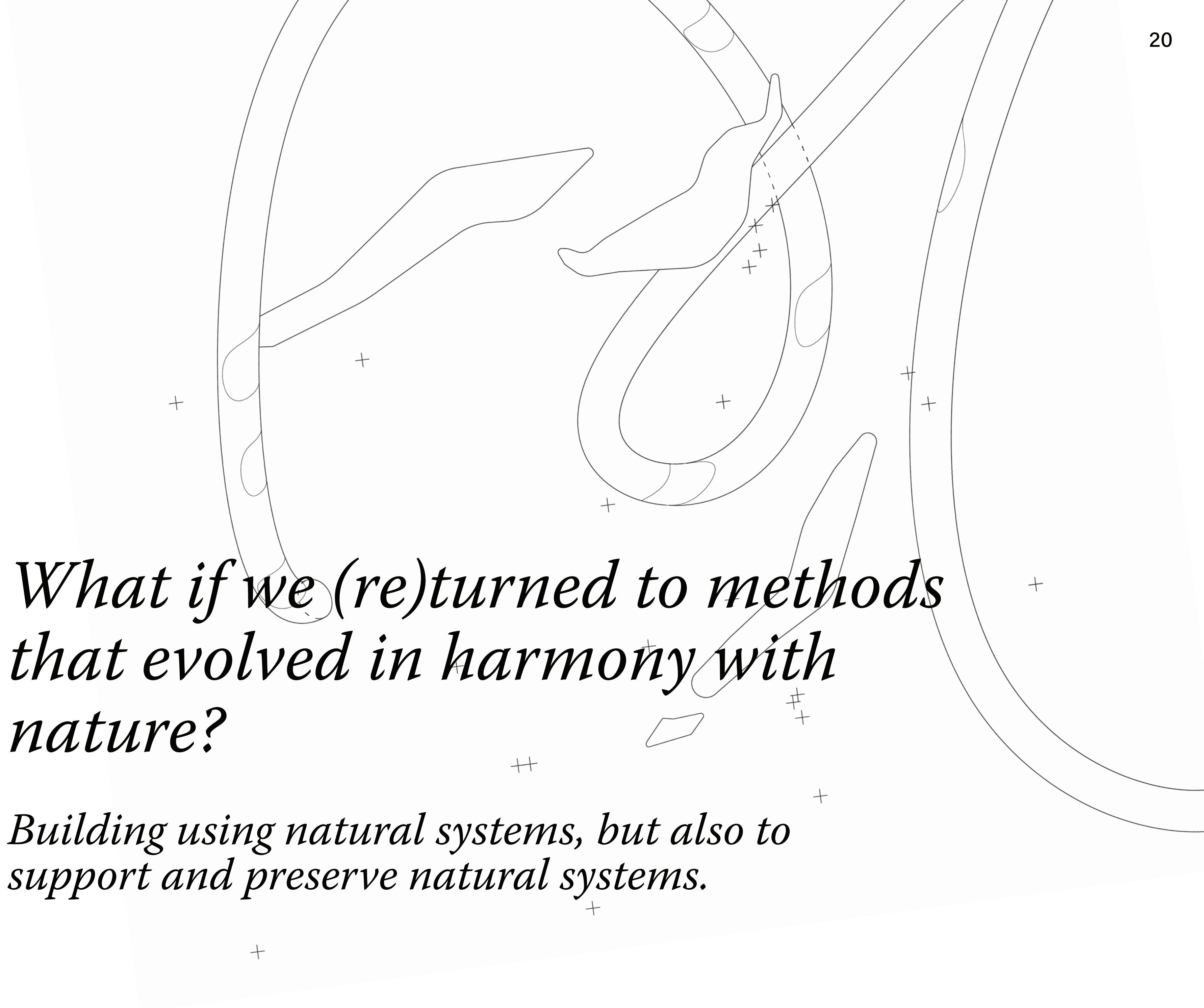


2028

To cater to increased consumer desire for information on the environmental impact of products, manufacturers begin to implement Environmental Impact Rating tags across markets, rating products on their environmental effects and giving instruction on disassembly and recycling.

What if a single scan could tell you the environmental impact and the material value of a product?

Highlighting the past traces and future value of materials.



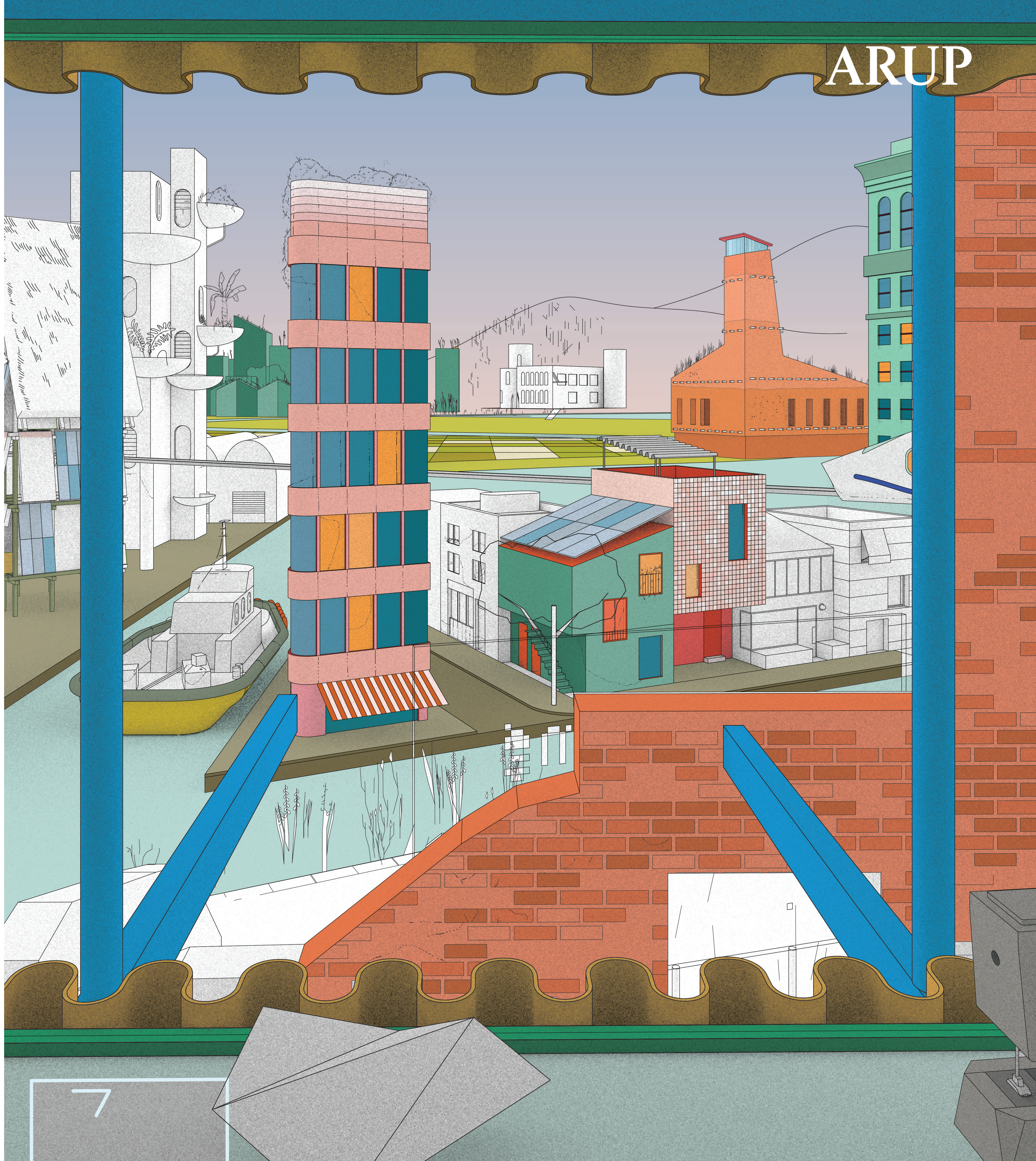
What if we (re)turned to methods that evolved in harmony with nature?

Building using natural systems, but also to support and preserve natural systems.

Collaboration

Fostering a culture of (re)making

Natural ecosystems are networks of mutual relationships, many of which are driven by mutual benefits. Translating this to our ecosystems of making shows how collaboration among all participants can drive regenerative practices and increase efficiency. One entity's waste becomes another's resource, and for the best results proximity is key. Only thus can circularity be achieved.



Competition is healthy inasmuch as it drives innovation, but it hinders processes of 'ex-novation'—the gradual and deliberate fading out of harmful methods that perpetuate flawed systems. Here, collaboration is required to fill the gaps.

The 'Factory as a forest' framework[12] seeks to apply biomimicry to a larger scale, and to implement exchange and symbiosis. This leads us to simplified processes and designs (described above) but to complex webs of interactions.

Diversity, not monoculture, is the foundation of circularity.

Industrial campuses already exist, but they are changing as new manufacturing methods take root and communities demand more in return. Residual heat is recirculated, and the delivery of social value is growing. The natural ecosystems, however, are often still seen as performing a one-way service: water bodies, for instance, are exploited for cooling. If it seeks not only to reduce its footprint but also to increase its handprint, Industrial Symbiosis can go further and deliver a positive impact on its local ecosystem, too.

Successful collaboration requires a fundamental rethink of the stores of value. Intellectual property that is fiercely defended hinders a system-wide improvement. The Open Source movement, which rest on the idea of a creative commons, is growing.

As making becomes more decentralised and democratised—through digital fabrication, through controlled organic growth, through localised workshops, through prefabricated building blocks and on-site robotics—the process of manufacturing certain types of products at scale may become less valuable to companies. Business models will have to change accordingly.

Such a culture of collaboration and 're-makism', that is of a circular economy, rests on a re-evaluation of craftsmanship and skills. The widespread ability to maintain, repair, refurbish and re-use is essential to meeting any of our environmental targets. And there is a clear desire in the population to learn these (evidenced by many YouTube channels dedicated to fixing things). Consequently, new education models that prioritise hands-on skills and system-wide approaches specifically in response to the nature crises are emerging.

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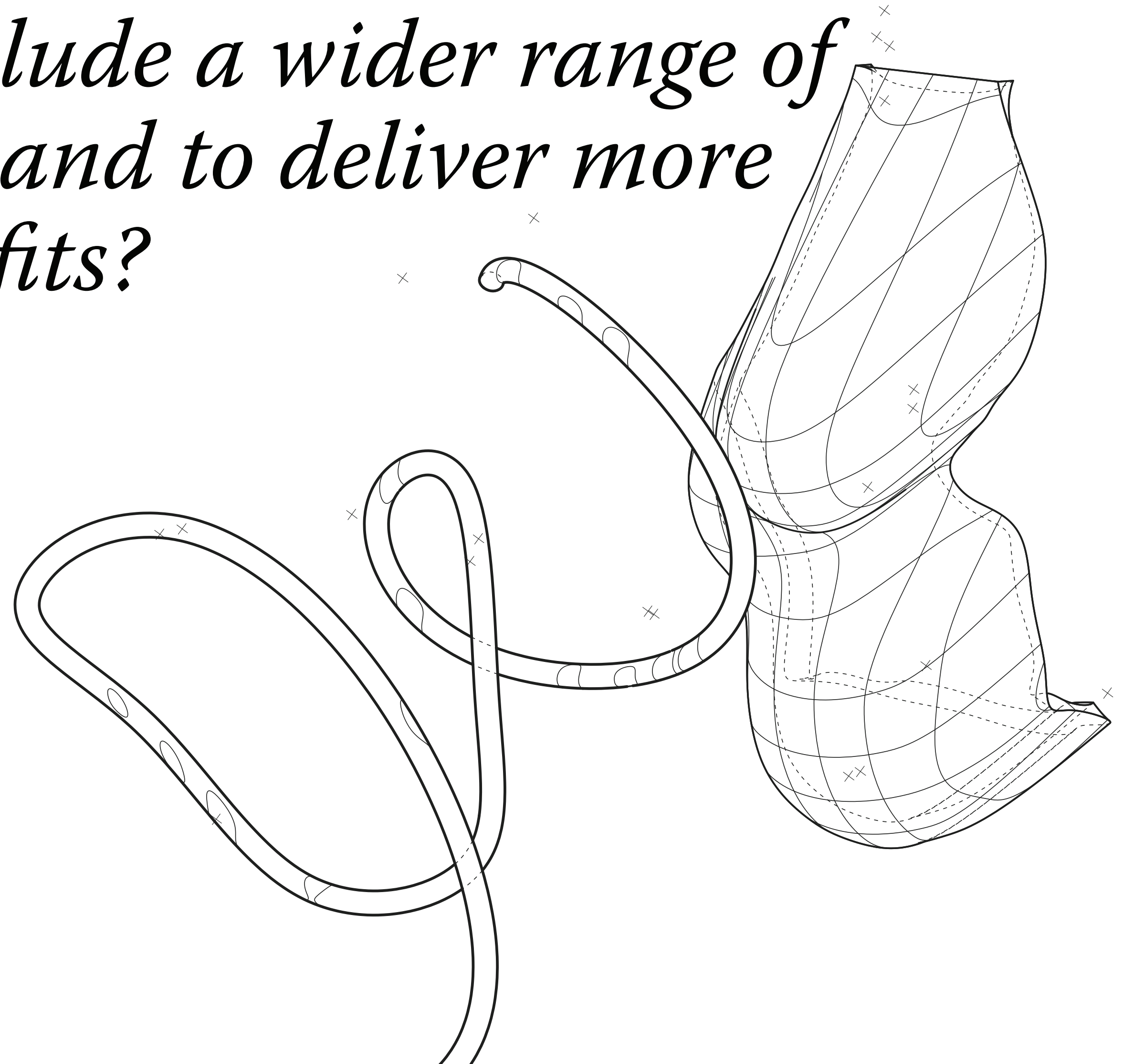
12. Ryan, C. (2018)

Click here to listen to story (web view only):
Common Place

How can we better balance competition with collaboration?

How can our business models change to include a wider range of stakeholders and to deliver more societal benefits?



Case Study

Neighbourhoods of collaborative making

The past years have seen a growth in community maker spaces such as the Newark's Makerhoods. This approach to urban and economic development combines affordable living, shared facilities for manufacturing, and business support. With its focus on neighbourhood and micro-business scales, the model drives both the overall economy and individual prosperity. A core element is the access provided: the provision of spaces, tools and assistance in designing, prototyping and repairing all kinds of items; as well as the power of collaboration.

There are currently more than 2,000 maker spaces like this in the world, indicating a growing culture of making and remaking.

On a social level, these facilities bring people together as they learn from each other or work on projects with their neighbours. It has the potential to strengthen community ties, something also reflected in the rise of community gardening. This improves both individual wellbeing and community resilience.

As living and working move closer together in location, there follows a reinvigoration of the neighbourhood. There is a case for seeing such manufacturing facilities in a similar way to health, educational and sports facilities: as a part of any city's essential infrastructure.

What would you make if you had the tools and space to hand?

Case Study

Rethinking STEM for an age of climate crisis

Founded in 2019, Black Mountains College is based on a farm outside Talgarth in the Brecon Beacons in Wales. Its courses aim specifically to prepare students for careers in times of climate breakdown. With the goal of building a generation versed in the innovative skills and ideas required to tackle the climate crisis, Black Mountains College offers fully-funded vocational training as well as higher-education options. Together with Cardiff Metropolitan University and industrial partners, BMC delivers its radical BA course in 'Sustainable Futures: Arts, Ecology and Systems Change.'

Most classes at BMC relate to nature; with many taking place outdoors. All courses aim to foster an ecological imagination and systems-change approach based on hands-on experience to address some of the world's most urgent challenges. Students learn skills for adapting to ongoing natural crises, building on the latest climate science, neuroscience, environmental history, critical thinking, and making.

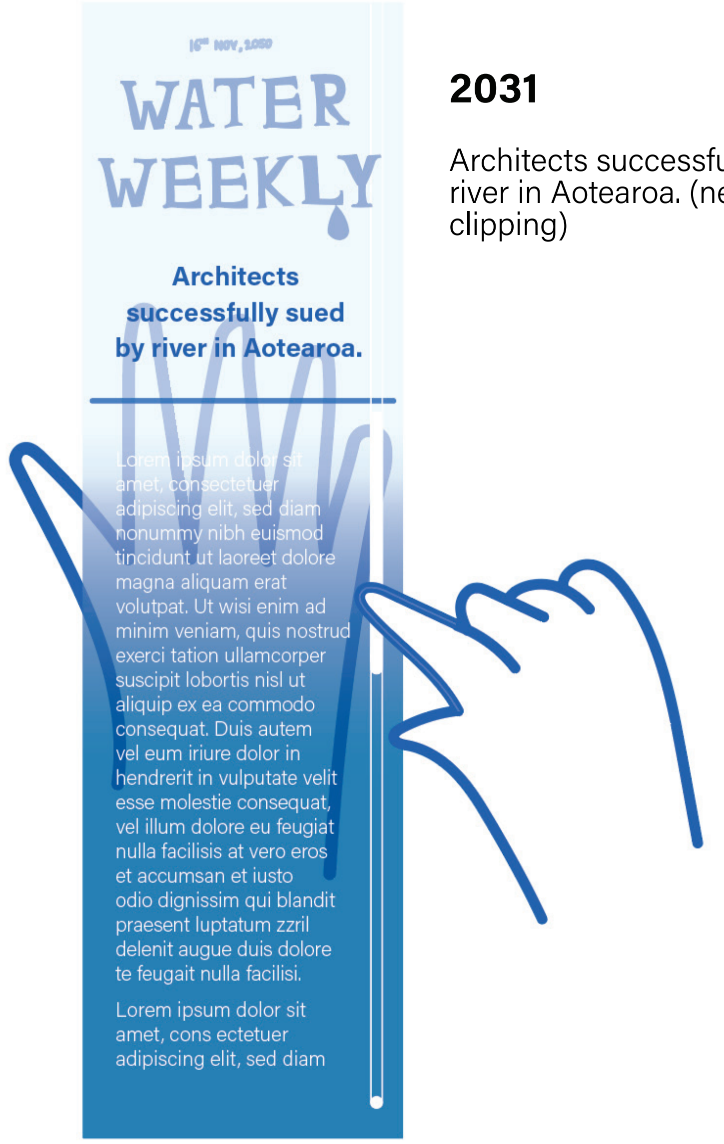
In its first year, the school received over 100 applications from academics wishing to join the staff, indicating a strong desire to increase the amount of climate-focused academic options as well as interdisciplinary education models.

In the future, more colleges and schools that offer climate-literate courses which teach practical skills could better prepare students for a changing social and ecological landscape. Their success could normalise future preparedness and climate literacy as part of national curricula.

What skills would you need to feel better prepared for a regenerative future?

2041

Formerly drought-ridden countries have been saved by regenerative water production and cleaning processes, eliminating water scarcity across the globe.



WATER WEEKLY

Architects successfully sued by river in Aotearoa.

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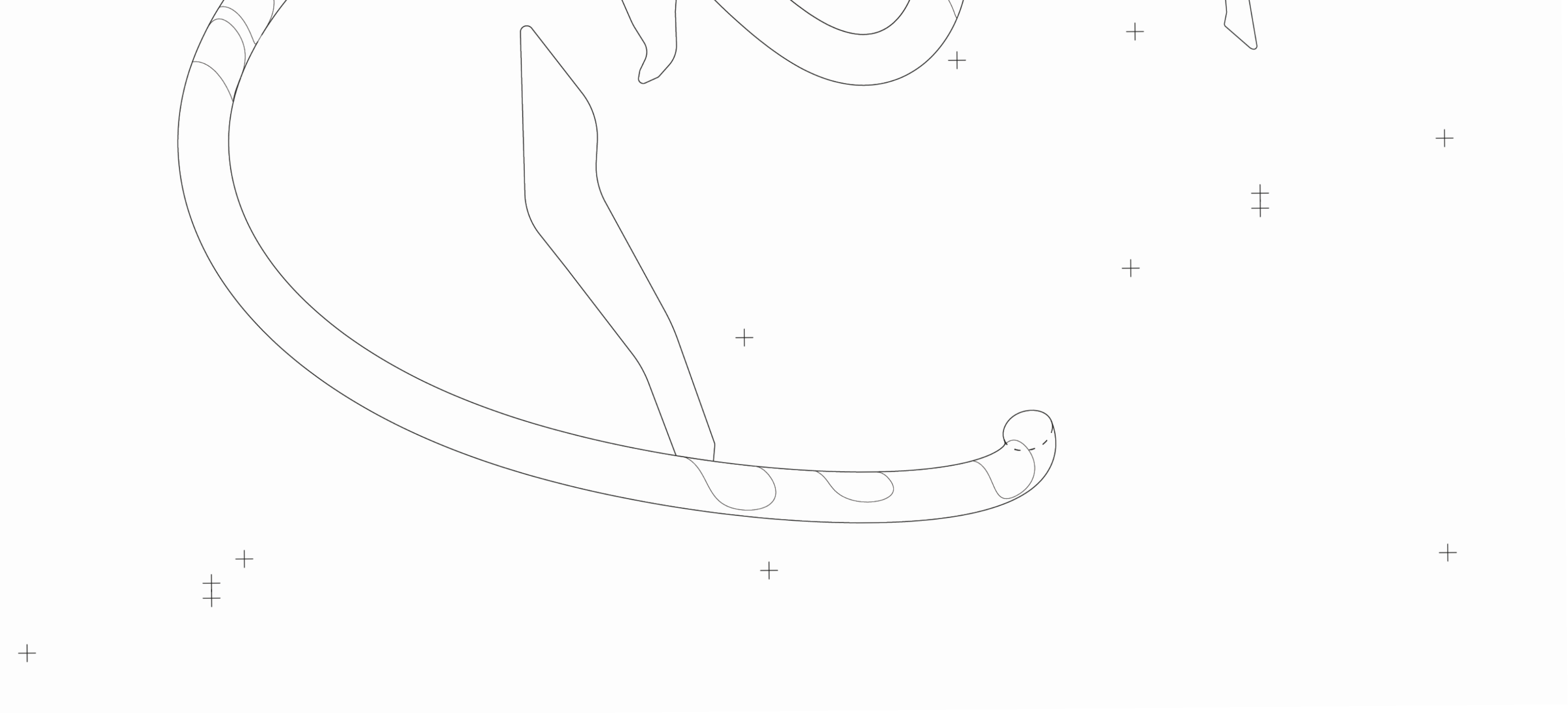
2031

Architects successfully sued by river in Aotearoa. (newspaper clipping)



What if we only used renewable building materials?

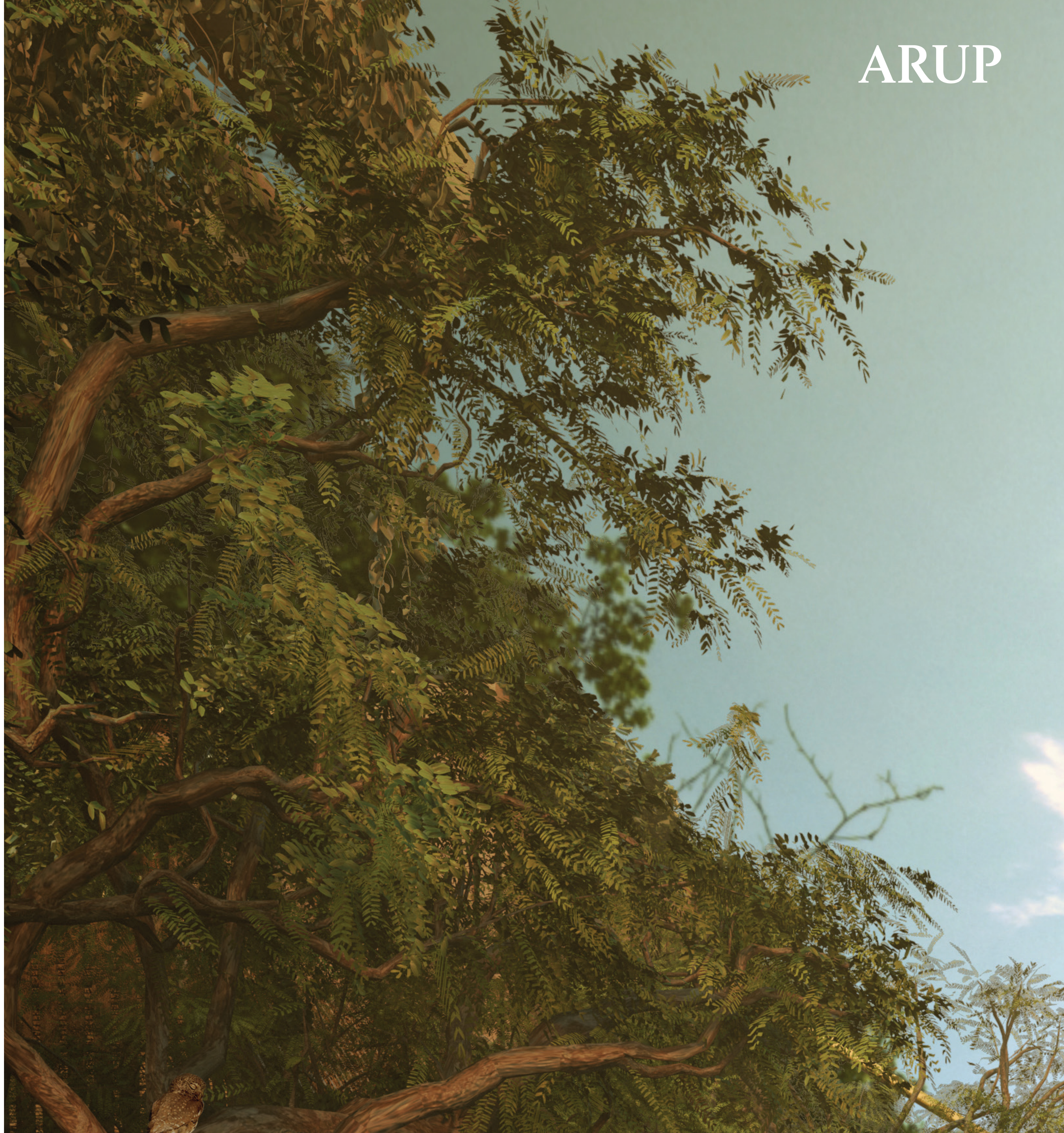
Inventing biodegradable and naturally replenishable construction elements.

ARUP

Deceleration

Rethinking logistics

The movement of products and resources is an essential part of making systems, and also a harmful one. At the urban scale, the so-called last mile has the most disproportionally large impact in the supply chain. This is often due to just-in-time logistics and the correlated notion of speed. Speed has been a key metric of efficiency but it is a root cause of environmental damage. Here, we challenge it.



A proverb attributed to Laozi has it that 'nature does not hurry, yet everything is accomplished.' In contrast, the industrial notion of efficiency tends to have speed as a key metric: faster output, faster delivery. This is reflected in just-in-time logistics that leave no room for delays and is compounded by the long distances that goods travel. Speed, after all, is distance per time.

Deceleration can be achieved by changing both.

As technical processes become less polluting and less energy-intensive, and as making ecosystems return to urban centres, the distances of delivery to customers shorten. This way, a product's last mile potentially becomes its only mile, creating opportunities for the transformation of urban logistics. The move towards more self-sufficient cities may be in its infancy but is underway and gathering pace.

The time dimension, on the other hand, can sometimes be driven by false expectations and received wisdom. One of them is that customers prefer same-day or next-day delivery, which have been shown to be far more carbon-intensive than slower delivery. Some studies show that, when customers are given better information about the environmental damage of their choices, more than half are ready to accept slower speeds in favour of a reduction of their impact.[13]

To become more regenerative, it is important to accept and clarify that there is no such thing as 'free delivery'.

Rethinking logistics at an urban scale can lead us to see movement and delivery infrastructure as a public good, akin to the water supply, which in many places is being (re)municipalised. In the United States, for instance, the postal service remains in public hands and is the largest federal agency.

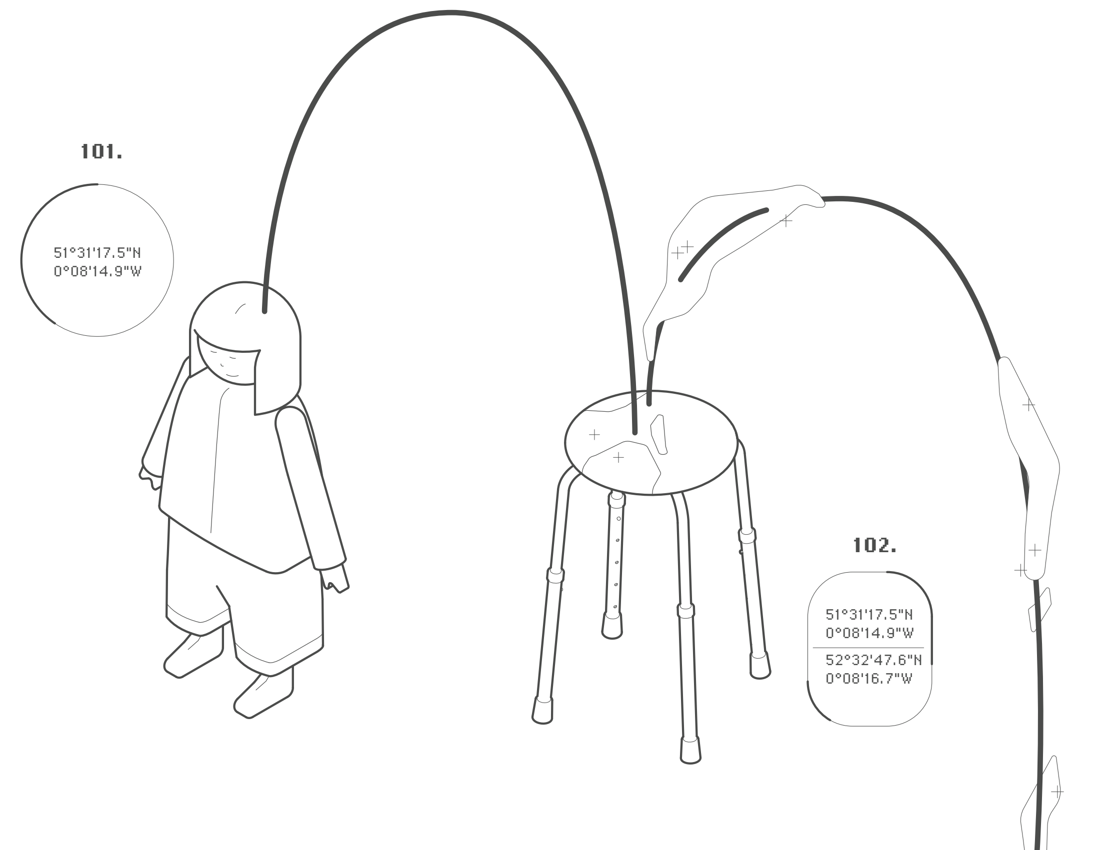
Whether in public, not-for-profit or private hands, well-connected and shared networks of supply-side depots and customer-side storage facilities that are linked not just in a hub-and-spoke way but more as a spider web could make the last mile of goods much more regenerative.

13. PFS Commerce (2021).

Click here to listen to story (web view only):
Slow and Steady

What critical infrastructure that is fragmented could be consolidated for the common good?

How can we slow down our movements at all scales?



Case Study

Demonstrating community-led sustainable development

Findhorn Ecovillage in the Northeast of Scotland has been a UN Habitat model for best practice in sustainable living since 1998. Its holistic approach encompasses education in bioregional literacy, as well as supporting residents to reduce their ecological footprint. The community owns a windfarm that produces more than 100% of the village's electricity needs. Local gardens produce organic food and source vegetable boxes from nearby growers. A wastewater treatment system developed on site uses biological technology and natural processes to purify water so that it can be released into the sea without harm.

The ecovillage's building code underlines the cost-effectiveness of retrofitting and zero-carbon buildings. It pushes for the use of timber that is grown locally in a purposefully managed forest, as well as local stones for skirting and natural clay for roofing. Findhorn is also famous for its re-used whisky barrel constructions.

The strong focus on locally available materials and energy sources helps the residents of Findhorn have half the ecological impact of their fellow British citizens on average, and one of the lowest in the industrial world. This is achieved despite residents' and visitors' larger-than-average air travel, which is due to the ecovillage's remoteness. The community is currently developing ways to create economic opportunity that do not rely on air travel.

Findhorn is also an inspiring model for the 15/20-minute city, where all the facilities and resources a community needs are accessible within a short distance. Scaling up is not straightforward and Findhorn's holistic approach must be adapted to local conditions and needs. The ecovillage does, however, demonstrate how a shared vision, community ownership and regional action can deliver great results for both people and planet.

What could your place and community learn from Findhorn's low-impact, locally sourced living?

What if everything the city consumed was produced locally?

Achieving a local balance of production and consumption.

Case Study

Challenging cities to produce (almost) everything they consume

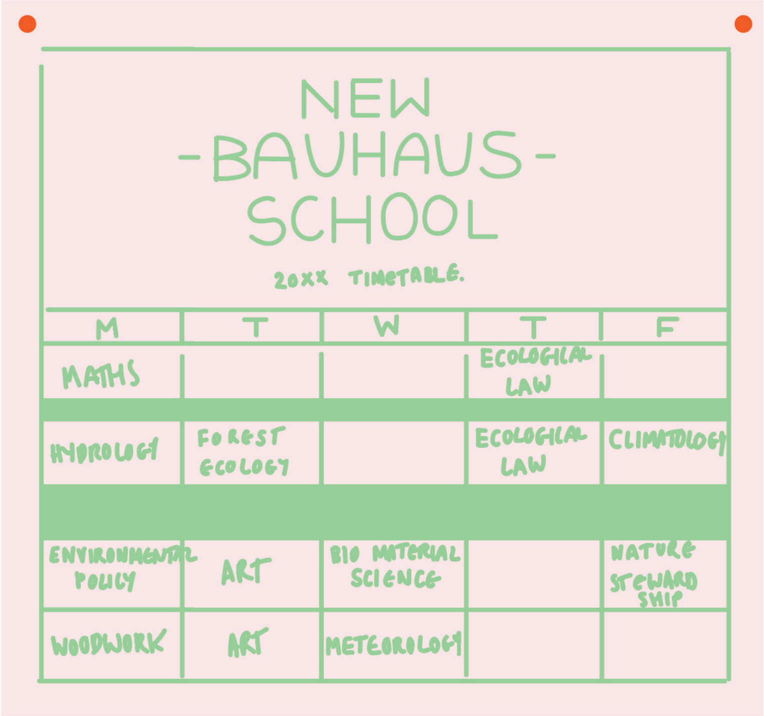
The Fab City Challenge is an international initiative launched in 2014 by the then-mayor of Barcelona, challenging cities to become self-sustaining by 2054. Since then, the project has expanded into a global network of 40 cities, 11 regions, 1 island and 2 countries who cooperate with each other to improve, implement, and exchange their sustainable urban practices.5 The tag line is "to produce (almost) everything you consume".

In 2018, the Fab City Manifesto was published, containing 10 guiding principles for promoting sustainability and liveability with actions at local and regional levels. Additionally, the Manifesto explains a new socioeconomic model based on local manufacturing infrastructures and globally distributed data. The ambition is for localities to shift from a 'Products In – Trash Out´ (PITO) to a 'Data In – Data Out' (DIDO) system. This is possible thanks to small and micro-manufacturing facilities and new technologies.

Today, the Fab City Foundation and Initiative continues to recruit city leaders, enthusiasts, researchers, industry actors, and policymakers to promote collective action and co-designed solutions for the common wellbeing of the planet and the self-sustainability of cities. Through the development of projects for social innovation and courses on urban innovation, as well as its development of research materials, Fab City helps localities across the world transition to a circular and equitable economic model.

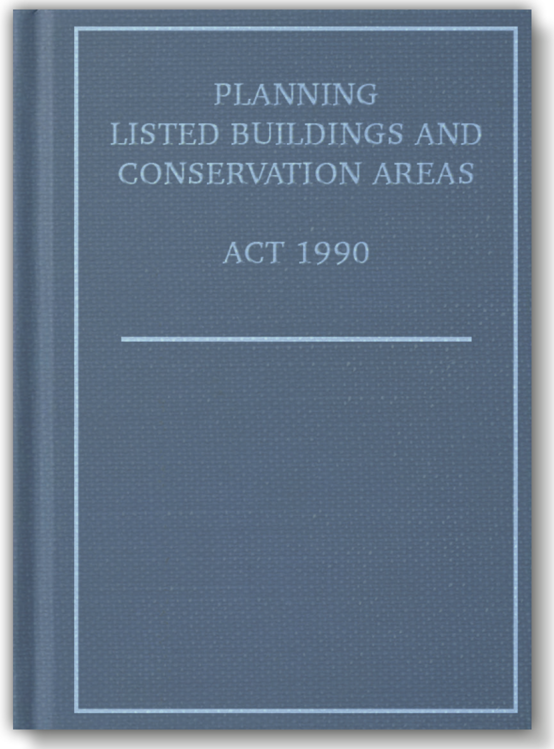
The Fab City Challenge is an ambitious goal that may never be realised, but it highlights the power of mission-driven collaboration over competition. Sharing best practice and innovation is an essential part of sustaining regenerative goals.

Which models and innovations could your city or hometown learn from?



2033

New Bauhaus school opens, accepting 10,000 students. The Bauhausian model of education and design is flipped on its head: the emphasis shifts from arts and crafts for mass production to a total work in service of nature.



2029

Stricter regulations are implemented for the demolition of buildings in the UK. The new grade III listing requires a strong case for demolition and the mandatory reuse of materials on the same site.

All new buildings are automatically grade III for 99 years.

What if nature was your primary client?

Prioritising ecological resilience and avoiding any practices harmful to nature.

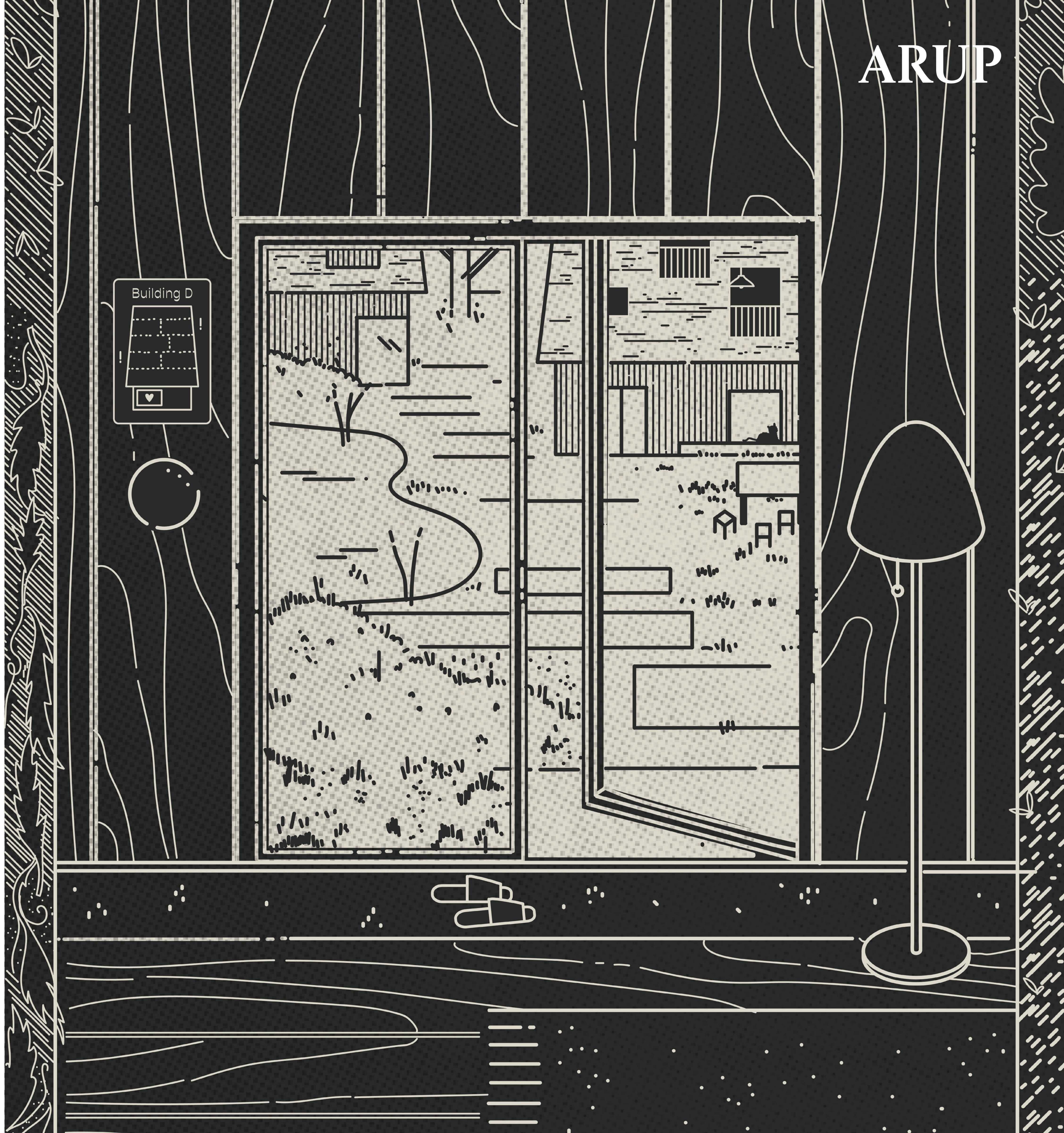
What if urban centres became hubs of making?

Shifting the focus from economic production to fostering skills and resilience.

Re-use

Re-evaluating products and spans

In the 'take-make-waste' model, the period between 'make' and 'waste' is fairly short. Completing the circle means to abandon the idea of waste, as we've discussed, in favour of recovery. We can also extend the period between 'make' and 'end-of-life'. This takes us back to value, this time of a product. Extending product lifespans by preferring re-use and repair over recycle, helps us to achieve a more regenerative future.



Planned obsolescence is a crime against the environment and against consumers. Though this is not strictly true in legal terms, several companies around the world have already been sued for practices of planned obsolescence.[14] This marks the beginning of a shift towards making producers responsible for the longevity and impact of their products.

Anti-obsolescence is a growing sentiment. The Right to Repair is becoming more widespread and entering legal frameworks, requiring manufacturers to provide spare parts and to make repair and disassembly easier. This could make durability through repairability a new parameter for successful design, and some brands are already offering unconditional lifetime guarantees on products—including one manufacturer of notoriously breakable umbrellas (Davek, in New York).

On the consumer side, perceived obsolescence drives customers to replace products before their end-of-function. This is partly cultural—countries like Japan and Germany tend to have longer product lifespans than others—and partly driven by marketing: artificially creating increased demand in the pursuit of a linear, infinite growth.

Planned and perceived obsolescence also exist in buildings: most buildings are razed to the ground well before their technical lifespan, most frequently for reasons of economic profit.

Introducing re-use, modularity, repair and maintenance to increase the lifespan of products and buildings is essential. This can be done technically, through skills, and through regulatory incentives. Another lever is that of emotional attachment, which has been shown to increase care for a product and building.

Economically, there are emerging business models that turn 'sharing' into a profitable endeavour: this manages to extract more value out of individual goods through a much-increased use of them, and a reduction in their idleness. While, at the same time, a sharing economy reduces the need for ownership, hence overproduction of goods.

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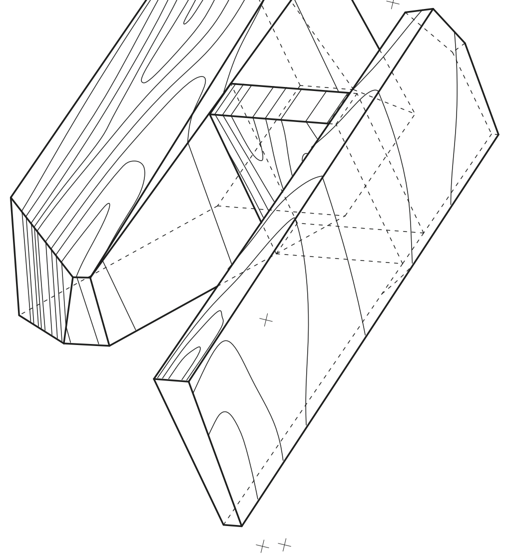
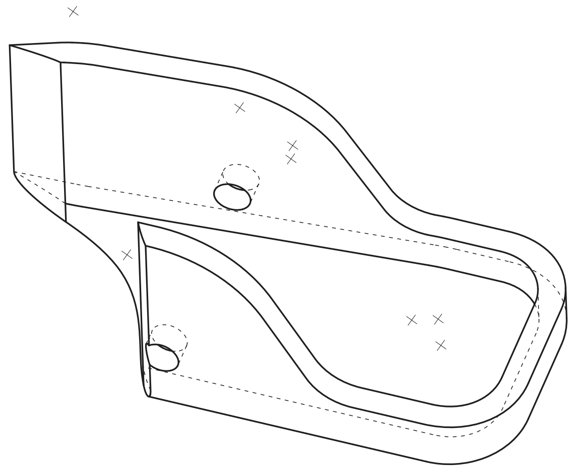
14. Bisschop, L. et al. (2022)



Click here to listen to story (web view only):
What We Leave Behind

What models and incentives exist to extend the lifespan and use of products and buildings?

How can we avoid obsolescence altogether? How can we close the loop of the making system fully?



Case Study

Thousand-year buildings

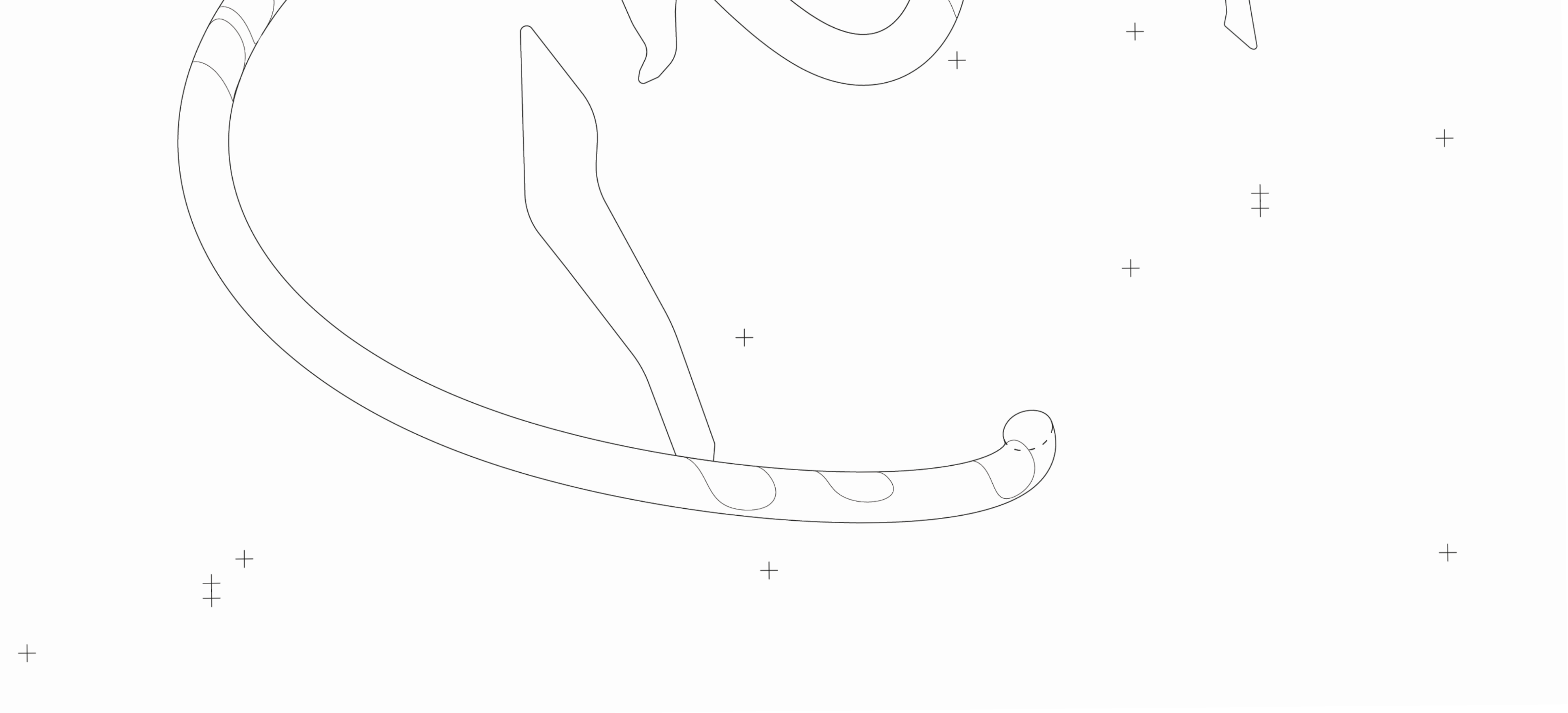
Saltford Manor in Somerset, UK, is the oldest continually-inhabited private house in England. Built in 1148, it has had a series of alterations and additions made to it over the centuries by a succession of owners. For instance, in the 15th century, the cellar was turned into a living space and the hall horizontally divided into two floors.

The buildings best-known for their longevity tend to have administrative, religious or educational purposes—cathedrals, universities, town halls or lighthouses, for example. Saltford Manor demonstrates that, even in the private sector, continued maintenance and adaptation help to extend building lifespan and reduce the need for new construction and new materials.

The vast majority of razed buildings are brought down because they no longer deliver economically. This is an example of 'perceived' obsolescence. Saltford Manor shows the potential that lies in defining a different kind of value—the emotional attachment owners have had to the dwelling has bolstered their care for it. This is reflected in ideas of custodianship rather than ownership.

Valuing this kind of custodianship could be applied to commercial sectors to support longevity: incentivising building caretaking for future growth and opportunity rather than present-day profits only.

How could you contribute towards a culture of caretaking for longevity?



What if we built buildings to last for 1,000 years?

Prioritising longevity and designing for future generations.

What if we had materials that didn't cost the Earth?

Exploring non-toxic alternatives to plastic.

Case Study

Creativity as the fabric of remaking

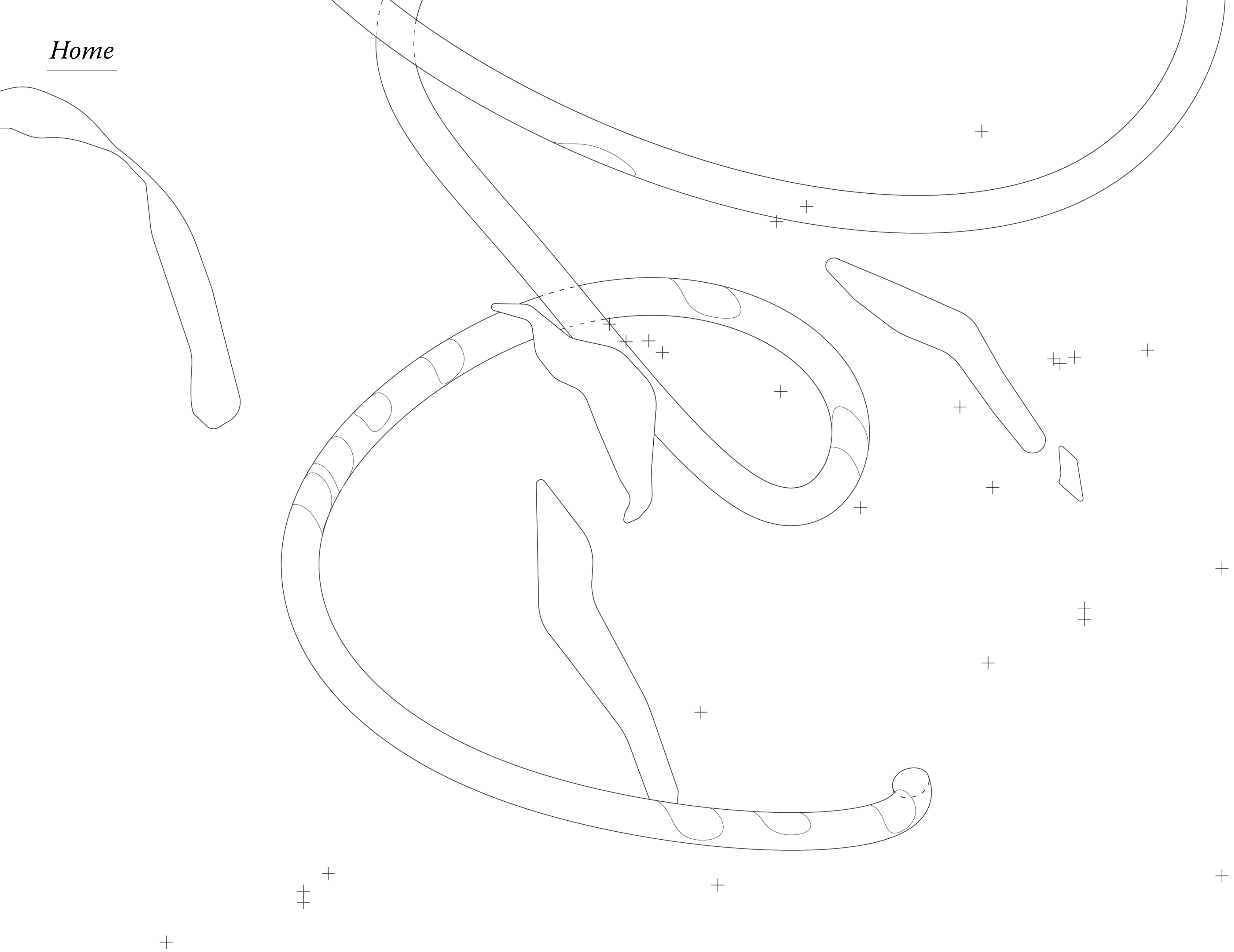
RÆBURN is a fashion brand based in East London, whose founding philosophy and values revolve around remaking: the reuse and upcycling of materials. The first collection of their founder, Christopher Raeburn, used decommissioned military stock to create limited outerwear for men and women. From woollen field jackets to nylon parachute canopies, each 'RÆMADE' style is produced by meticulously deconstructing the original and reworking the materials into unique, limited-edition garments.

Raeburn has also partnered with global brands such as Timberland to scale up re-used and mono-fibre materials that could be more easily deconstructed and re-used. This incorporated circularity and disassembly into the design itself, marking a shift in mindset.

The team actively seeks out disused materials, such as life rafts, parachutes, uniforms and sports kits. They trawl vintage markets and warehouses, and their work aims to prove that there is no such thing as waste. Taking a system-wide approach to resources, materials and goods circulation can help us to reduce the vast amount that goes to waste at the end of its life.

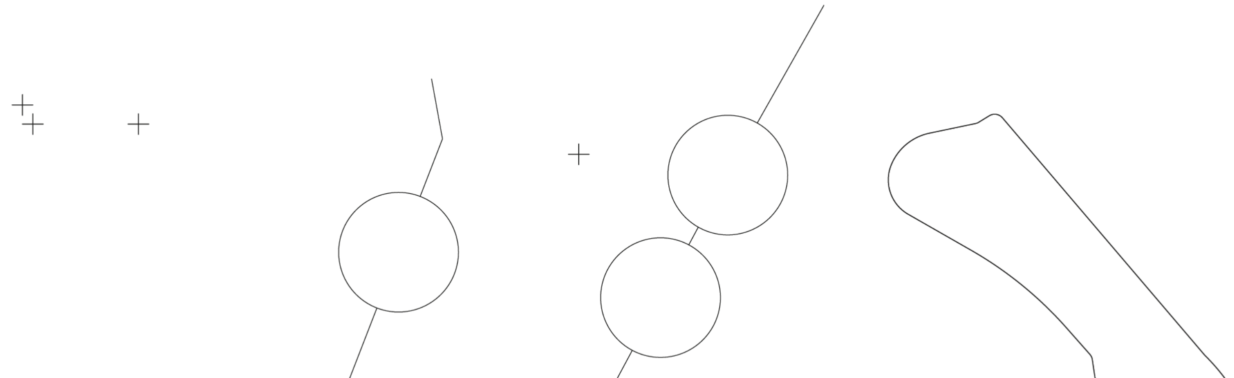
Pioneering responsibility in design, the brand also shows how the upcycling of materials can deliver viable circular models. Raeburn brings creativity and open-mindedness to the core of an industry often accused of high environmental impact, and it provides a replicable model for other fashion brands seeking to become more sustainable.

What disused materials could you remake into something you need?



What if ‘regenerative’ was the most desirable feature of products and buildings?

Prioritising lifespan and longevity when we make new things.



A note on our methodology

Foresight, also called 'Futures Thinking,' is not about prediction. It is about exploring a wider range of possibility. We all hold assumptions about the future, whether we realise it or not—based on current norms, on our own experiences, and on the stories we are telling one another on a daily basis.

The tools and techniques of Foresight first make us aware of those assumptions, and about the forces and factors that are shaping our context. They then allow us to construct a variety of futures that are *possible*, not just probable. As a result, we can think more clearly and critically about what futures are preferable, and for whom.

The development of Future of Making followed a typical Foresight process, drawing heavily on design research (and featuring many iterative loops along the way):

1. *What is changing?* Horizon Scanning to gather intelligence from diverse and credible sources regarding our changing operating context, from established trends to weaker signals of change.

2. *So what does that mean for possible futures?* Structured and gamified world-building exercises to bring detail and richness to verbal and visual images of futures, as well as challenging our assumptions about what exists in those futures.

3. *Now what does that mean for materials and making?* Identifying recurring themes and bringing structure to our view of possible future systems. Development of a navigable framework and emotive stories and artefacts.

The head and the heart

Whilst *Future of Making* is accessible online, it was originally conceived as a physical book and an exhibition. The intent is to create a tangible experience that informs, inspires and instigates change, and reinforces materiality (things you can touch!).

As human beings, we are primed to make decisions emotionally. This creates a bias towards the present because "emotionally, the future is not real".[15] What affects our emotional decision-making, however, is often cultural, the result of a continuous exposure to narratives and values.[16]

This is why we use stories and speculative fiction, future histories and 'what if?' prompts, inspiring case studies and visions of a future that speak to the heart as much as the head.

You can listen to our six stories by clicking the 'play' buttons on each chapter title page, or read them at the back of this publication.

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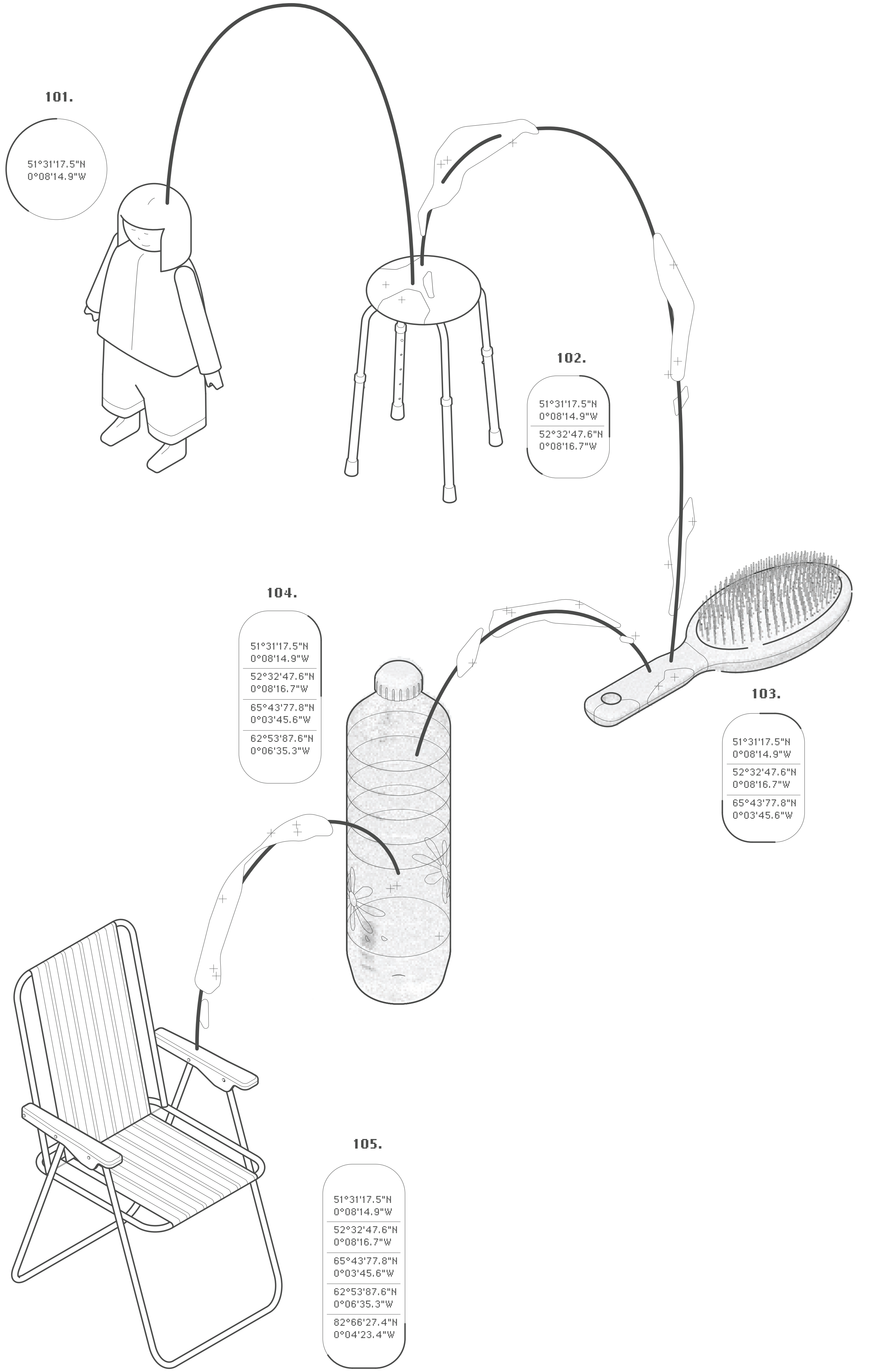
15. Hagens, N. J. (2020).
16. Gazzaniga, M. (2012).



Get in touch

Foresight can help your organisation anticipate, and shape, better futures.

Want to bring the Future of Making into your own space? Get in touch:
foresight@arup.com

Connect with Arup's Materials specialists:
materials@arup.com

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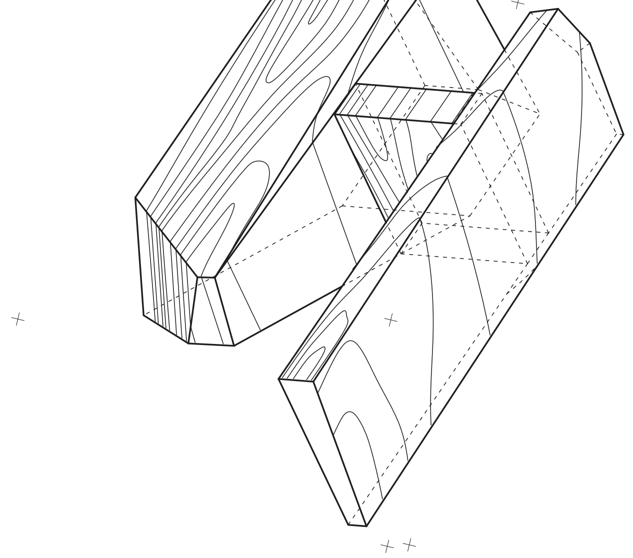
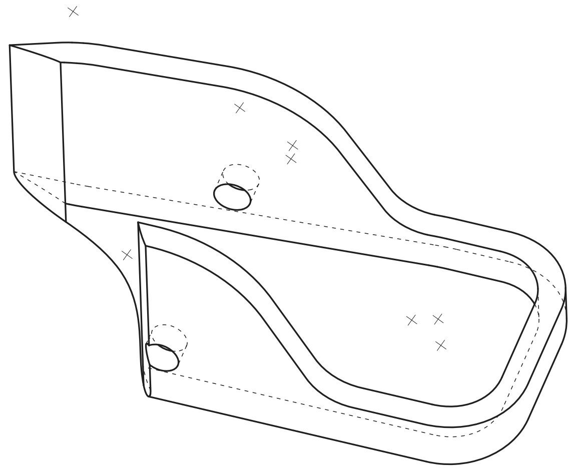




Speculative fiction

Six stories of a future of making

To become regenerative designers, we must first imagine a regenerative world. These stories aim to put a human (or material) lens on possible futures and to make them more emotionally real. Read more about their role in our methodology section.

They are purposefully non-specific on time and place.

The Unconventional Detective

The Unconventional Detective

The street was relatively quiet, the midnight glow of the streetlamps casting the sidewalk in a soft, pale orange. People often questioned their love of the night shift, but Chi genuinely enjoyed it. There was a stillness to the city in the dead of night that seemed to enhance colour, sound and smell.

The bioluminescent sign in the window read OPEN. As Chi entered the threshold, their co-worker Ana greeted them, her bag already on her back and her keys twitching impatiently in her hand. Chi had started working this shift in their first year of university, recruited by their professor of forensic materials. It was meant to be a temporary gig, but the value placed on materials recovery by the government had steadily increased over the course of their studies, leading to a demand for more 'librarians,' and the library had taken them on full-time after their graduation.

The pay was low, but Chi viewed the role as a privilege. They now saw first-hand the outputs of the foragers they had studied at university; both licensed and unlicensed - and of those who had


Today's Waste
Tomorrow's Solutions
INSTRUMENTS
樂器
CERAMICS
陶瓷


LIBRARY
PLEX)
ELECTRONICS (SIMP E)
簡單的電氣
FURNITURE
家具

discarded items without proper care, leaving them with spotty or unreliable material information. Licensed foragers were trained to retrieve and log materials safely – careful dismantling, extraction and gathering of information was part of their job and they were bound to a strict code of conduct. While members of the public were encouraged to bring in household and scrap materials, unlicensed foraging from waste sites was forbidden.

But Chi's job wasn't to judge anyone. Their job was to investigate the materials that were brought in, to find and log their properties and potential uses on the database. The database could be used to match materials with potential buyers and some were snapped up quickly, off on the journey towards their next incarnation. Other materials remained in the archive for the time being, waiting for a buyer, or to be processed by a senior technician if they were dangerous. Chi sorted objects, aided by their trusty material scanner. Even hazardous or seemingly useless materials could be repurposed, and it was their job to locate that glowing grain of potential.

The sound of the door opening snapped Chi out of their reverie. The first dropper of the night. Looking up, Chi waved.

"Hey Aaron, not seen you in a while."

Aaron was not the usual forager. A quiet 19-year-old, always dressed in black with messy hair and distracted eyes, Aaron never let on exactly where he found his materials, but Chi felt kindly towards him.

"How's your son doing?" Chi asked.

"He's fine... yeah. Well, he's—" Aaron paused, looked at

Chi, but then seemed to change his mind about saying anything further.

"What've you got for me today?"

"A lot of the usual, some mycelium insulation - this bit over here I'm hoping is all copper wire. I did the tracing scan, and they seem pretty well accounted for."

Chi smiled, appreciative of Aaron's efforts as they began to unload the materials together. Professional miners always scanned their items before bringing them in, while everyday citizens tended to skip this step. If everything was accounted for – the objects components and all the previous lives they had led in various formats – then Chi could catalogue the materials straight away and bring them one step closer to their next incarnation. While Aaron had no professional mining experience, he did his best to make Chi's life easier.

Aaron looked down, fidgeting a little. His cart was now empty, but he had a tote bag hanging from his left shoulder.

> "Anything else I can help you with?" Chi asked.
>
> "Well, there is one thing. I did find this other scrap, but I'm not exactly sure what it is. I tried to do the scan, but all that came up was 'missing information' from 2048 to 2050. Do you think it's worth anything?"

Chi had long suspected that Aaron dabbled in both worlds – earning money in a legal way by bringing materials to the library but also by selling information about where black market and possibly illicit valuable materials could be found. They knew that Aaron supported both his toddler and his mother by working two jobs and scavenging on the side, and so they always tried to give him the best possible deal without prying too much into details.

"Why don't I pay you now for the wire," Chi said, "copper's been scarce lately so you'll get more for it than you usually would. Then I'll ping you a message when I'm done looking at the rogue material, let you know how much it's worth."

"Cool," Aaron mumbled, avoiding eye contact with Chi. "I appreciate it."

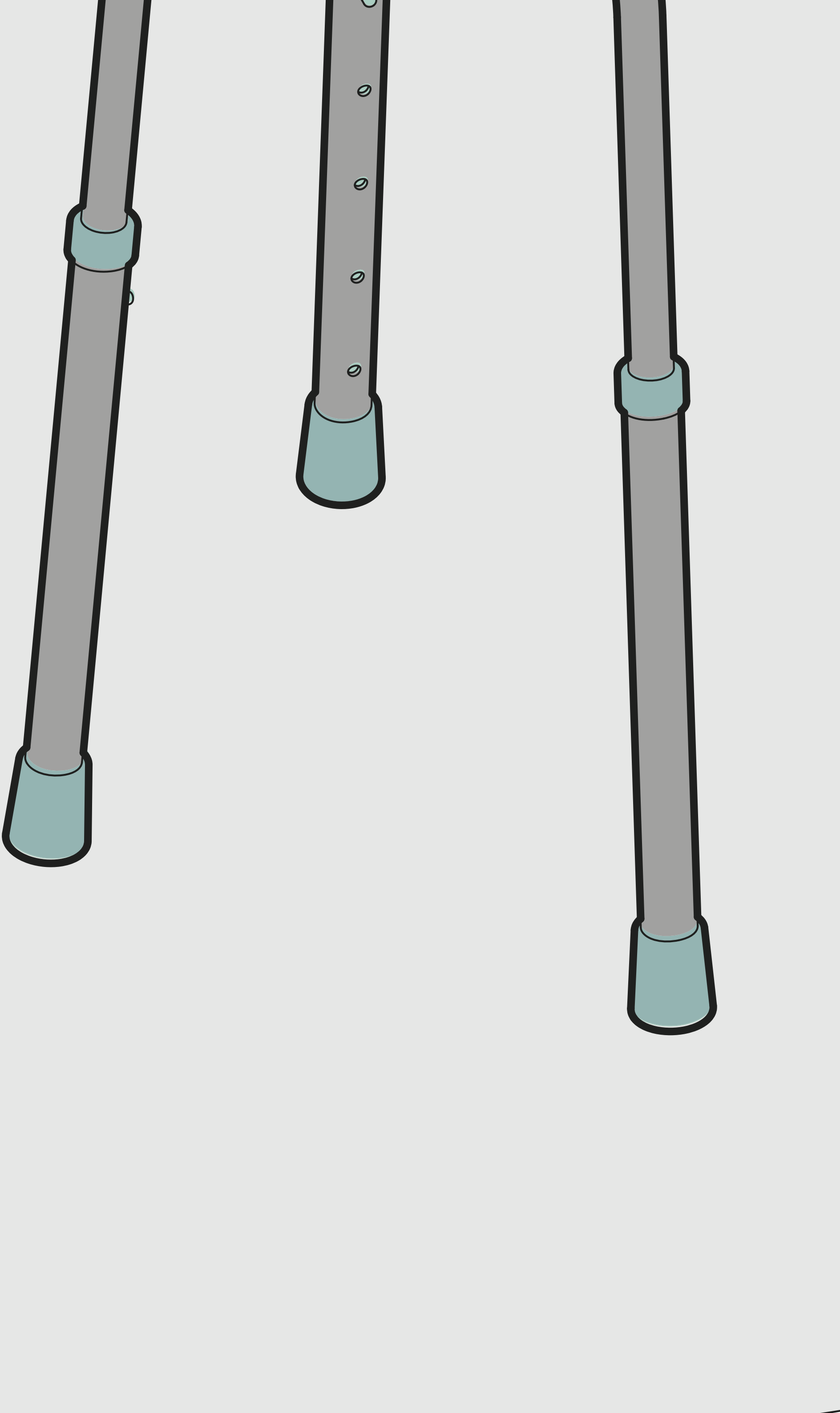
After the exchange Aaron disappeared into the darkness, leaving Chi to do their favourite part of the job – the investigation. First, they archived the brick and wire in the construction sections, where they would be scanned and catalogued with the correct information. After completing this update, Chi put on their gloves and moved to their makeshift desk area next to the till.

Aaron had been right about the scan. Immediately, an alert appeared with ‘missing information’ for the past two years. Placing it on the scanner’s rotating platform for 3D modelling, Chi selected DEEP SCAN from the holographic menu. Chi could see that this material had had a long life and had been used all over a 100-kilometer radius from where it ended up, unceremoniously dumped in a ditch. Some sort of plastic composite, it had existed as a toy, a medical stool in a hospital, the handle of a hairbrush, and a reusable bottle before its trail had gone cold.

While the report was supposedly complete, Chi noticed a disparity between the reading and the material texture. They took out their tools and scraped a bit of the material off, putting it in a petri dish and examining it under their microscope. Chi felt sure they could detect more than the scanner and used their forensic skills to piece together the clues from the material. They input their own findings along with the correct report information into the government database tool, which used AI to collate the data. After a few seconds, the screen displayed the results, reading that the material was most likely recently part of a lawn chair.

Chi logged this information in the database and the digital material passport. Reading further, the report listed recommendations, including ‘Could benefit from being bolstered with biomaterial for extended use’ and ‘Recycle Options: Polyprop fiber, toothbrush bristles, insulation’ and ‘Decomposition bacterium: ideonella amandiensis’.

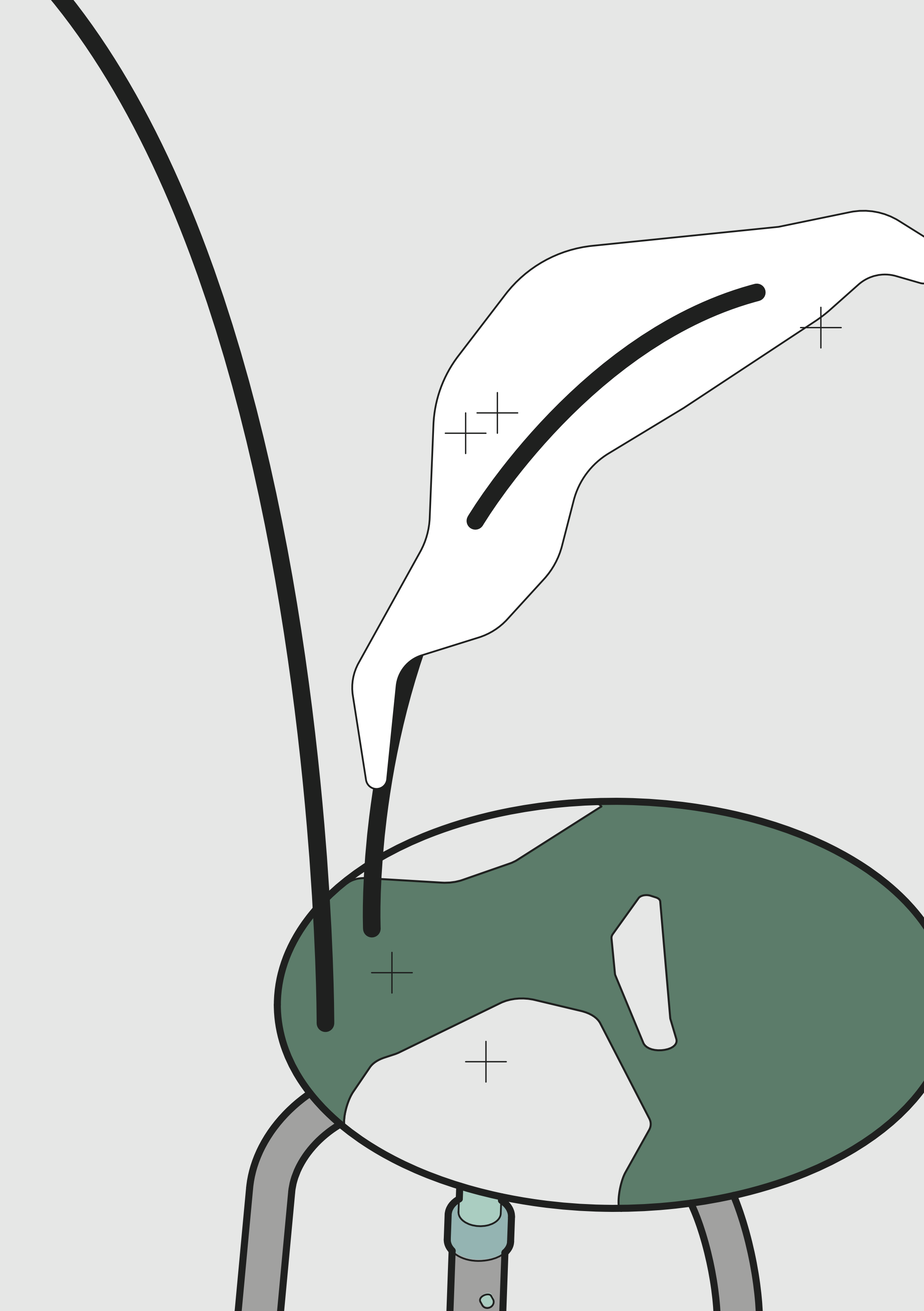
When Chi clicked “PAIR WITH BUYER”, a list appeared on the screen of nearby factories and individual makers who were looking for this material.



Chi found a candidate immediately – a local NGO that specialised in breaking down materials and returning them to the nature. A worthy cause, but they also knew that Aaron could probably make more from it on the black market. Chi hesitated for a moment, then quietly changed the material weight in the database, before carefully using their tools to cut the material in half.

After putting half of the material in their bag, they put the other half on the 'Reserved' shelf, selected the NGO as the top buyer and assigned them a pick-up slot.

Outside, the sky was starting to brighten, the dark receding to leave a blue fade in its wake. Those with early shifts or long commutes were emerging sleepy-eyed from their homes to replace the nightwalkers and revellers. Through the library door came an unfamiliar figure, dragging a cart that seemed to weigh as much as they did. Smiling to themselves, Chi reset their scanner, ready to take on the next project.




Metamorphosis

Metamorphosis

DIARY ENTRY #000

Date: June 16, 2023

Material: Recycled Plastic Pellets

Material Information:

62% Polyethylene

19% HDPE

19% Polypropylene

Use: For the manufacturing of plastic goods.

Plastic type 487P: Created through a combination of plastic types for commercial use. Sorted, shredded, and reprocessed at Rio Circulo Plastic Plant. Melted on May 8, 2023. Ready for use as substitute for virgin plastics.

Diary Entry #596:

Date: August 4, 2029

Use: Doll (Model TY707S-6).

Owner: <private individual, ID masked>.

It was <name masked>’s first day at her new school today. She is growing so quickly. I know she is afraid of the other kids, she whispers it to me every night. She hugs me tight. I am so glad that even as a simple object, I provide her comfort.

Diary Entry #722

Date: January 30, 2033

Use: Hospital Stool (Model HS918D-2). Owner: Manizales County General Hospital.

Today I held 18 patients and family members. One sat squeezing the sides of my seat, nervous, waiting for news from the doctors that always seemed to take an eternity to arrive. Another cried – happy tears – as they were called in to see their new baby. And then the worst, always the worst – feeling the tenseness as someone receives bad news. It’s hard here. I must remind myself my job is important.

Diary Entry #900

Date: April 10, 2039

Use: Hairbrush Handle (Model PL228Y-7). *Owner:* <private individual, ID masked>.

Brush, brush and brush again. Every day I brush.

Diary Entry #999

Date: March 4, 2044

Use: Lawn Chair (Model CX843T-4). *Owner*: Sunset Hotel, Esmeraldas.

Sitting in the sun really never gets old, it almost makes the rainy days worth it. From my perch I can see the street, children playing, dogs being walked. A dog tried to chew me once. I don't think it liked my taste.

Diary Entry #1027

Date: December 18, 2047

Use: Lawn Chair (Model CX843T-4). *Owner:* Sunset Hotel, Esmeraldas.

Today I broke. I hate breaking – not knowing what is coming next. I'm in some sort of box? I can't see. Where am I going!?

Diary entry #1049

Date: N/A.

Use: N/A. *Owner:* N/A.

Time passes slowly as I watch the bikes passing by behind the fence with the NO TRESPASSING sign. I feel myself accumulating dirt and grime – and for the first time in my life, I feel worthless. Who dumped me here?!

Diary Entry #1053:

Date: N/A.

Use: N/A. *Owner:* N/A

Metamorphosis

Somehow, I'm still in the dirt. Life brings its changes – that's part of being used in so many things, after all. But this is treatment I've never experienced before, just being dumped in the middle of the night on the side of the road, as if I will never have a use ever again! Quite scary really, being smashed, taken away in the darkness, then thrown unceremoniously into a ditch. I don't recommend it.

PRESENT DAY.

After what seems like a lifetime, I am picked up and put into a box. There is some wire, some bricks. I'm not sure where I'm going – I think these items were for construction – something I myself have never been involved in, but hey – even an old dog can learn new tricks. I can feel myself moving, jostling around with the other materials. Suddenly we stop. I'm separated from the rest, lifted out and put into a tote bag.

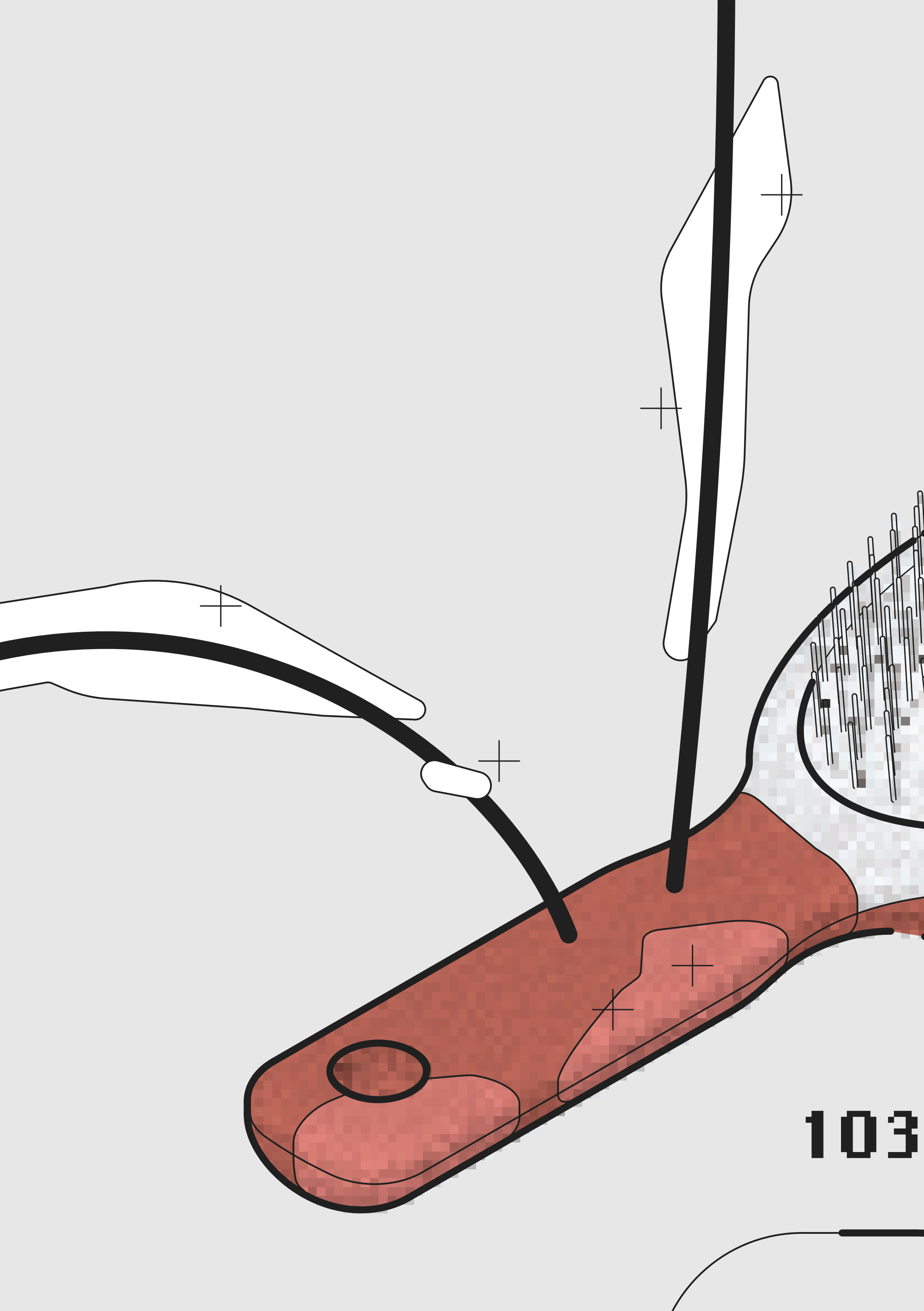
"Hey Aaron, not seen you in a while... anything else I can help you with?'. I hear the person who saved me. He explains where he found me, how he doesn't know what I am.

"Why don't I pay you now for the brick and the wire, and I'll send you a ping when I'm done looking at the rogue material, let you know how much its worth."

I'm gently picked up by gloved hands.

The humming of the particle scanner lasts for a long time. I feel Chi gently splitting a part of me away, placing it in their backpack. They gently place the rest of me on a shelf marked 'Reserved'. I feel lighter. The following day, someone arrives at the material library. From their discussion with Chi, I gather that they have some use for me. Before I know it, I'm boxed up and leaving the library.

When I'm eventually unpacked, I'm placed on yet another lab desk. There are plants – or are they plants? Materials of all sorts seem to be climbing the walls and stringing their way across the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high, glass-paned ceiling. Some of the materials are growing along pre-built structures, some are self-sustaining – I can see something that looks like the mycelium-based material I was taken to the library with.

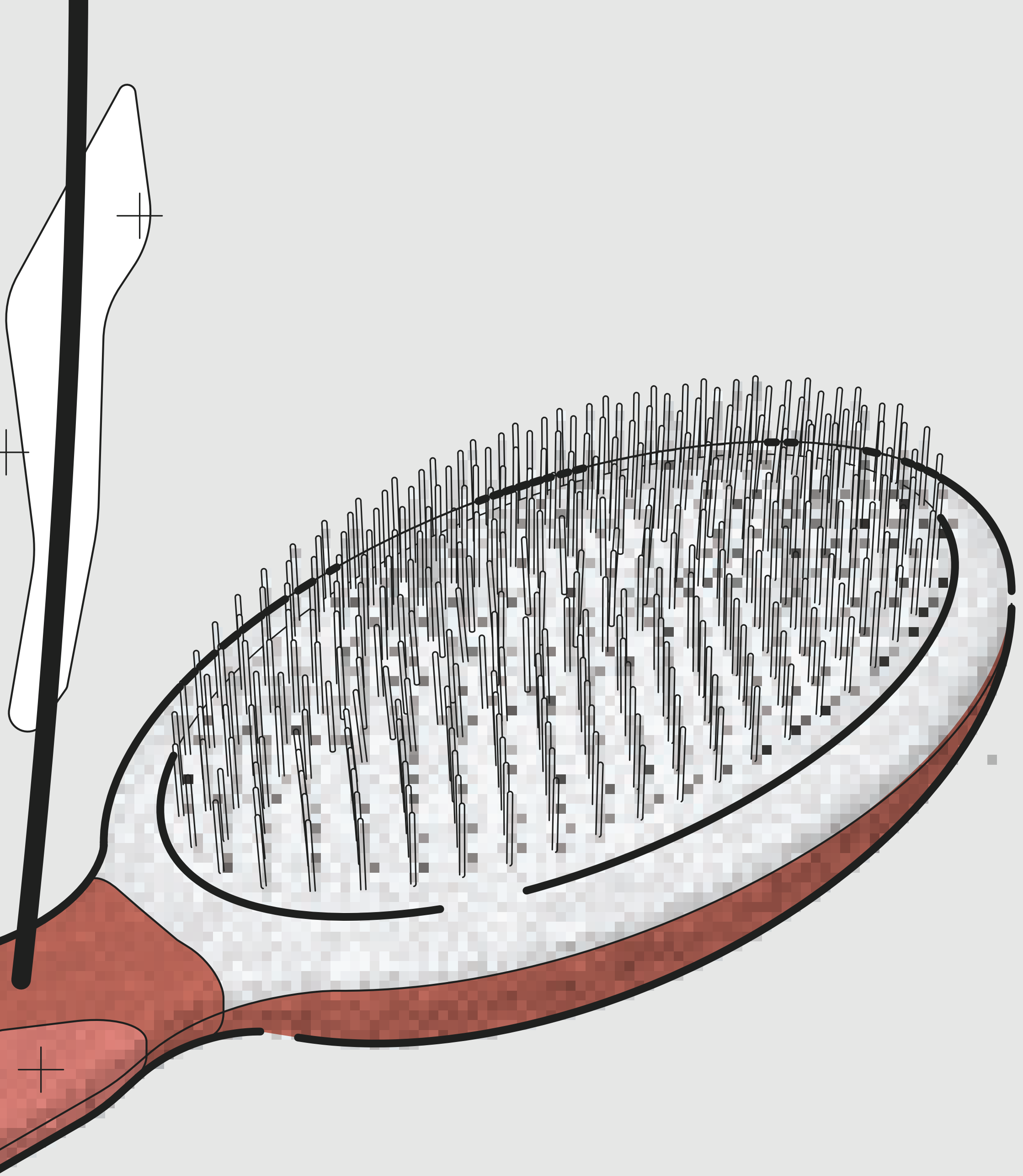
I am picked up and put into a glass compartment. Something damp and cool is being applied to my surface.

'Hey Robyn, what are you working on?'

'Plastic composites to be used with the new crops... they're making biopolyester. I'm hoping I can break down the rest of it naturally as well.'

It's the end of the first cycle, and stewards clean up their stations. I have learned that in the following days I will be left alone as the material stewards focus on research, letting the bacteria that have been applied to me complete my transformation. As the night draws in, only the soft hum of the biobattery-powered UV lamps are audible. I can feel my surface gently buzzing, changing. It's not the sharp reawakening that comes with being melted, poured into a fresh mould – this is more peaceful somehow. I feel like I'm spreading out very slowly, over a large space.

Time passes and I am breaking down. I enjoy watching the plants above have material harvested from them; skeins of thread synthesised from plastics, the fruiting bodies of mushrooms. I can feel my molecules dislocating from each other. Will different parts of me exist in different plants? I know I am disintegrating, but after all the lives I've led, a rest is starting to sound appealing. It feels right, somehow, a return to the soil.



103.

The Voices at the Table

Voices at the Table

Rosa, the Common Place's biome specialist, and Pavel, its lead futurist, were catching up in the cafe over sweetened algae lattes. Aditi, the team's architect, had just left them to take a call in one of the soundproof hallway booths. In meeting room 11, where they'd all had their morning team meeting about a circular retrofit project, a conversation was taking place between Chikao, a safety and equity expert, and Leo, materials specialist. Leo was also the team leader.

"It's just...I've been here five years now, and I've only ever received good feedback. I feel like I'm already doing enough to deserve this."

"It's not about deserving Chikao, I've told you it's a funding issue. Trust me, your talent doesn't go overlooked. But we just can't afford it this year."

This was his final answer then. Leo had kept Chikao behind after their team meeting only to dash her hopes of a promotion. It wasn't just about the recognition of her efforts either – ascending to level 5 would earn her a pass to the hazardous materials lab

Project File > Makerspace Retrofit and Redesign > Live Design Brief...

Client / Company name

East Springs Urban Biome

East Springs City Council

Heart of Making Collective

About the client / company

East Springs City is home to 50,000 residents, of which 95% hold a membership to a local makerspace. The Heart of Making Makerspace serves the city centre, with 10,000 individual/family memberships. Originally a school built in 1856, it became a community makerspace in 2030 after being abandoned for decades.

Recently, it has transitioned from hosting programmes for five surrounding schools to ten, as well as four retirement centres, requiring a reinterpretation of the space to ensure that all makers can be catered to. The makerspace site is also home to an endangered bat population, a thriving river and green ecosystem, and various insects and mammal population that live beneath the building.

Checklist

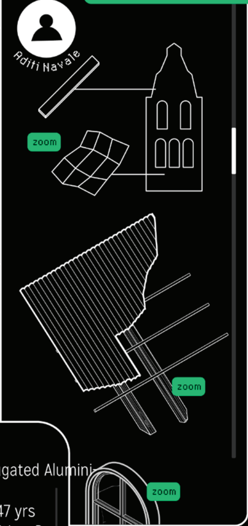
- *Process latest site scan data*
- *Share updated design and access statement with councillors*
- *Update digital twin of new design and share with Structural Engineer*
- *3 illustrations to add to next weeks community presentation*

65% of materials used must already be on the makerspace site in accordance with the Use What Exists Law, absolutely necessary.

We need to preserve the historic façade and features of the building in accordance with the Historic Preservation Act

Existing material survey

Aditi Navale

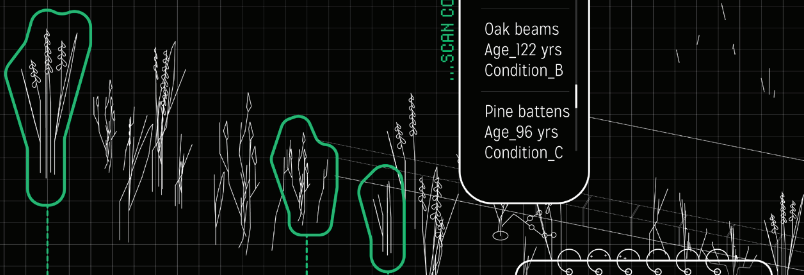


...SCAN COMPLETE

Corrugated Aluminium
Age_47 yrs
Condition_D

Oak beams
Age_122 yrs
Condition_B

Pine battens
Age_96 yrs
Condition_C



River species impact report

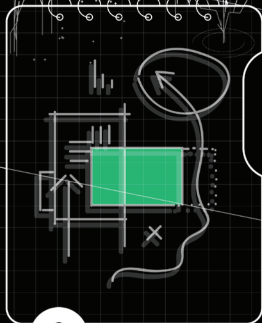
Bull rush
Condition: Good
Occurance: 393
Considerations: Nesting habitat for ducks

Common Reed
Condition: Good
Occurance: 129
Considerations: Sedge Warbler nests present

Water sedge

Rosa Guitierez

Building must cater to local biome, disturbing no more than 3% of local animal and plant populations in the building process.



Pavel Nowak

Ensu… spa… acc…

Concept | Iteration 1.0 | Iteration 2.0 | Iteration 3.0


Existing non-human residents
Pipstrelle bat: 5
Beetle: 28
Starlings: 1 nesting pair
Read full report
Climbing Ivy
Foxglove
Read full report
Heart of Making Centre
Barge no.73
info
Mooring specs
info
info
(Text incoming.....)
Vote results
Project Archive
Contacts
Project files

and the corresponding training. For an equity professional, this was her next career step – prioritising nature as a stakeholder was leading to leaps and bounds in sustainable practice, but sometimes at the expense of more vulnerable communities out there. Important conversations were had in that lab, she just knew it. How could her work have any real impact while she was excluded from the discussions where decisions were made?

> "You'll just have to be patient." said Leo. "Just keep doing what you're doing."
>
> Before Chikao had a chance to respond, the door to the meeting room slid open and Aditi popped his head through.
>
> "Sorry to interrupt – Leo, the technician from the Mate rial Library just arrived. Thought you might want to say hello?"
>
> "Ah, great!" Leo stood up. "I'll come now. Good to chat, Chikao."

He left the room without looking at her.

Chikao allowed herself a sulk. You can always follow them she thought to herself. Just go and introduce yourself to the technician too. I'm sure Aditi doesn't sit around waiting for invites. But she felt too angry to be around Leo right now. She sighed. He'd left his interface up on the desk and the flicker of a notification, accompanied by a faint ping sound caught her attention.

Classified was the first thing she read, and then Thysia Advisory Proposal. She paused, re-reading to make sure she hadn't made a mistake. Thysia. She stabbed at the notification quickly, before it had the chance to disappear, and a text-heavy document opened up. Thysia was the name of a city a handful of hours away by waterway. Founded and built just ten years ago, an experiment in environmental utopianism funded by billionaire Longtermists, it had soon become infamous for its strict, nature-serving policies, committed to preserving ecosystem health often at the expense of human health. The city's carbon output was minimal and on paper it was a sustainability success, but life for those mining its waste and living by its laws was far from rosy. For Chikao and her teammates, Thysia was almost a joke, a shorthand for dystopia masquerading as innovation.

So what was this doing in Leo's inbox then?

It wasn't that their technology wasn't impressive – and you could live well in Thysia. The founders and their like had been given first pick of the luxury accommodation available. All circular systems, of course, and repurposed materials – but spacious and comfortable nonetheless.

Part of the reason Thysia had been well-received in the early years was its pledge to house environmental refugees as 70% of its population, purpose-built housing and waste recovery economies providing a new lease of life to those displaced by wildfires, floods and the creep of climate gentrification. It had been billed as a many-faceted solution: an ecocity demonstrating groundbreaking technologies, housing thousands of vulnerable people and trialling nature-focused policies stricter than anywhere else on earth.

Heart beating, Chikao's eyes skittered over the first couple of paragraphs. Reputational security...social equity certification...proposed exchange of valuable e-waste...she was struggling to process what the text in front of her was suggesting. This was in her remit. Was Leo planning on bringing her on board? Not that she had any intention of reputation laundering for green tech billionaires, and Leo would know that. Perhaps she had misunderstood? If not, Leo was going to face a lot of heat when this got out.

Last Summer, not for the first time, a Thysian inhabitant had died from exposure during the heating ban hours, but the city council had released detailed data on the man's diet and daily routine, arguing that his unhealthy lifestyle had made him vulnerable to the cold – if he'd have looked after himself better he would have survived the ban like his neighbours had. Similar deaths were, of course, to be expected amongst the elderly – and those working the city's toxic waste dumps. It was right there in Thysia's slogan: 'Build and Sacrifice'. Residents underwent restrictions – a minimal housing footprint, periods of time without heating and cooling, abstinence from certain foods – but they were given homes in an eco-utopia. Surely this was better than their previous lives of perilous migration. And the rich sacrificed their money, without which the construction of Thysia and the employment of all of these people would not have been possible.

The wealthy also kept to the bans in theory, though really anyone rich enough could afford bypass tokens allowing them to offset their power usage via green investment. There were rumours of forbidden, power-hungry facilities like cinemas, heated spas, restaurants and nightclubs hidden at the cores of their luxury complexes but only residents were ever allowed inside, so this was hard to prove. The one journalist who'd managed to sneak in was still serving her prison sentence.

Chikao could feel her sense of reality tilting. Was she being naive about this? For all the jokes – God, that sounds like something they'd do in Thysia – would her colleagues simply switch sides and follow the money if times were harsh enough? If Leo was courting Thysia as a client, perhaps she shouldn't be surprised. Her thoughts flicked back to their earlier conversation and she mentally replayed own polite requests, her timid responses. Perhaps I've just not been speaking his language.

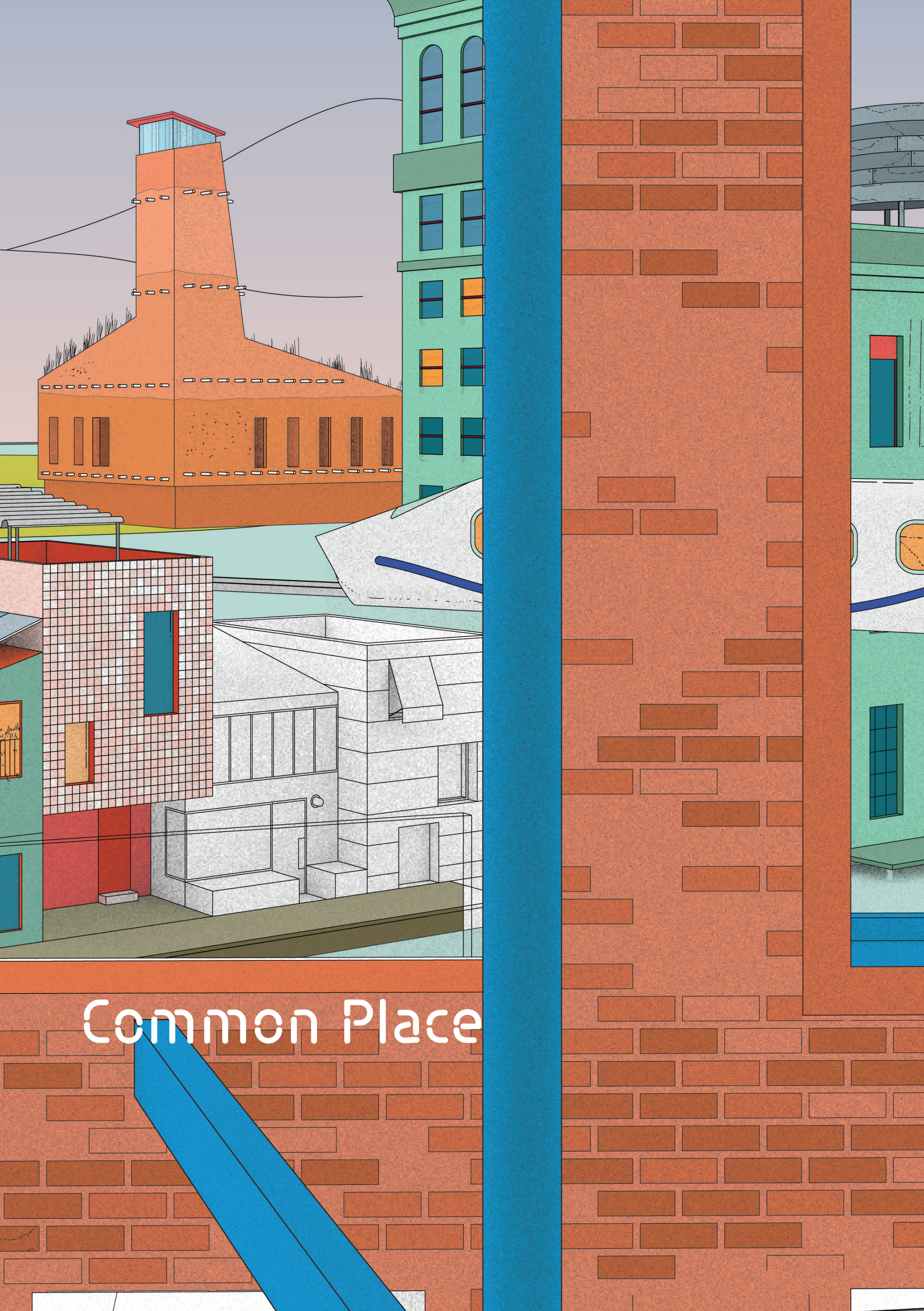
Sending a screenshot to herself from Leo's device would alert him, but even a photo taken using her own personal device wasn't safe – the building's Cloud used AI-enabled duplicate recognition and there was always a chance Leo could track the image down, along with the data on who captured it and when. She remembered something she'd glimpsed in Pavel's chaotic 'artefacts drawer' a few weeks ago and went to the back of the room to see if it was still there. It was. F

rom a thicket of old cables and vintage handheld devices she pulled out a chunky digital camera – an ancient Olympus model from the early 2000s, before every device that you could fit in your hand was connected to the internet. She swiped through all 3 pages of the proposal and photographed them all.

Click, click, click...

The digital camera made a sound designed to mimic it's even clunkier analogue predecessors, a flair which made Chikao smile despite her fear that the door would open any second now. Done, she marked the email as unread, minimising it so the interface went back to displaying the teams plans for the retrofit. Her eyes travelled over the annotations to the diagram, the ideas she and her teammates had been enthusiastically adding over the course of the morning, renewable materials and nature at the forefront of their minds.

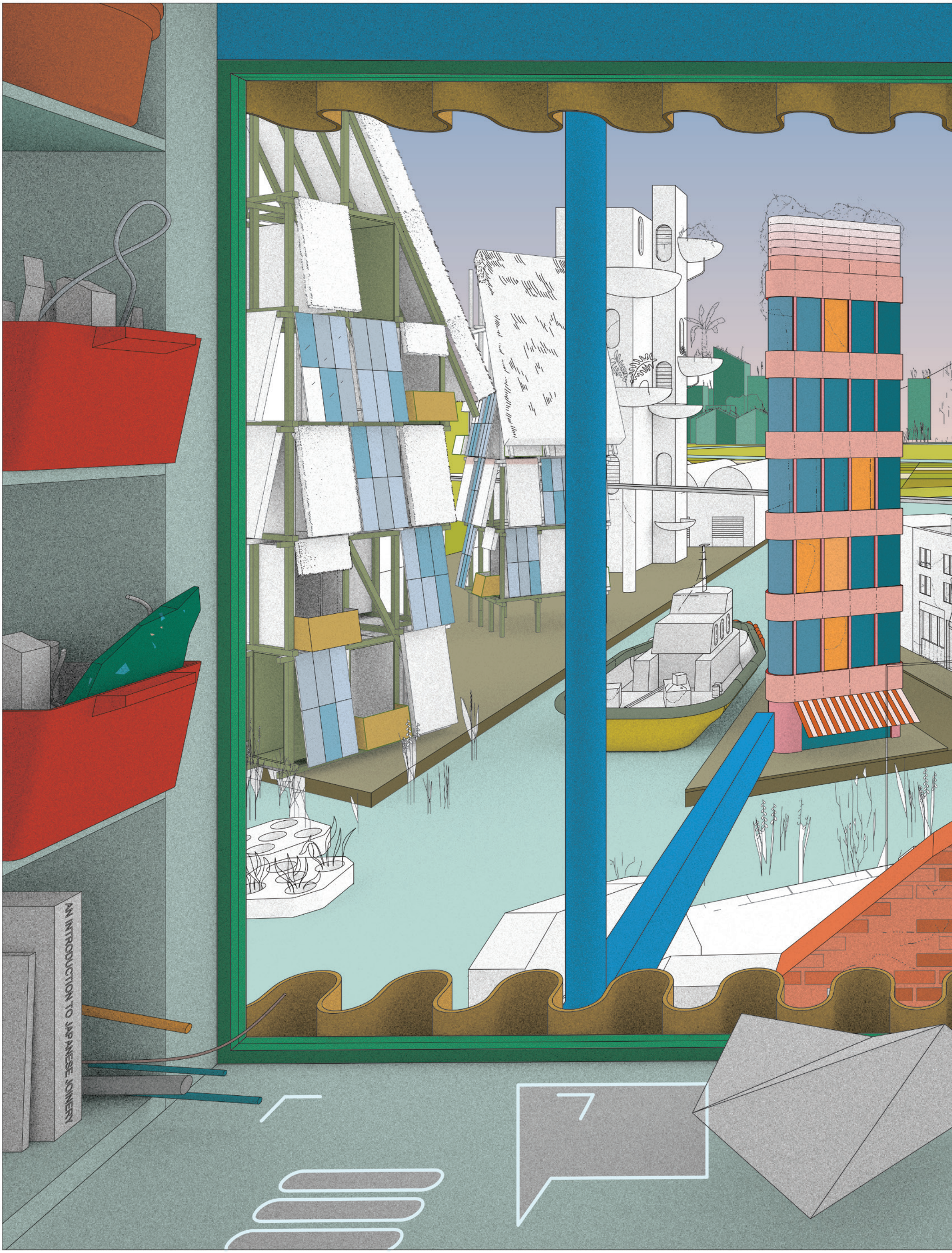
Did their leader really agree with these suggestions, or did he secretly think they needed to go further, prioritise nature completely and restrict human behaviour? Carefully she wrapped the camera in her scarf and placed it in her bag. Chikao had some reading to do. She had a feeling Leo might end up getting her that level 5 access pass after all.


Common Place

Common Place

What was it about the Common Place that drew people in? Its contemporary users might point to the inviting interior, well-lit with plenty of seating, or the access to creative tools it provided, but the truth was that the building had been in the habit of magnetising the public long before its current inhabitants had been born. In its past lives as a bank, a 'meanwhile' gallery and a multi-level indoor market among other things, it had consistently drawn people close with its curious facade, and kept them close once they were inside.

Ley lines, some would blame it on, while others would tell you that if a place looks good and offers seating, it will always draw a crowd – plain and simple. But those who made it what it is today had perhaps been the first group to fully make use of its magic; the way it encouraged strangers to relax and open up to one another, sparking unlikely alliances, fruitful friendships and creative partnerships. It was this group who had based their renovation on the potential of that social, creative energy, making the Common Place what it was today.


AN INTRODUCTION TO JAPANESE JOINERY

Common Place

A dilapidated Victorian building, it had been saved from demolition, although only just. When funding for the arts dried up, it had become a squat, providing much-needed shelter but slipping further and further into disrepair. A developer acquired the lot, preparing to tear down the building and build luxury flats in its place. A month before demolition, the government put in place the Retrofit for Purpose Act, which required all historical buildings with 50% usable construction materials to be retrofitted for community use while "including or alluding to" the traditional building facade styles of the time the building was constructed. Following numerous town halls and various citizen lobbying efforts, a combined group of residents, students and activists had funding approved to create a multipurpose shopping, making, and learning space: thus the Common Place was born.

On the outside, its restored brick and stone formed a homage to the past, a contrast to the neighbourhood's modern timber, earth and green facades. The parts of the building requiring complete reconstruction were designed using AI-enabled techniques to optimise its energy consumption and incorporate energy-saving biomimicry. Natural airflow was encouraged by the shape of the renovated wings of the building, rainwater harvested and reused by a collection system on the roof. Once considered revolutionary, the consistent robotic maintenance of the building fabric was hardly ever registered by people these days, but it helped the Common Place grow and respond to changing conditions.

The interior had evolved into a testing ground for the think tank of makers that had found a home there. Door handles self-sanitised, tables and counters were reconstituted from the building's renovation waste, and bioplastic insulation panels with mycelium fillings reproduced autonomously to keep the walls intact. Even the soft furnishings were an experiment, woven and stuffed using a diversity of plant materials.

In the computer lab, a frustrated young designer was using a digital twin model to fix his computer. The room provided extendable recycled metal desks for him to spread his tools and open-source instructions on, with plenty of spare parts stored in cubbies along the wall. Tinkering for hours, sweating slightly in the summer heat, thinking hard. Almost there, but not quite…

A senior joinery class was taking place in the wood workshop, with participant working with timber collected from nearby biomes. Adjustable workshop benches and chairs allowed for accessibility for all users, making it easier for this older generation to learn a new craft.

In the multipurpose area, teenagers were doing their required making hours for school, brushing hands at the tool table, flirting and joking. On the top floor, roof lights flooded the space with a warm glow as children and adults worked together in the biomaterials club, with adults answering the endless questions of their young colleagues and unexpectedly receiving the wisdom that can only be found in young minds in return. Trellises and sunlamps lined a wall, with tiny green sprigs reaching for the light. Children balanced on stools peered into microscopes, seeing the materials they use every day in a brand-new light.

A young girl sat in one of the focus cubicles in the designated quiet area. This was the third day in a row. She was enhancing a trinket with sentimental value to create a carefully thought-out present for a loved one, indifferent to the rapidly sinking sun outside.

Every day, people donated their unwanted items or materials to the Common Place's own material library, which then offered them for free to those in need or looking to try a new skill. Partnering with the local micro-factory, the Common Place sold biomaterials at a reduced price for members, offering regular expert lectures on how to use them.

Each room had multiple tablets with access to instructional materials on how to build or fix nearly anything – videos, manuals, textbooks, digital twins – and skilled craftspeople were always around to give a helping hand. Forming groups, friends, families and neighbours thought ahead, learning how to build seasonal tools together to help themselves and their communities – garden water reservoirs for the rainy season, solar-powered batteries in the lead up to summer. Making is necessary, but it is also enriching, a chance to build face to face relationships – something that just a few decades before had been fading into non-existence.

Not anymore.

All that this particular community had needed to re-ignite the spark had been a designated space; a pin on the map to ground and validate their way of living. No-one could say what the Common Place would be housing in fifty, one hundred, a thousand years – but for now, this was what it provided, and it seemed perfectly content to do

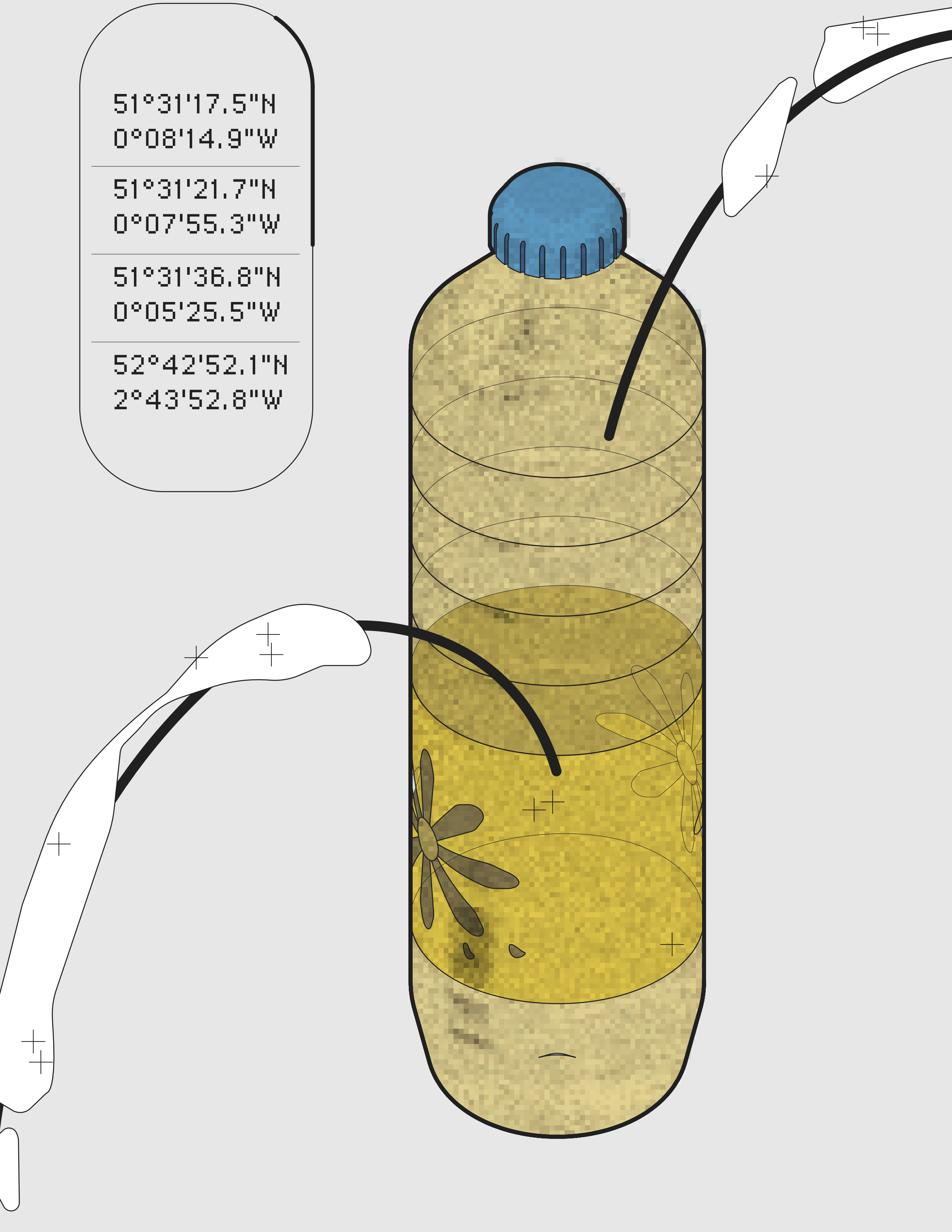
104.

51°31'17.5"N
0°08'14.9"W

51°31'21.7"N
0°07'55.3"W

51°31'36.8"N
0°05'25.5"W

52°42'52.1"N
2°43'52.8"W



Slow and Steady

Slow and Steady

You hear a noise. Soft at first, then louder and louder. Light is leaking through a crack in the curtains and brightening the room, pressuring your eyes to open.

Slowly, you sit up and push back the warm duvet, reach for your alarm, and then try to gently extract your legs from bed without disturbing the cat, which had been sleeping your feet. Putting on your slippers you rub your eyes. You walk to the kitchen and pull out the jar of loose-leaf breakfast tea. It's tea more often than not, these days – there's a jar of chicory-based powder that promises to mimic the flavour of instant coffee, but that would only make you miss the real thing even more.

Today is your delivery day. The one day a week you take earning credits as a delivery driver to augment your student stipend using time currency - each hour of your labour equates to one service credit. Checking the weather, you layer up – it's bright outside but the cloudless sky means you'll feel the winter cold more keenly, even as all the cycling warms you up from the inside out. You know without checking that your flatmate Kate has already left – it's her delivery day as well but her shift is different to yours, start-

ing and finishing earlier.

Putting on your delivery goggles, you check the depot database to see which deliveries are waiting to be picked up within a five-mile radius, tapping the glass to load them to your navigation system. You mount your bike. On your route you stop at small shops and businesses that show up on your navigation as delivery hubs. It's useful having all of this data to hand – the package contents and value ratings, the destinations and delivery order, though you sometimes feel a little anxious, all too aware of the local hacker groups whose skills regularly defy the delivery company's security system. You aren't the only one to whom this data is valuable.

You refresh your interface and find five more packages to be collected and delivered on your route; as you pedal, your mind wanders, subconsciously following the route displayed on the screen in front of you. Suddenly ALERT – RISK LEFT flashes. Reacting quickly, you dodge the scooter whizzing by at far above the speed limit. You yell out, but they are already long-gone.

You take a deep breath and try to return to your previous rhythm, though your adrenaline is still high. Just a reckless person, that's all – they don't care what's in your delivery bag. The next delivery is near the local micro factory, so you and your bike take the factory delivery barge to the dock, riding on the passenger level and looking out onto the water and at the delivery drones efficiently floating downstream.

As you complete more drops, your interface is becoming less crowded. A discreet orange bubble notification suddenly pops up: a message from Kate. Probably on the topic of what to have for dinner – it can wait. The sun is beginning to set as you enter the familiar complex and dismount, wheeling your bike alongside you down the path. You ring the doorbell and scan the package, waiting patiently. The familiar name on the delivery label makes you smile, knowing this package will make the recipient's day. You inquire about his children when he answers the door, thinking how you should reach out to your old childhood friends. You briefly discuss his wife, whose passing affected the entire complex, both past and present residents of the lively community that she was such a part of.

He thanks you for his delivery, and in return hands you a neatly wrapped package as you say your goodbyes. Turning away, you slowly walk to your bike at the other end of the complex, walking familiar paths and shortcuts without thinking. Kate's message – you open it to see what it is she wants.

Take care on your route – got mugged today. About 2 hrs ago by the Primrose Lane lights.

You stop in your tracks. You begin tapping out a response, then quickly backspace and ring her directly.

> *Are you okay? I just saw your message, what happened?*
>
> *I'm fine. It was very quick, it happened while I was waiting at the lights. Must've been tailing me for a while and waiting til I was on a fairly deserted street.*
>
> *There was more than one? Did they hurt you?*
>
> *No, no. I mean, I fell off the bike, or rather I fell with the bike after they let it go. So I'm a bit bashed up. They were after a package I had. You hear her sniff. They got it, too. A load of copper – they knew what they were looking for.*

She sounds more upset about failing to safeguard the package than she does about any physical altercation.

> *Hacker-grabbers then. We'll report it together once I'm back. I'll be quick as I can, okay? Do you need me to bring you anything? First aid bits?*
>
> *No, I've patched myself up. But shall we just get a takeaway tonight? I'm too drained to cook.*
>
> *Of course. I'll see you in fifteen.*

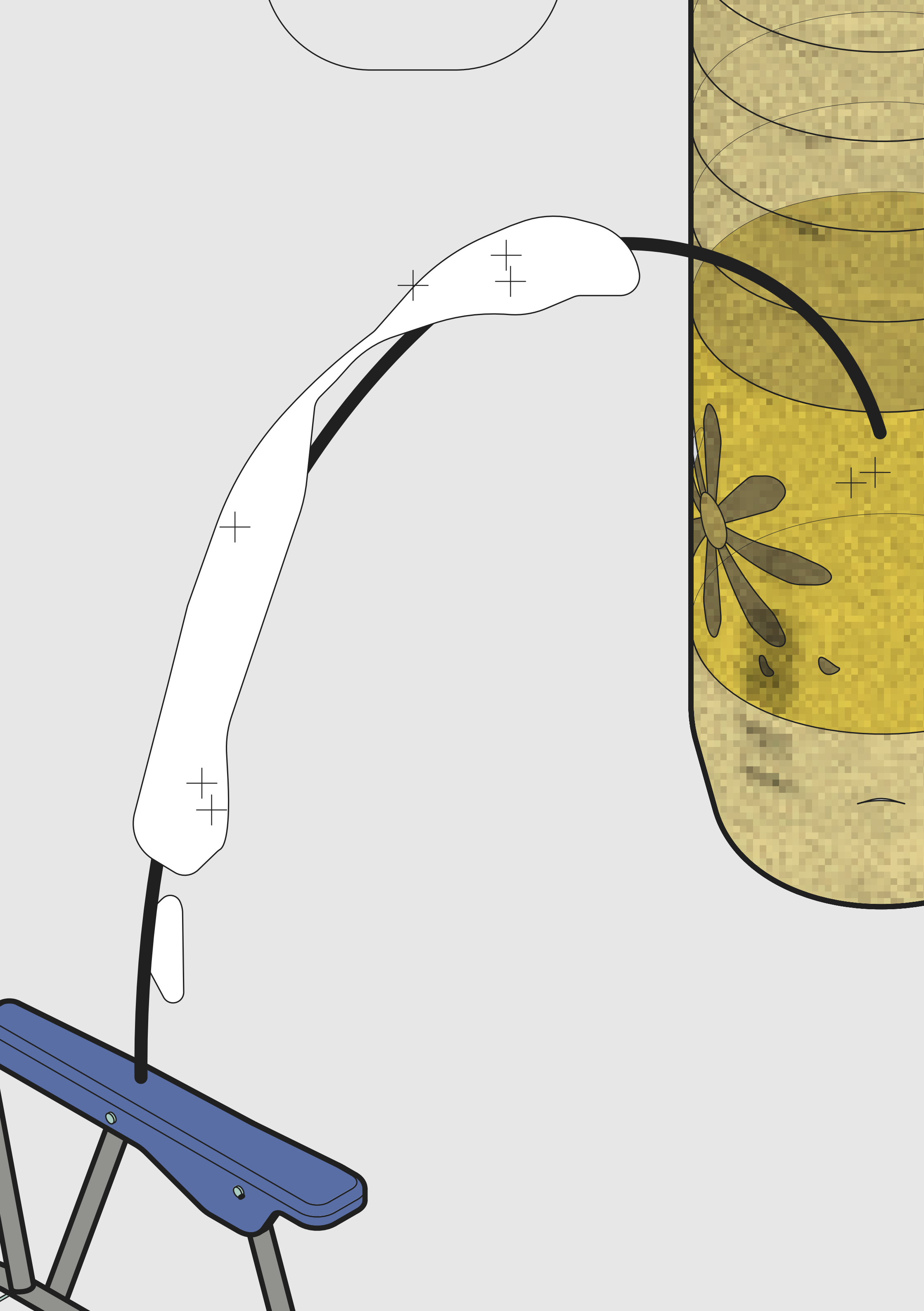
The last couple of deliveries are on the way home anyway – but the parcel Alex handed you for his grandchildren will have to wait.

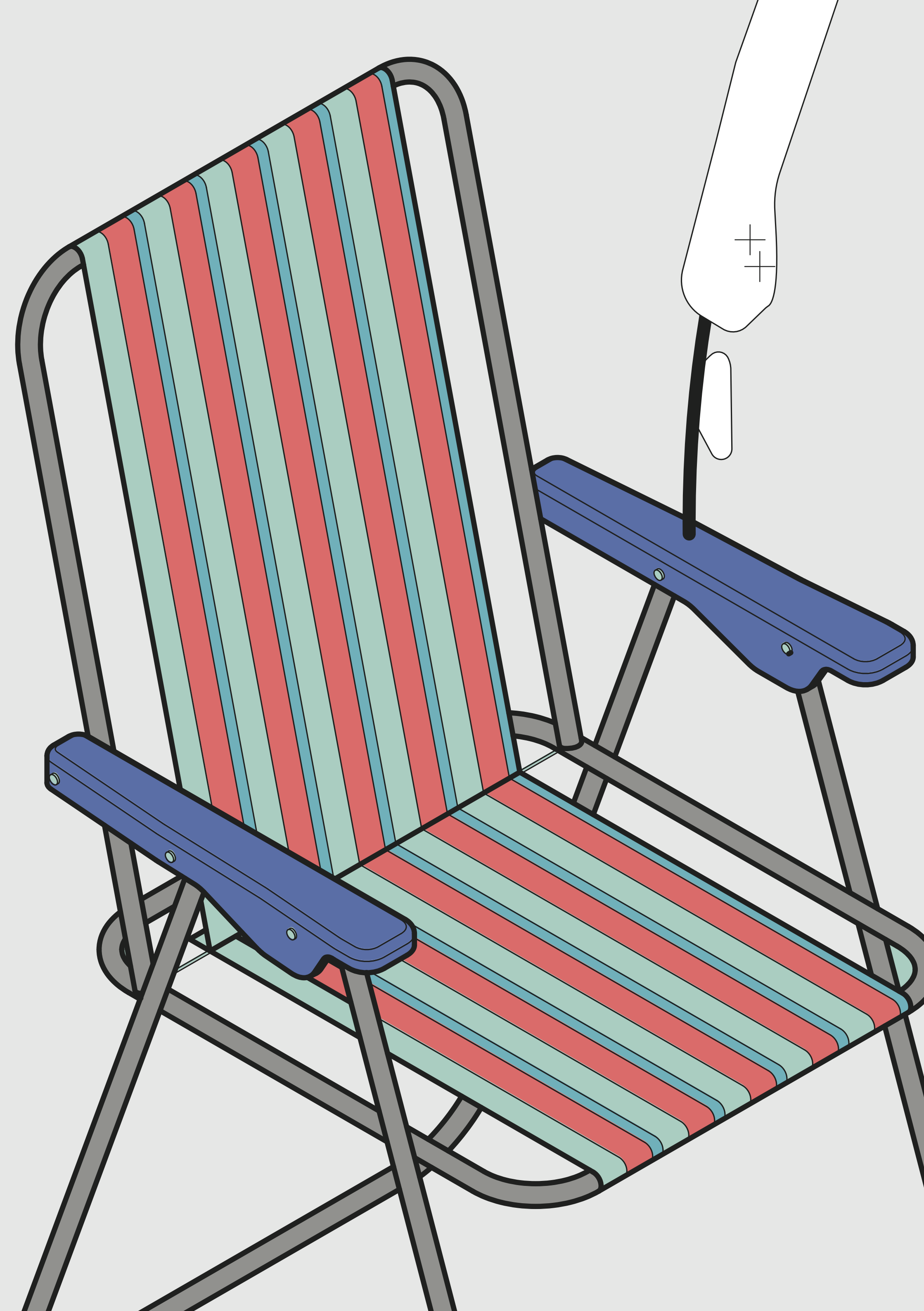
You know about the groups constantly finding new ways of hacking into the delivery systems and material databases and using the uncovered information to their advantage - but this is the first time they've targeted someone you know.

You've heard tales of scavengers in desperate situations and know that not everyone has had the same choices as you: further education, affordable student housing and a family to fall back on. Those not granted government or familial support experience society's new valuation of frugality and circularity very differently, struggling to find work and housing. You are painfully aware that communities like yours are held up as examples of thriving, environmentally and socially sustainable progress by the same governments whose harsh regulations on building reuse left hundreds homeless; whose harsh new penalties left many with criminal records that only worsened their ability to earn.

You've spoken to Alex and other elders about this before at cosy communal dinners – to his generation it had felt like revolutionary progress when they received funding for their communal home – government support for such a project had been unthinkable while he was growing up. Alex's vision of the present day is understandably rosy. But when you cycle through some of the more dubious parts of your route – zones that didn't get their grants, or where buildings that didn't meet environmental standards have been left to decay – you wonder about the true intentions behind the policies you and your friends have benefitted from. Not everyone is a student, or can afford to be in training. For some of those who are ill, in debt, working several jobs, carers - you can understand why sustainable living targets are not exactly a top priority. You can understand why people like Kate, and like you, might be targets not only for the value of the packages you carry to and fro, but for what you have perhaps come to represent.

You shiver. You know all this. It's not the first time you've thought about it. But it doesn't dampen the fury you feel at whoever has

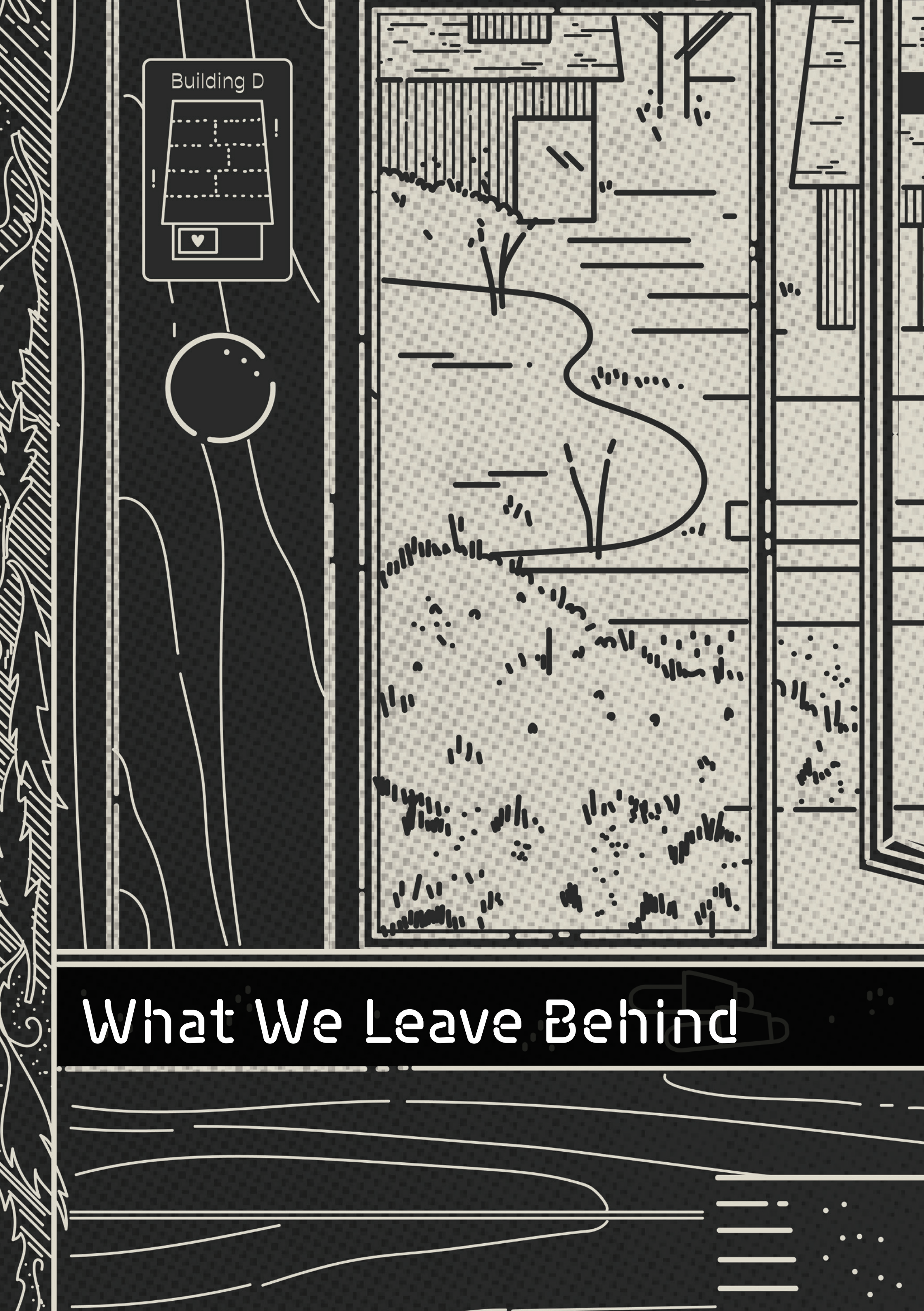




hurt your friend. You rub your gloved hands together to warm them up, and mount your bike. Time to be off.

You cycle back as fast as you can, barely leaving the seat of your bike to deliver the final two parcels on your list. The warm glow you felt leaving Alex's has long since evaporated, and as you speed homewards you can't shake the feeling that there's a target painted on the back of your jacket. You and Kate will have to alert the Materials Library so they can keep an eye out for copper – but if the scavengers are savvy they'll hide their tracks and use the black market to sell it off bit by bit, over a long time.

For now, you push the thoughts aside. You've arrived home and Kate is your priority - you need to summon the energy to cheer her up. You double check you've locked the bike away properly and make your way to the front door. Warm light is spilling from the windows of your apartment, and the kettle is waiting inside.



What We Leave Behind

What We Leave Behind

The sun glowed deceptively as the delivery courier rolled to a stop, their breath misting the air. Snowdrops, white and waxy, had begun to push their way out of the ground either side of the path, but it still felt like midwinter. A little further down the path that led to the multi-family housing complex, Alex looked out of his ground-floor window, mentally overlaying the view with the smattering of poppies, cornflowers, buttercups and ragged robin that spring would bring. They'd come every year since he'd moved in 30 years ago, every year he and his family had tended to the garden. Every year he found himself impatient for their arrival, paranoid they might not come at all.

Alex and his wife had been members of an experimental retrofitting cooperative, transforming a long-abandoned office building – a common find after two global pandemics – into a residential space. With the goal of making an adaptable, inclusive, and beautiful living complex that would last 1,000 years, they worked together to use materials already on site, adding new features with biobased and regenerative supplies.

Alex and his wife started with a small floor plan, eventually adding a spare room and expanding the kitchen space. When they had children, they added more bedrooms, negotiating with a wall-sharing neighbour to expand into their unit in exchange for a higher complex contribution tax. This modularity had been built in as part of the collective's renovation - recycled walls, floor plans that could grow and shrink over time, agreements to switch units when necessary – to accommodate what the residents needed, whether they be parents and children, multigenerational households, young couples, singles, or students. Collectively, residents paid a site manager to perform yearly scans of the building, using digital twins to check for any issues and making sure all utility use was within government guidelines.

The process was not without its challenges. It took a while to perfect modular walls that kept noise out efficiently. Neighbours argued over expansion and changes, and some individuals decided the lifestyle was not for them after all, leaving to live elsewhere. But for a core group, the building became a home, a way of life and a personal achievement. Residents added to the building maintenance and construction guide, creating a VR manual for all who lived and would live in the building for generations to come.

They downsized their unit again when their children left, and five years ago, as Alex's wife became a wheelchair user, they traded units for a more open-plan one on the ground floor. When she fell ill, they adapted their spare room to make her more comfortable. He was grateful for their home and its endless flexibility, easing his wife's discomfort and, by extension, his own.

They had done most of the alterations in their unit themselves, taking advantage of local making classes and the repair instructions that came with the apartment, decorating their home to be as bright and warm as possible – the opposite of what each of them had had growing up.

Since his wife's passing, Alex had lived in the complex alone. Both his children had offered to turn their own homes into multi-family units, but he had refused. His best memories had been


Building D

made here. He enjoyed looking out of his window and watching the trees, plants and creatures change their behaviour with the seasons. He enjoyed being with his old friends and helping new people integrate into the community. It was important to him that they understood how lucky they were.

He had met Imani at a time when life seemed unmanageable, uncontrollable, to a point where he didn't know what he should do next. He had just left his hometown, after coming out to his parents as transgender. It was difficult. He didn't get kicked out, and his parents didn't disown him or anything like that. They had tried their best. But it was his unhappiness they couldn't understand, and he found himself needing to get away from the place where he had lived so long as someone he was not, putting physical distance between himself and his past. A fresh start.

Imani was the first person he'd met that he felt he could be his true self around – once the nerves of their first few dates had dissipated – and when she introduced him to the rest of her collective and their vision, he could see for the first time a future that excited him. And it had been exciting. Watching the world change so quickly but remaining grounded, thanks to the people around him and the effort they put collectively into building their homes, preserving skills and restoring the nature around them. He'd grown up in a world where he could work a full month without spending time in the same physical space as a single person. Where it was normal to do so. He and Imani raised their children to appreciate craft and interaction, to see the value in every item, every person that passed them by.

A noise jolted Alex from his reminiscing as his unit's system alerted him that he had a visitor. Looking to the screen, he could see a familiar cyclist courier standing with a package on his doorstep and went to open the door. She greeted him and handed him the package.

"Thanks Flora, I appreciate it. It's good to see you."

Alex said with a smile. He was grateful that even in the privacy of his own unit, he was never alone for long. People were always thinking of him.

> "Of course! How's Farah?"
>
> "Oh, she's great, the children too. I was actually just down there last month visiting – gave the grandchildren some of Imani's things."
>
> "I bet they loved that. We all miss her so much."

Flora scanned the package, now in Alex's arms, so she could mark it as delivered. "Anything I can take for you?"

Alex handed her a care package of his home bakes for his grandchildren – this delivery would be a favour, no need for scanning. He was grateful for it. He closed the door and turned towards the warmth of his kitchen. He retrieved his own scanner and scanned the parcel he'd been given.

> Item: Seed Packets
>
> Last purpose: Cardboard box
>
> Recycled materials: cardboard, paper, rPET
>
> (former plastic), bio-glue
>
> Virgin materials: 0%

His Sweet pea seeds had arrived – a perfect excuse to go outside, despite the cold. He opened the drawer under the sink and rummaged around for his gardening gloves. This sink, which he'd fixed up at least three times over the years, the seaglass vase on the windowsill that he and Imani had traded their neighbour a custom-made chair for.

That wall over there, now closer than it had been when Imani had still been around, before Alex had sold some square footage to the family next door. And now Sweet Peas for the garden, though they would take a few months to show up. So long as Alex was here, caring for the place, it would keep changing and evolving until his final day.

Future of Making

Reimagining our material culture

Acknowledgments

Future of Making is the result of extensive signal-spotting, expert engagement, pop-ups and design research from Arup University's Foresight team and wider collaborators. At Arup, we continuously work to explore the future and to enable our members, clients and partners to be better prepared for the trends and drivers impacting our business and ways of working.

Our special thanks go to Arup's materials experts and relevant Skills Networks. Skills Networks at Arup are communities of experts and enthusiasts focused on specific areas to foster excellence, drive quality research and propel transformational initiatives.

Team

Alexander Alexiou
Amanda McFerren
Bill Searle
Charlie Warwick
Claudia Palcova
Eleanor Tomlinson
Emily Clements
Jordan Blunsom
Julien Clin
Lola Bushnell
Lu Deng
Malina Dabrowska
Maria Elges
Marie Cruwys-Wong
Mona Ivinskis
Ness Lafoy
Peter Webster
Rhiannon Williams
Robbie Firth
Sarah Bushnell
Tobias Revell

Expert champions

Alexis Harrison
Emily Walport
Graham Dodd
Jo da Silva
Mark Bowers