SCOTT BROWNRIGG
DESIGN RESEARCH UNIT

INTELLIGENT ARCHITECTURE \ ISSUE THIRTEEN

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ABOVE
Bricklayer robot working on construction site
Copyright Engineer Studio via Shutterstock

INTRODUCTION:
Architecture and Making

Here Board Director Neil MacOmish introduces the notion of making in architecture; how we make buildings, the way in which they are made and what they are made of, and the impact these considerations have on the concept, context and climate.

Architecture is about making. The first question to be asked is why? Why make anything at all as clearly (it could be argued) that first consideration of a sustainable position should be build nothing?

As noble as this might seem, it is clearly not always or often practical. There remain substantial pressures and demands to build places to live, work and play. Extending this necessity then, we have to make things – spaces and places, the buildings we occupy and the wider built environment. Even re-use and re-purposing require some aspect of making.

How we make them, the way in which they are made and what they are made of, becomes critical in our response to the finite resources we have on our planet. This is consistent not only in construction, but in life-long use and thereafter, in being dissembled or simply decay.

This also requires additional judgement about appropriateness, longevity and safety.

The materiality of a project should have a direct correlation to the concept, the context and climate in which the project is based. We would suggest that if one thinks about truly seminal pieces of world architecture, it is impossible to conceive of them being made in any other material than that they are built of – the material is an intrinsically linked aspect of the concept.

All materials have limits and are dependent upon their molecular structure. These can be shifted and pushed to their limit by new techniques (for instance laminated glass or timber) and by composites, but in general, eventually their limits are finite. Glass and concrete are not good in tension but they are in compression, timber vice versa. However, the way in which these materials come together in composition, can transform their natural state, make us think differently about the world and the places and spaces we find ourselves.

The way in which materials come together – what we call detailing – is not just about keeping water out, keeping air in or acting as the first point of climatic modification. These should be a given. The juxtaposition of materials should be as carefully considered as the composition of the building itself – indeed should inform that composition. This is the art of detailing - the tectonics.

Tectonics in architecture is defined as "the science or art of construction, both in relation to use and artistic design." It refers not just to the "activity of making the materially requisite construction that answers certain needs, but rather to the activity that raises this construction to an art form. It is concerned with the modelling of material to bring the material into presence: from the physical into the meta-physical world."[1]

This issue of iA explores all of the above, it is about process as well as product. It looks at how craftsmanship might become digital craftsmanship, how contemporary manufacturing might learn from traditional techniques, how intuitive knowledge can inform material science.

Making ●

1 Maulden, R, 1986, Thesis (M.Arch) Tectonics in architecture: from the physical to the meta-physical 1986, Massachusetts Institute of Technology

ABOVE

3D printed house Copyright Matjazz via Shutterstock

ABOVE

Master Mason Copyright iStock.com duncan1890

DESIGN PROCESS: The Digital Craftsman

Director Ed Hayden looks at the fall of the Master Builder, a multi-skilled craftsman who works directly with the materials of the trade, and the rise of The Digital Craftsman, a new creator born from the power of manufacturing in architecture and computational design.

Whilst there are many prehistoric and classical structures in the United Kingdom, British architectural history can be said to begin after Augustine of Canterbury arrived in Great Britain in 597 with the first Anglo-Saxon Christian churches[1], and these were led by the master builder. The great cathedrals of the Gothic age were designed by these master builders (often referred to as 'master masons') who had gained structural and architectural knowledge first as apprentices then from experience.

Historically, the term has generally referred to the head of a construction project in the Middle Ages or Renaissance period[2]. The phrase itself has been in use since as early as 1610, when William Camden coined the term[3].

These multi-skilled craftspeople lead a peripatetic life, travelling from one city to the next, designing and directing the construction of cathedrals, enjoying great patronage and prestige, then moving on to the next project elsewhere.

The master builder was thus a multi-skilled craftsman who had demonstrated great knowledge and experience, and worked directly with the materials of the trade, deeply understanding the properties of stone, timber and metals and crafting his architectural vision directly from these materials.

Over the more recent past, the loss of craft skills within the construction industry was highlighted in the 1990's with the 'Egan Report' and the 'Latham Report' lamenting the fragmentation of the industry[4] and the attendant loss of cohesive knowledge and oversight which was historically embodied in the abilities of the 'master craftsman'. This fragmentation of knowledge and loss of craft skills has also reduced the ability of the creative designer to realise their designs. Equally it could be suggested that the separation of the architect from the materials of the trade results in a loss of understanding of the properties of these materials, and how far they can be pushed and utilised to achieve a symbiotic relationship between form and function.

THE RISE OF TECHNOLOGY

The advent of computational design and manufacturing in architecture and construction has changed the way in which architects and designers can 'create', removing the artificial separation between the 'design' and the 'creation', and allowing the architect and designer to directly become craftsman once again.

As the tools that we have at our disposal for the design process increase exponentially with computing power, so does our ability to realise designs that are no longer limited by manufacturing processes or the skill of the constructors.

> **"The advent of computational design and manufacturing in architecture and construction has changed the way in which architects and designers can 'create', removing the artificial separation between the 'design' and the 'creation', and allowing the architect and designer to directly become craftsman once again."**

LEFT

Wells Cathedral | Copyright Ian Woolcock / Shutterstock.com

EXTENDED REALITY

The use of virtual and mixed reality headsets alongside augmented reality software allows the designer to sculpt and create directly within a three dimensional virtual environment. Taking us back to the 'hands-on' experience of designing seamlessly starting from sketch, and continuous design refinement to the completed project.

Mixed reality design tools have been a staple of the games industry for many years, and tools such as Tilt Brush let you undertake these sketches in 3D space with virtual reality, your room becomes your canvas, your pallet is your imagination. Gaming engines such as Unity and the Unreal Engine toolkit allows you to create stunningly realist 'real time' environments[5]. With Unreal Engine 5, Epic have achieved a major breakthrough in real-time rendering, enabling the visualisation of billions of polygons in each frame. Such advances speed the convergence of architecture, game design, product design and XR (Extended Reality), unleashing immersive, cinema-quality and hyper-realistic XR experiences[6].

The toolkits developed by games designers for 'level design' within gaming environments are making their way into the architectural profession, and the overlap between this and the BIM information we have now adopted as normal is obvious.

The physics and lighting built into these game-engine driven XR visualizations will allow designers to explore projects in highly dynamic and customizable ways, enhancing comprehension of fit, feel and scale of every level of architectural design from the door handle up to entire city blocks.

ARTIFICIAL INTELLIGENCE

The next stage is a greater understanding of the material properties which we have lost over time with our disconnection from the ingredients of our profession. Currently we treat many aspects of architecture as the assembly of pre-manufactured products, with the trick often being how to assemble these materials in unique and interesting ways. Conversely the master craftsman learnt over many years of apprenticeship and hands on training about each material and what the properties of each one could enable him to achieve.

Artificial intelligence (AI) as an assistant to the architect offers a new way to interact with the materials upon which our designs are based. Creating an AI 'assistant' to work alongside the designer as a font of knowledge of material properties and forces which act upon those properties with any design is the next step in regaining the 'craft' of architecture. →

Some of the major BIM companies investing heavily in this technology include Autodesk, ENGworks, Bentley, Trimble, Hexagon, Nemetschek.

We are already seeing practices embrace the notion of AI assistance, allowing the 'real time' testing of an infinite number of statutorily compliant flat layout for example, and this process is inevitably going to permeate throughout the practice of architecture, due to the increased efficiency and option-erring it permits.

DIGITAL MANUFACTURING

Empowered with the ability to design in a three dimensional virtual environment, and with the modelling and testing by the AI assistant, the world is open for direct manufacture from digital design information. 3D printing was the precursor to this, but now we can see this technology being 'scaled up'; there are already examples such as the 'printed bridge' a parametric design directly manufactured from the 3D model by two 'sintering' robots working in unison, and this is just the start.

Prototypes of entire houses 'printed' in concrete are already old news, and it is easy to envisage multi-headed 'printing' technology creating the structure, insulation, waterproofing, electrical cabling and plumbing in a single coordinated uniform operation directly from the digital design information.

XR EXTENDED REALITY

A final step is the combination of craft skill on site with this digital design information, augmenting the understanding of the labour force on site by overlaying the precise design information captured in the digital model with reality.

Augmented or mixed reality systems such as Fologram for HoloLens can accurately position digital content in 3D space, and automatically corrects for 'hologram drift' over large distances.

This means that fabrication instructions are the design, and thus eliminating the need for following 2D drawings, which cannot easily depict complex forms which are curved in multiple plains, and can easily be misinterpreted on site.

As Fologram demonstrates "The use of mixed reality to communicate complex 3D designs to stakeholders regardless of digital literacy allows constructors and craftsmen to intuitively follow complex designs, simplify set out tasks and assembly sequences using mixed reality instructions."

The faculty from the University of Tasmania used this technology to design and construct a collection of intricate curved brick walls. A feature wall was completed by two bricklayers working from the same holographic model and saved weeks of construction time. String lines and plumb bobs were replaced with a holographic guide that allowed the brick layers to accurately position each brick in the design. Without needing to leave the construction site, the bricklayers could interact with the holographic model to change the course of bricks being displayed resulting in the project being completed in only seven hours of brick laying[7].

ABOVE RIGHT

MX3D Printed Bridge | Copyright Thijs Wolzak

RIGHT

Holographic Construction of the Hobart Hospital | Copyright Fologram

This represents a new interaction between designer and constructor, removing the risk of misinterpretation and ensuring that the designer and the constructor can work as one. The combination of these strands will transform and democratise design.

Three-dimensional design tools such as Unreal Engine and Unity already allow rapid and unlimited design within a virtual environment. In the future we will be able work on complex multi-disciplinary projects untethered from the large flat screens we use today.

We can envisage some designs taking place in virtual 3D spaces from beginning to end, with entire teams joining from their preferred work location using technology no bigger than a pair of glasses. Continued software and hardware development will allow designers to flip between models and scales at will. AR will allow for enhanced in-person collaboration, while VR will allow us to change context and simulate design outcomes seamlessly.

With the additional opportunities in using Extended Reality to aid in creating more efficient project design the opportunities seem almost boundless in what it will enable us to do next.

AI digital assistants can continuously check the design sits safely within a near infinite number of material boundaries, such as strength stability and resource efficiency. The mission is to enable the employees to easily and quickly materialise, communicate, and test their ideas, and the firms which fully embrace this technology will dominate design in the future.

New systems for direct manufacture by additive manufacturing processes, 'printing materials' or subtractive manufacturing (computer controlled, removal of material layer-by-layer using lathes, mills, routers, and grinders) will allow these ideas to be directly and efficiently manufactured from these 3D designs. Allowing every detail to become 'bespoke' at a lesser cost than pre-manufactured products.

Finally combine this with automatous assembly and we could see a new era of design freedom, the advent of the Digital Architectural Crafts; the age of The Digital Craftsman ●

1. **British Library. Augustine of Canterbury. Retrieved from: https://www.bl.uk/people/augustine**
2. **Wikipedia contributors. (2021, March 3). Master builder. In Wikipedia, The Free Encyclopedia. Retrieved August 6, 2021, from https://en.wikipedia.org/w/index.php?title=Master_builder&oldid=1009969321**
3. **William Camden. The Philological Museum. University of Birmingham. Retrieved August 6, 2021 from: http://www.philological.bham.ac.uk/cambrit/fronteng.html**
4. **Designing Buildings Wiki contributors. (2021, January 13). Latham Report. In Designing Buildings Wiki. Retrieved August 6 2021: https://www.designingbuildings.co.uk/wiki/Latham_Report**
5. **Brian Crecente. (2020, October 19). The magic of creating Kena: Bridge of Spirits. Unreal Engine. Retrieved August 6, 2021 from https://www.unrealengine.com/en-US/developer-interviews/the-magic-of-creating-kena-bridge-of-spirits**
6. **Unreal Engine: https://www.unrealengine.com/en-US/**
7. **Fologram: https://fologram.com/**

ABOVE

Lego model of Seward Park, New York

PURE RESEARCH: Architecture and Un-making

At the 2019 launch of the RetroFirst campaign, the Architects' Journal reported 'Worldwide, the construction industry consumes almost all the planet's cement, 26 per cent of aluminium output, 50 per cent of steel production and 25 per cent of all plastics...We lose more than 50,000 buildings through demolition every year and, while more than 90 per cent of the resulting waste material is recovered, much of this is recycled into a less valuable product or material, rather than being reused.'

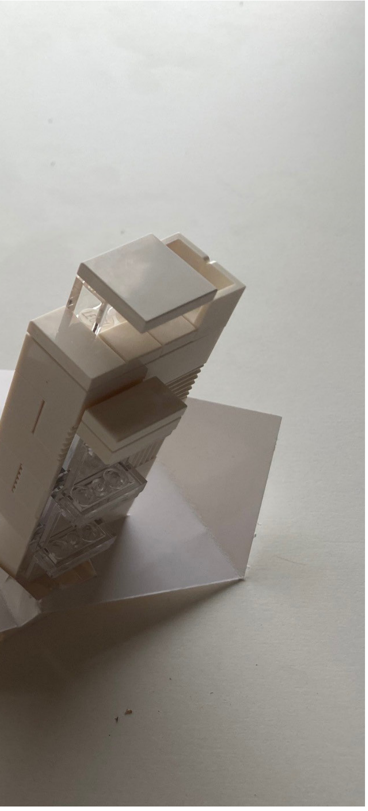
Here Helen Taylor explores architectural attitudes towards reuse, recycling, and the circular economy.

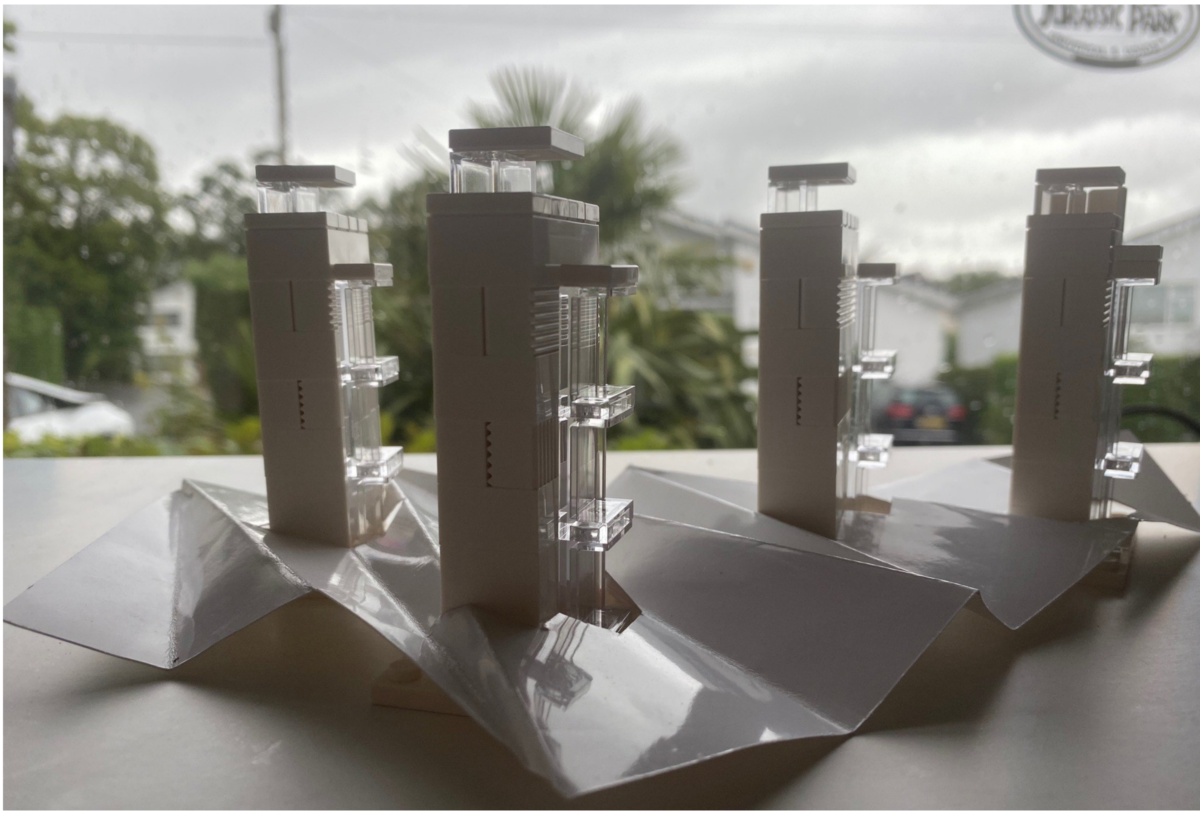
Anyone who has seen the Lego movie will know all about the "kraggle"- the mysterious powerful negative force that turns out to be (spoiler alert) glue. The way materials are stuck together is also a challenge in the real world of un-making. The earth is a closed system with limited finite 'mineral' resources. The climate emergency and the vital need for carbon reduction also applies to our thinking about materials, their value and how we retain it. Despite the efforts taken to develop and deliver site waste management plans, and encourage recycling, data actually shows a significant reduction in the re-use of construction material over the last 20 years. There are many reasons for this from bricks being laid in concrete mortar that can't be reused, to a lack of provenance, and to reclaimed materials not being specified.

This situation is driving some of Scott Brownrigg's key sustainability themes:

Resource Depletion: Resource use in both construction and operation needs an increased focus. This attitude applies to the specification of materials from sustainable, ethical sources and targeting the use of locally sourced, retained, reused or recycled materials wherever possible.

Circular Economy: The industry needs to be transformed- from a construction project based focus to become wider built environment guardians- and to design for the whole project lifecycle. The AJ RetroFirst campaign aligns with our approach, considering reuse and refurbishment first, but also designing for reuse, adaptability and – increasingly - for deconstruction and disassembly . Considering every building as a material bank. This approach means that materials built-in to a project must be capable of being economically dismantled for reuse, which impacts material selection and fixings.





Healthy Environment: As we have seen during the recent and ongoing pandemic, a healthy environment is vital for our physical and mental health and the heath of the planet. Preventing pollution of air, water and land is critical. Consideration of the lifecycle of construction materials must include consideration of potential pollution during that life such as:

- Disturbances to the existing environment, whether on green field or brown field sites
- Specification of materials during the design stage and associated need for plant, processes and techniques within the construction stages
- Manufacture and transport of materials and products
- Handling and use of materials on a construction site
- Pollution from the operation of the built environment (sewage, waste etc.)

Each of these activities poses a risk of introducing pollutants into the environment which can affect the workers on site, the neighbourhood, or the local ground, water and air quality. Our environment is the largest determinant of overall health, therefore the built environment has a key role to play in relation to our health and wellbeing as well as that of the planet.

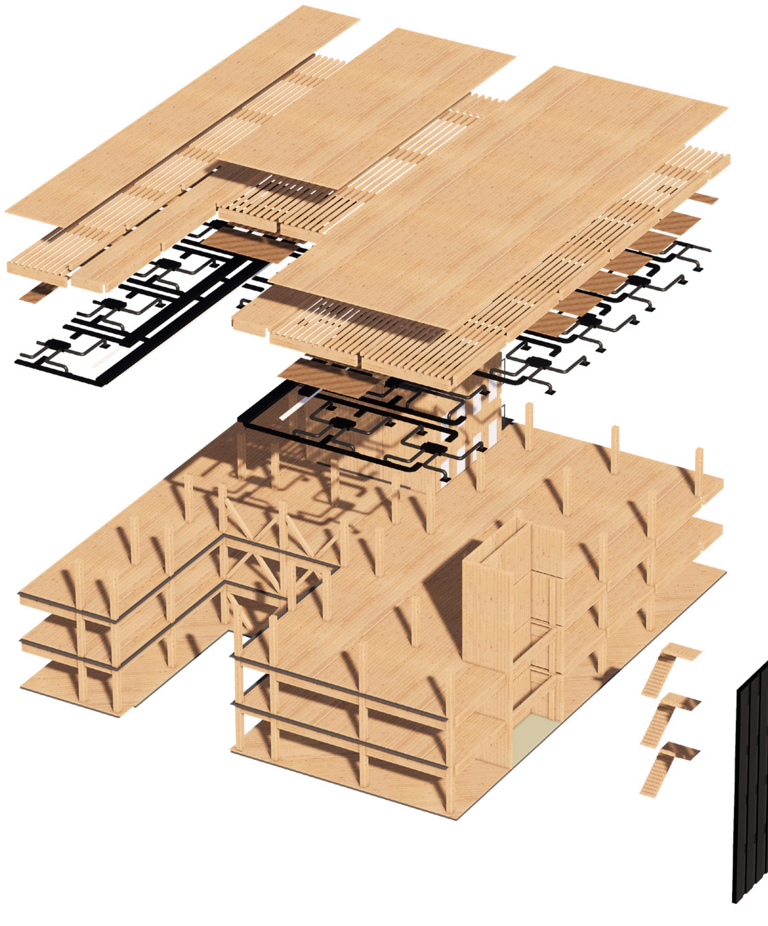
In the developed world, we spend approximately 90% of our time within buildings and are therefore exposed to a range of chemicals arising from furnishing and finishes. The WELL Building Standard® is an increasingly popular evidence-based system for measuring, certifying and monitoring the performance of building features that impact health and well-being. Our team of WELL Accredited Professionals provide advice and guidance for projects that includes material design and specification as a key element of accreditation requirements.

The quality of both design and construction matters to managing material resources. Post-Grenfell remedial works are uncovering that buildings were not put together the way they were designed. Our Technical Advisory Group are addressing projects completed relatively recently where investigation reports show inadequate insulation was installed, for example. If the materials used are brick slips embedded in an insulation and rain screen cladding. It is a challenge to upgrade and repair without a significant material waste. Retrofitting projects started for fire safety reasons quickly turn out to uncover much further reaching issues, calling into question what owners of such buildings should and can do in terms of maintenance. The way the buildings are put together, and the difficulty of disassembling them for repairs, leads many to turn to demolition and starting again. An enormous waste of embodied carbon which cannot be recovered.

As a result of Grenfell, the regulatory changes in the draft Building Safety Bill propose to further increase the involvement and responsibility of the Principal Designer (PD) required by Construction Design Management (CDM) regulation in the UK. Under CDM currently, the PD co-ordinates health and safety (H&S) in relation to the design (whenever this occurs), makes sure designers have taken account of H&S "so far as reasonably practical" (SFARP) and ensures everyone in the project has the information they need to do their tasks safely. Under the Building Safety Bill, the PD will have to verify that every aspect of the design has been delivered exactly as the drawings and specification and that it complies with Building Regulations. The PD can only do this if they have the expertise and if they have been on site to see every nut bolt and screw put in place throughout the entire construction phase. This is a challenge to the industry in terms of expertise, liability and insurance . However, it would lead to the situation where the building information contained in the Health & Safety (H&S) →

ABOVE
Victoria Gate under construction

RIGHT
Stora Enzo - Modular Timber Office System



file at handover, and the digital twin, will be a completely reliable document of the make-up of the building and become the manual you use when you take it apart, or repurpose. For example, embedding the performance data of a beam in the digital twin means that when it comes to be reused the strength is known, without need for testing and verification. An ecosystem of digital twins and digital material passports will become a crucial part of managing our built environment as well as supporting carbon reduction.

The drive to modular and off-site construction can address issues such as build quality and reduction of negative construction impacts. However, these need to be designed with the circular economy in mind. Efficiencies gained in early stage construction cannot be at the expense of later adaptability and material recovery. This means appropriately sized modules and components, fixed together to reflect the life-cycle of each layer as set-out in Stewart Brand's Shearing Layers diagram. "Cradle to cradle" or 'take back' schemes can be specified to support the reuse of materials in the lifecycle of the building.

Moving to a truly circular economy in the built environment will only work if all parties involved are part of it. We need a systemic shift in terms of supply chains and value. As architects and designers we are already starting to address the technical challenges and make the fundamental shift in our attitude to materials- seeing buildings as material banks.

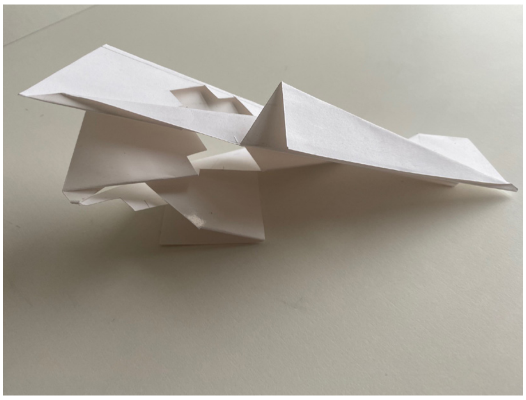
ILLUSTRATIONS

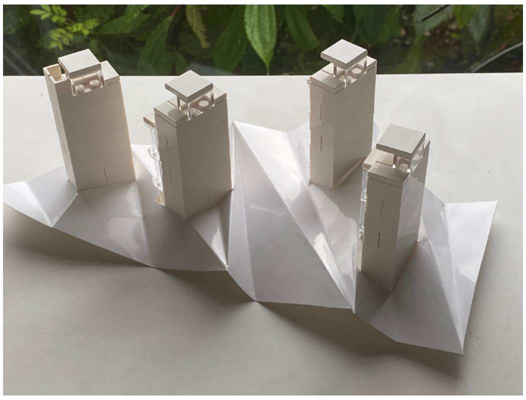
Victoria gate- construction image
We took an original Scott Brownrigg designed building from 1985 and redeveloped it for the 2018 market- retaining as much as possible of the existing structure but replacing the façade and interior finishes and adding 25% to the footprint with an additional floor.

Lego models of Seward Park New York
Lego is immensely versatile and doesn't age. Older and newer sets can be blended and recycled endlessly. A great vision for building products and materials.

Layering diagram- with thanks to Stewart Brand's Shearing Layers diagram
A building is conceived as several layers of longevity of built components. The lifetime of different elements of a building can vary from well over a hundred years down to a matter of months, or even weeks. The structure of the building has the longest potential lifespan and is the limiting factor in adapting a building to a new use. The structure and fabric can be made to be adaptable and over-engineered to last a lifetime, while the internals will be fickle and have to be designed to be reusable or compostable. Keeping each of the layers independent allows the structure to be retained when upgrading the fabric and the building will be easier to disassemble at end-of-life so that the components can be reused, remanufactured or recycled. Using the layered approach helps to make the building easier to maintain, as the services will be more accessible for repair and maintenance.

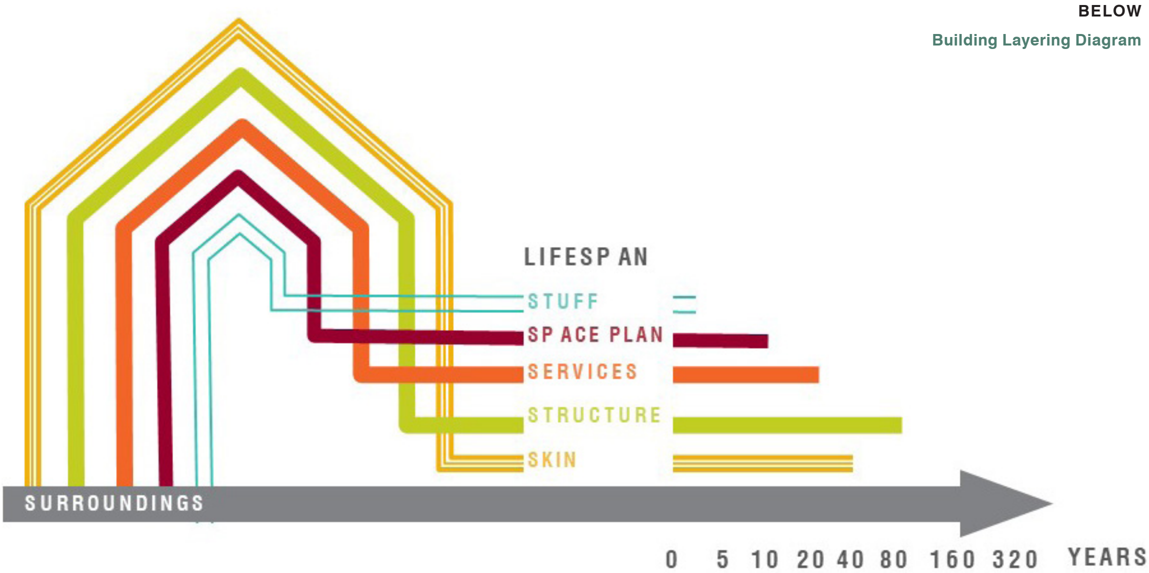
Stora enso office concept
The flexible timber office developed in collaboration with Stora Enso uses a modular, kit of parts approach pre-assembled to ensure transport to site in optimised loads. Simple and quick to construct using a clip system it is completely demountable and the timber frame is reusable ●





ABOVE
Lego models of Seward Park, New York

BELOW
Building Layering Diagram



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DESIGN PROCESS:
Mount Ngongotagh New Zealand – Craftsmanship, Making and Dimensional Rules

Leading a new cultural tourism masterplan for the Ngati Whakaue Tribal Lands in New Zealand, Board Director Neil MacOmish describes how the stories and craftsmanship of the local Maori people have shaped a new destination that is truly reflective of the place, people and culture.

Renzo Piano famously said, In architecture, the philosophy should inform the detail, BUT the detail should inform the philosophy[1]

Our client, the Ngati Whakaue are the Iwi (Maori People) that have occupied the land around Lake Rotorua for the last 750 years. During that time, their craftsmanship and making has been honed and developed and informs an essential part of their culture.

Typically, these processes oscillate from the practical to the decorative, from art to science.

The clients brief was clear but simple to us having won the commission to undertake this cultural and tourism led masterplan. There were to be three pillars that all aspects and each component would be judged against – Our People, Our Stories, Our Place.

So in this regard, an essential consideration in how the masterplan was conceived needed to be underpinned by how it and all the constituent parts, would be made and consequently what the making would represent in the narrative.

Our research consisted of a substantial amount of historic material describing the heritage of the Iwi, our own background research, work undertaken by Professor Terry Stevens as well as a lengthy site visit and engagement sessions with all parties who had a vested interest including neighbours. Two key aspects of this research were discussions with staff and students at Te Puia, the Maori cultural and geothermal centre in Rotorua and the discovery that one of our clients' principle businesses was the production of engineered timber.

All of this mapped a rich narrative for our use in the concept design and organisation of the proposed masterplan.

For instance, in the use of engineered timber sheets, a 1200mm panel size was an optimum dimension that could be fabricated and would result in little waste material on or off site. All buildings and dimensional criteria would use this 'rule' to establish an aspect of the masterplan's spatial characteristics in a wholly sustainable way. Even buildings that require long spans or on difficult parts of topography are conceived in timber – glulam or composite frames as well as the skin and external walls. The Karearea (The Hawk's Nest) hotel is a typical example of how this is manifest. A slender timber frame that moderates the severe slope is occupied by modular bedroom units that are simply slotted into place.

"Young Maori's are given a three year course in how to carve using both traditonal and contemporary techniques... This process of carving onto everyday objects and enviornment makes everything 'thier own': part of them, thier families (Whanue) and community."

ABOVE

Representation of a war canoe of New Zealand by Prattent, T, active 1780-1800; Parkinson, Sydney, 1745-1771; Hogg and Company. Ref: B-085-013. Copyright Alexander Turnbull Library, Wellington, New Zealand

BELOW

Leleuvia Magimagi Detail | Copyright Leleuvia Island Resort, Fiji, Photographer Colin Philip

Much has been made of modernism's concerns with decoration – Adolf Loos et al and the much miss-quoted "ornament is crime"[2] – but this clearly has not and is not always the case.

At Te Puia, young Maori's are given a three year course in how to carve using both traditional and contemporary techniques. The first year is generalist in the craft – second and third years offer you a choice of whether to specialise in wood, stone or bone, all very different skill sets. This process of carving onto their everyday objects and environment makes everything 'their own'; part of them, their families (whanue) and community. It also makes a clear connection between their culture and stories – the carving often makes specific reference to events, personalities and icons within Maori history. We used these particular devices in specific locations to make equally specific reference to this heritage – the eight Maori children totems that mark the boundary of the site (each representing an elemental part of the natural world), abstract references to patterns which represent key elements of their cultural narrative (the closed asymmetric spiral – the opening tree fern, which represents life/rebirth, Maui's fish hook – transformation etc) – these not only form part of a 'decoration strategy' but also inform building plan and form and mark 'nodal points' along a carefully choreographed 'cultural pathway' that threads the masterplan together.

This pictorial form of recording their histories and heritage is supported by an oral record (songs as well as stories) – little is written. These two aspects of remembering and recalling their rich history actually make it easier the represent the pervading narrative within strategic design considerations and the composition of the overall masterplan – as well as in the detail. →

ABOVE
Unibody wooden bike frame by Jan Mucska
photo by Jachym Kliment
BELOW
Young men learn traditional carving techniques at the Whakarewarewa Maori Carving School | Copyright Denisbin via Flickr

An extension of this process of making is the Maori tradition binding material together – in particular, things that need to flex or move in response to external forces. Examples of this can be found in both boat making and vernacular architecture.

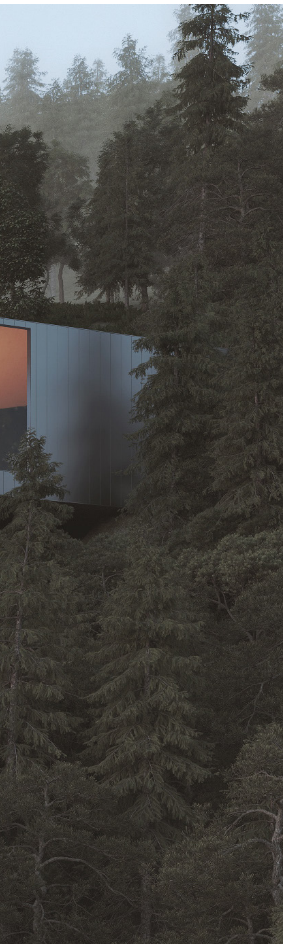
The first is an obvious response to the constant motion of water – particularly at sea. The constituent parts of canoes and larger vessels have bound joints to accommodate the different stresses and forces. However, this knowledge became an essential part of the Maori construction process in buildings. It was not just a tradition of transferring one technique to another purpose – for simple ease, but an understanding of the geological conditions that they were building in. New Zealand sits on the south-western edge of the Pacific Rim of Fire. Earthquakes and seismic events are a frequent occurrence. Joining key structural elements together by binding them using rope or flax, enables buildings to move rather than collapse. The craft and skill involved in this merges with an idea about decoration.

Indeed, Alvar Aalto used a similar device in his Villa Mairea – both to represent wrapping and the peeling of the bark on silver birch trees – but also as an actual jointing technique.

We took this particular element of making and used it in the proposed reception centre of Lake Rotorua – a detail on the external columns that hold up the 'Hoe' roof (a Maori war paddle). →

ABOVE

Villa Mairea, Norrmarku, Finland Alvar Aalto © Lindman Photography



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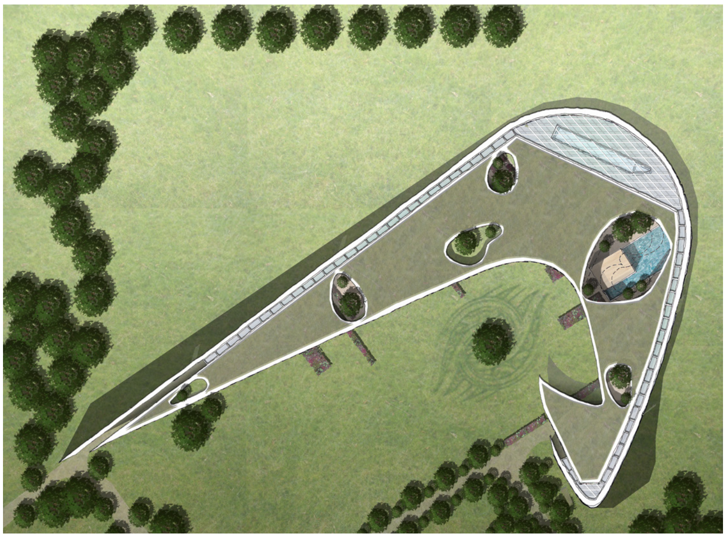
Mount Ngongotaha Masterplan



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Mount Ngongotaha Masterplan

All of this informed not only our architectural concepts, language and contextual response, but also an idea about function and programme.

To take these craft and making techniques forward from their 750 years of tradition, we proposed the idea of a Maori innovation centre. This would use honey making as an extension into health and well-being products as well as a re-wilding programme using Flax for similar purposes. It would also promote the synthesis of craft and technology into new digital techniques.

Adjacent to our site is a mountain bike facility called Crankworks. It holds an annual event where 27,000 competitors come and race in a huge number of different categories. With new ways of making and forming timber, our client is now making crafted, authentic Maori mountain bikes. These are as strong and lightweight as carbon composites, but look and feel like a handcrafted version, with organic forms that allude to traditional art forms.

All these things combined make for a masterplan response that is grounded in those key elements of the client's brief = Our People, Our Stories, Our Land ●

References:

1 Archiscapes. The art of sketches | Renzo Piano (6 April 2015). Retrieved from https://archiscapes.wordpress.com/2015/04/06/the-art-of-sketches-rpbw/

2 Loos A. 30 May 2019. Ornament and Crime: Adolf Loos. Penguin Classics

RIGHT
Eigen Haard housing by Michel de Klerk, Amsterdam

BUILDING STUDY: To ‘make’ or to ‘manufacture’?

This discussion piece by Alistair Brierley explores the fundamental differences between ‘making’ and ‘manufacture’ and how their influence and implementation affect both our envisaged and completed buildings.

Visits to both Amsterdam and Utrecht in 2019 highlighted by Michel de Klerks’ crafted residential masterpiece Het Schip (The Ship) and the cubist abstraction of the Schroder Haus by Gerrit Rietveldt brought these issues into sharp focus and opened up questions in terms of how we approach the construction of our own buildings.

I had wanted to visit Mikel de Klerks’ apartment building in Amsterdam for many years. In order to get there it was necessary to step outside the concentric geometry of the parallel canals and break free of this particular urban grain. Travelling to Europe via Amsterdam whilst studying had offered this opportunity on more than one occasion, but I had failed to reach the site (which lies on the wrong side of a railway embankment) when walking from the city centre. However in the autumn of 2019 I finally made it, diving through a pedestrian tunnel from the adjacent park and following the embankment out of town. Experience tells us that the final sighting of a real building in context as opposed to a film or a photograph, presents the real face and personality of the object. And so I found myself walking in a straight line to the apex of the site where this magical piece of Amsterdam School architecture had anchored itself a century ago.

It is the actual and evident ‘making’ of this red brick and tile hung composition that is immediately extraordinary. The use of a limited palette of materials, primarily brick, terracotta, wrought iron and timber, has been exploited and celebrated to the maximum. Michel de Klerk understood his materials and used them to sculpt and form an extraordinary sequence of architectonic moments that coded and narrated his vision for social housing. Whilst the Bauhaus School was embracing the New Machine Age, and its buildings and products were aiming for mass production and standardisation, the Amsterdam School were exploring the use of sculpted brickwork, as opposed to concrete, render, steel and glass.

With hindsight, it is fascinating to acknowledge that buildings within Europe of a similar vintage could have contrasted so much, both in their materiality and detailing, as well as their iconography and philosophical stance towards ‘making’ buildings. The Bauhaus protagonists, alongside early Corbusier, extolled the virtues of mechanisation, and indeed the home was infamously described as the ‘machine for living in’. It was largely the stripped down aesthetic of white painted render and the separation of frame and enclosure that excited the architects of Weissenhof in 1927. However these homes were far less radical than their imagery suggested. In a sense, the making of these buildings was of secondary importance to the architectural position they occupied, whereas the painstaking laying of bricks and mortar in Amsterdam was decried as old fashioned.

The notion of mass production has to some extent devalued the intrinsic value of the ‘made’ object. Parts of de Klerks’ style as seen in Amsterdam were derived from the British Arts and Crafts movement and the work of Frank Lloyd Wright in America. Here the picturesque was not to be decried, rather celebrated. Details and junctions were all carefully considered, as was the joinery and ironmongery that became part of the formula. These buildings were inherently tactile, and their solidity reinforced the nature of them being ‘made’ and crafted. The polarity of this is evidenced in Mies Van der Rohe’s own stance to both components and standardisation. The stripped down purity of a Miesian column, or cladding component was not overt or extravagant, rather understated and precise. Within the floating and intersecting planes of the Barcelona pavilion, the ‘making’ of the building is on show and up for scrutiny. These simple forms and extravagant materials were contrary to the work of Mackintosh, Voysey or Maurice Webb. In this example Mies was able to celebrate both individual components and materials by their separation, whereas Michael de Klerk and the Amsterdam School would offer the crafted juxtaposition of brick, stone, wrought iron and wood.

All buildings are either ‘made’, manufactured, crafted or even printed. Most by definition are modularised, as architecture often aspires to a level of standardisation. Repetition is no bad thing, and always good for process, quality control and cost. As such the maker has to ensure that the standard or typical family of details for a building is fully understood and executed. Extravagant or non-standard moments in construction need to be handled with extreme care. As such a corner, a cantilevered soffit, a freestanding column or pilaster are all more self-consciously on show than the standard bay or module.

The choice of materials has enormous consequences for the ‘making’ of buildings. The continuing debate over form and function, and the materials chosen to express the personality of a building is always there for the architect. The contradiction of the stone dentil seen on the frieze of the Parthenon is only a decorative reminder of the fact that temple construction was originally envisaged in wood and not stone. As such, is this material interpretation permissible in the true spirit of ‘making →


HEMBRUGSTRAAT
WESTERPARK
ZAANSTRAAT

ABOVE
Trip to Michel de Klerk's Eigen Haard housing in 2019

honestly and with integrity? Has the cavity wall and the acres of stretcher bond that clad some contemporary buildings debased and nullified to true nature of the material and its place in the building process? Is it acceptable that there is a steel or concrete frame within that supports the building? Are the stick on, pre-fabricated lintels that demark openings in our brick buildings to be decried?

This returns us to the traditions of 'making' and vernacular architecture. A brick and flint cottage with a thatched roof supported on a timber frame is evidently a 'made' and crafted object. Equally so are the unitised panels that are craned up and inserted into the 50th floor of a high rise, whether they are triple glazed sealed units or pre-fabricated stone faced panels. To an extent the process of 'making' has a nostalgic ring, a harking back to the days when the artisan was respected. On the other hand manufacturing suggests the 'making' of things on a large scale using machinery, and incurs a different emotional response. Is a Saville Row suit more authentic and valuable than an off the peg equivalent, and what is the built equivalent of this example?

This brings us to the duality and inextricably linked phenomena of building and architecture. However good or bad, all architecture has to be 'made' or manufactured. Whether the highly finessed and unique hand carved staircase in a Gaudi building, the rope wrapped column as seen in Alvar Aaltos' work, or the myriad of identical components that clad the Seagram tower, they are all part of the 'making' process.

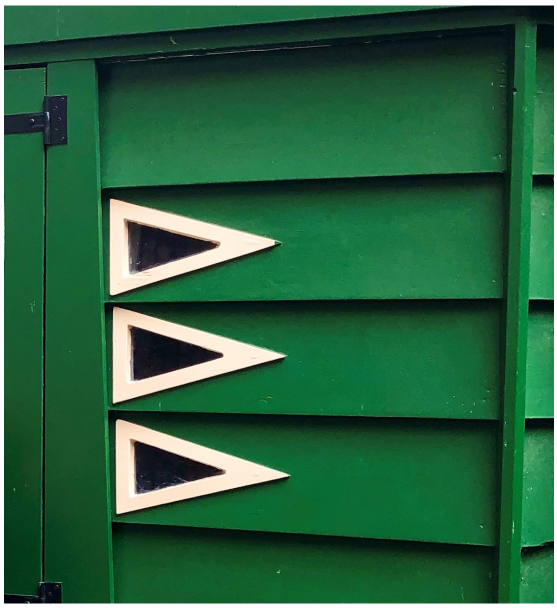
Some may have viewed the various anti - rationalist tendencies of the Amsterdam School as a serious alternative to the emergent International style, but there is no doubt that de Klerk occupied the same ideological ground of Corbusier, Gropius and Mies. However the main and obvious difference one experiences when visiting Het Schip is the actual physical manipulation of the building that was carried out during the building or 'making' process. This sequence of 'making' an object in a tactile and physical sense is seen in the detailing which is always representational rather than theoretical. In direct contrast to cubist principles, which offer a puritanical asceticism, this residential experiment in Amsterdam offers an exuberant plasticity that is universally understood. It is evident when visiting, that de Klerk was often improvising as he went along, and although the building just about holds together as a coherent whole, there are moments where a change in architectural rhythm and pace takes some adjusting to. De Klerk was accused of individualistic licentiousness by the ascetic moralists of the de Stijl movement and compared with a degree of scorn to the residential work of Frank Lloyd Wright. This was seen to represent American High-life which was wholly unsuited to the ideals of cubism that in its abstraction purported to embrace all men and everything.

Considering what we had experienced in Amsterdam we travelled to Utrecht and visited the miniature (and ultra-experimental) residence built by Gerrit Rietveldt for the Schroder family in 1924. The polarised approach of the architectural styles of both de Klerk and Rietveldt and their attitudes to 'design' and its 'making' or manufacturing processes are made clear in these two contemporaneous and radical approaches to constructing a building. The Schroder house offers a series of separated planes and volumes all working together to offer the impression of the assembly of prefabricated components, making up the floors, roofs, windows and cantilevered balconies.

In our contemporary world this house would most likely come flat packed with an Allen key and a series of construction diagrams. Besides this the prototype could then be processed, printed and packed at speed and offered by the thousand. The same cannot be said for de Klerks' plastic and expressionistic approach to form as seen in Amsterdam. This prototype is a 'one off' and not available for industrialised manufacture by volume. Any attempts at this would render the innate quality of the architects vision diluted and degraded.

The problems with disseminating the fundamental differences between 'making' and manufacture remain evident, as in the end both are intrinsic to construction. The notion of 'making' is sometimes seen as adding value by the eye and hand of a craftsman, digital or otherwise, and the time invested whilst manufacture may be decried or celebrated depending on cultural perception. In the exuberance and stylistic whimsy of de Klerks architecture, we see a series of junctions and formal attitudes to building that needed making by hand, rather than manufacturing largely because the work was improvised and then synthesised as the build progressed.

Approximately a century on from the completed work of de Klerk and Rietveldt in Holland, the evolving Scott Brownrigg oeuvre continues to develop. We find that there is an increasing drive and desire to use as much prefabrication as possible in order to maintain consistency in quality control as well as for speed and efficiency of construction. More sophisticated 3D design programmes that can transfer key dimensions and complex geometries into digital production see a rise in manufacturing, but not necessarily at the expense of 'making' and the tactile processes involved. Much of this comes back to the changing palette of building materials available to the architect, and the knowledge of how these can be applied to meet their optimum aesthetic and performance criteria. Both Het Schip and the Schroder Haus have provided inspiration for countless architects over the last century and echoes of both their ideologies and building processes remain as relevant today as when they were first envisaged and made real ●



RIGHT FROM TOP
Window and junction details are all carefully considered

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ABOVE
Filippo brunelleschi attr. modello architettonico della cupola e due tribune, 1420-36 Copyright Sailko, CC BY 3.0 httpscreativecommons. orglicensesby3.0, via Wikimedia Commons

DESIGN PROCESS: Manufacturing and Construction: Digital Craftsmanship and The Renaissance of Three-dimensional Design Communication

Three-dimensional design has transformed the architect's ability to communicate and has had an equally profound impact on the manufacturing and construction process. Here Rob Cullen assesses the façade design and delivery process for three exemplar residential projects to address what defines manufacture of building components in the 21st century, and how this impacts the role of the architect.

Within the 2020 RIBA plan of work, Stage 5 is identified as 'Manufacturing and Construction'. As recently as the 2013 edition, Stage 5 was previously identified as construction alone[1].

In antiquity, the appearance of the facades of buildings were resultant from the building construction technique, so the face material of the buildings provided structural integrity as well as the building aesthetic. During the renaissance, facades and their backings began to separate, the outer skin of a building was ornately crafted from expensive materials, with a structural base backing material behind this outer skin formed from the building construction.

Renaissance architects worked in three dimensions, preparing scaled timber models of their designs for builders and craftsman to scale from in order to form the base construction of the building. These then introduced sculpted components to create the façade, created independently of the main construction work.

Modern construction has taken further steps towards divorcing the external cladding of a building from the structure of a wall which provides the building's enclosure.

Until fairly recently, architects have produced constructional information predominantly in two dimensions, but now, with three-dimensional modelling becoming mainstream, the architect has now gained the ability to digitally model and craft buildings as a prototyping process.

The RIBA plan of works 2020 edition acknowledges this evolution in our way of working by the acknowledgement of the manufacture of building components in Stage 5 to accompany construction. So what defines manufacture of building components in the twenty first century? And how does this impact the role of the twenty first century architect?

In order to answer these questions, we assess the façade design and delivery process for three exemplar residential projects, all of which are conceived to be striking stone clad buildings: Bath Riverside Buildings B5 & B16, Building D Royal Exchange Kingston and Building H1 Chelsea Creek.

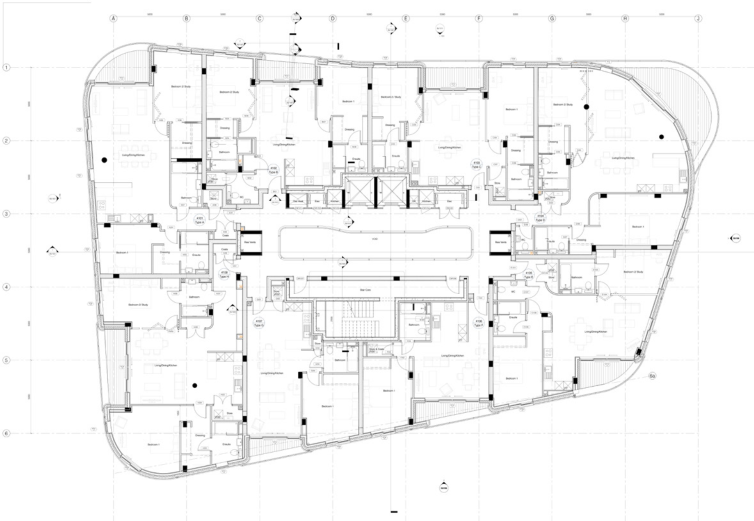
The commonality shared between the three projects is that firstly, they are all conceived by three of the UK's leading architects, secondly they feature stunning, innovate, crafted facades and thirdly, Scott Brownrigg's Design Delivery Unit either have delivered or are in the process of delivering all three projects.

The manufacture of building components has evolved with the evolution of building production facilities advancement in mechanisation and transportation have allowed for larger parts of buildings to be manufactured, items have become larger and more complicated.

In recent times, with the emergence of 'digital craftsmanship' facilitated by the use of structurally intelligent 3D software and BIM Technologies it is now possible for the complex and innovative projects to be delivered.

'VIRTUAL STONEMASONRY'

Some building components, such as curved brick specials and reconstituted stone components can be made in moulds, but how do the mould makers for such components know how to create the precise geometries that today's designs require? Our first project example, Buildings B5 and B16, conceived by Studio Egret West, can be described as the 'Wedding Cake' buildings, and can be described as organically formed pavilion buildings clad in Bath stone with undulating facades which step in as the buildings are taller.



DDU Project Architect Phil Roy explains that:
"The complexity of the design and bespoke scheme was enthralling, the design of both unique buildings captured ones attention due to the high level of complexity and detail with both the façade and internal design. The use of BIM software was the key attribute to the success of both these schemes, to facilitate 3d modelling, the complexity with the shape, material connectivity and sub contractor checking."

The façades of these buildings are constructed with a Structural Framing System SFS inner leaf encasing a reinforced concrete frame. The external cladding is reconstituted Bath stone with undulating geometries. The buildings were modelled using 3D BIM Software to establish the line of this encasement so subcontractors could design this system. The components of the stone cladding system which was faced the SFS were crafted digitally and virtually prototyped so that precise moulds could be made by fabricators.

This project is an example of how the role of the architect has evolved to include digitally making the building components and to leading and informing the process of manufacturing the façade components.

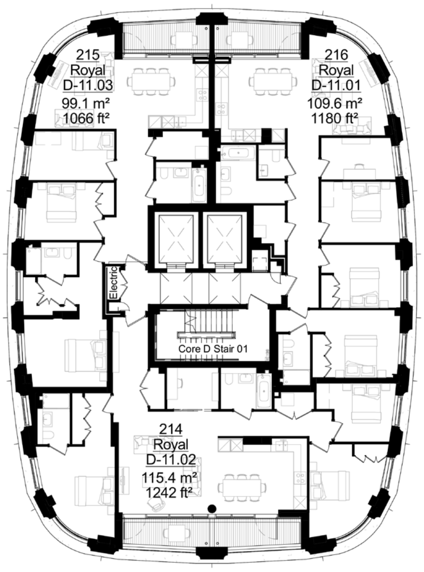
The stone fabricators utilised the three dimensional design drawings to create moulds, and the external cladding of the building was manufactured so that it could be transported to site. The architect's role also included the co-ordination of the subcontractor's drawings of the components back into the design. It is however worth noting that the final finishing of the stone was undertaken on site via a sanding process carried out by stonemasons.→

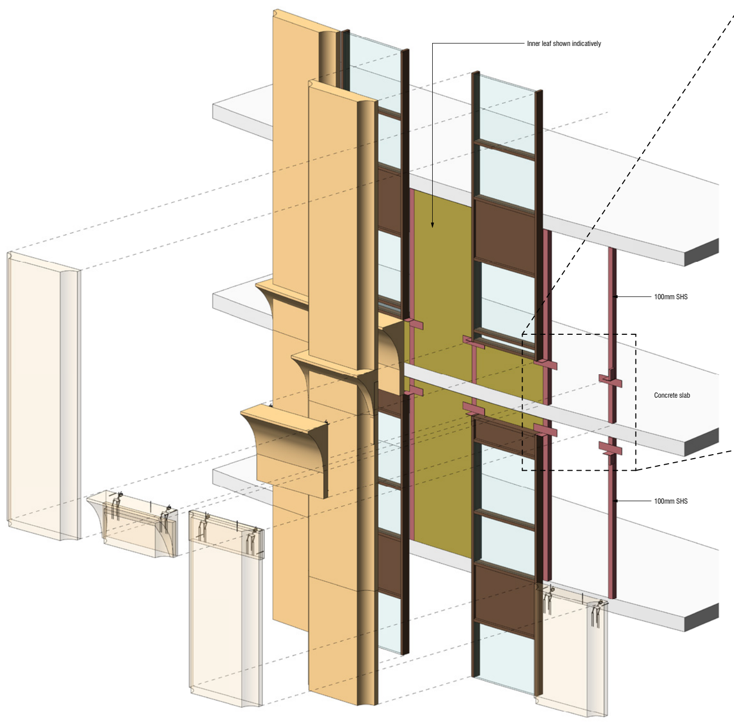
IMAGES
Bath Riverside B5 | Copyright Hundven-Clements Photography

‘CRAFTING PRE CAST CONCRETE’

Prefabrication and offsite manufacturing of entire facades of buildings can be considered to be a well-established construction method in the UK; however the technology for pre-casting such panels were limited by project budgets, the design of the components and the skills of the mould makers.

Pre-cast concrete cladding technology is still utilised today, benefitting from up-front input from architects which is brought about by the symbiosis of an understanding of the technology and the ability to digitally model the forms of the moulds required to manufacture pre-cast concrete elements. Consequently, the resultant buildings delivered are be far more varied in form and geometry than their pre-cast clad predecessors.





LEFT
Bath Riverside B5 typical floor plan

ABOVE
Precast panel assembly model

Building D, Royal Exchange Kingston is one such example. Conceived by renowned architectural designer Simon Bowden, this fourteen storey building is elliptical in plan, and is clad in an insulated pre-cast panelised system. The design features fluted panels which include compound curves arranged around the plan form. Whilst the technology to fabricate such panels has been in existence since the 1960s, the cost of doing so could be quite owing to the skills involved in making the moulding for each panel.

“The use of 3D modelling on this project has enabled us to resolve complex junctions of the desired profile where the vertical meets the curving horizontals, and to marshal the decorative features within the profiles both visually, and pragmatically to ensure panel jointing and sealing is fully controlled.

It also assists with 3D hygrothermal analysis of the façade to prove the proposals, as well as assisting in much more detailed sequencing analysis, to clearly show the interaction of the pre-cast panel system with the prefabricated glazing system, step by step to assist with a successful site installation.” Technical Director, Barry Clarke

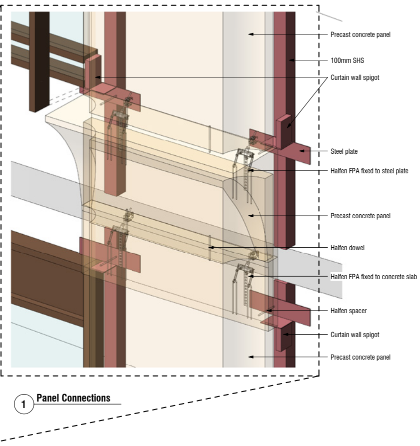
In order to deliver this elegant and complicated design for this project the designers (first the architects and then the subcontractors) were required to make the panels digitally. Digitally crafting the panels enables mould makers to understand and create the formwork to facilitate the construction of the panels and the sequencing of their installation. The panels are to be fabricated offsite and brought to site for installation. Combining this with an offsite pre-fabricated glazing system allows for an efficient encapsulation of the basic building frame.

The up-front digital design process is similar to that deployed in the virtual fabrication of the stone cladding at Bath Riverside, however the construction of the system differs because the cladding panels are fixed back to a secondary steel structure attached to the buildings re-in forced concrete frame.

The architect’s role in designing a cladding system of this nature extends further – to include full up front co-ordination exercise between all of the other trades involved in the construction of the façade to ensure statutory approvals are acquired. This process also requires considerable input from the design team; including structural engineers, façade consultants and the project fire engineer in order to ensure that the crafted components can be successfully integrated into the façade of the building.

One of the challenges faced when designing an insulated precast panelised system is the coordination of the fire-stopping, waterproofing and vapour control at the system supports, its positioning with respect to the building frame and the interdependence with other components.

Offsite manufacture will provide a confidence in the precision of the reinforced concrete elements and their interfaces with the other key façade elements. Confidence in the installation can be accrued by the fact that the designers have co-ordinated the components by constructing the building virtually.



> **"It's all about modularity, instead of creating and detailing a single façade, we had to digitally create in the region of 50 different modular components featuring a structural frame, insulation, doors and windows, fixings, fire stopping and external cladding."**

THE VIRTUAL CRAFTING AND ASSEMBLY OF UNITISED CLADDING SYSTEMS

Chelsea Creek Building H1, is a 30 storey tower which is clad in glistening, white Portland Stone coloured cladding. The concept architect, Squire and Partners vision for Building H1 is for a building with clean lines and a sharp aesthetic. This design features geometrically formed façade components which undulate in plan, and also in elevation.

If such a façade were to be traditionally crafted and constructed, then stonework could have provided a way to construct it; however this would not be financially viable in today's world.

The cladding systems used in Building D, Royal Exchange might give a satisfactory aesthetic however, a pre-cast concrete cladding system could be too heavy to be applied to such a tall building without major structural enhancements.

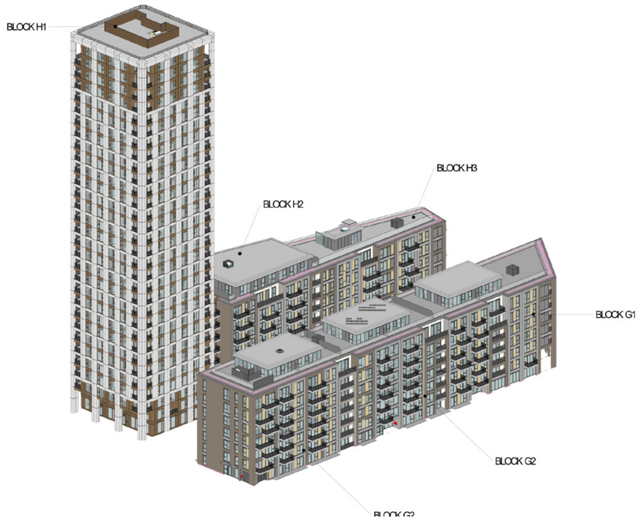
The manufacture of building components can extend to include entire façade systems; which combine multiple building components and a lighter weight approach to construction.

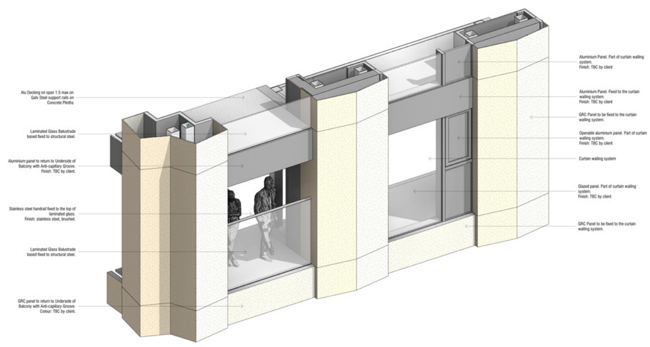
Design Delivery Unit architect Witek Mysliweic says "It's all about modularity, instead of creating and detailing a single façade, we had to digitally create in the region of 50 different modular components featuring a structural frame, insulation, doors and windows, fixings, fire stopping and external cladding."

In order to design such a façade, the architect needs to understand how systems are manufactured. Proprietary systems are selected as the basis of the design and the modular façade components are then integrated with these systems.

Every part of a complex façade requires consideration, from the glass reinforced concrete outer cladding layer, to the unitised 'stick system' structural frame and its fixings to a buildings superstructure, the insulated infill panels which fit between the stick system and the glazing of window and door units.

Fire stopping in a unitised system is, as within any façade, of paramount importance. Factory assembly of the units affords the opportunity for the installation of fire stopping products and the certification of the fire stopping to take place under factory conditions. The interfaces between the GRC and the unitised structure of the panels are very carefully considered and along with the project fire engineer, the architect plays an important role in using reasonable skill and care in the specification and detailing of the appropriate fire stopping products to be part of the unitised system.





ABOVE FROM TOP

Isometric view of Buildings G & H Chelsea Creek. Every GRC façade module in Building H1 is modelled as a 1:1 scale virtual prototype.

Detail of a mock up panel prototype testing the design and analysing key interfaces.

The co-ordination of windows and doors takes place 'up front', these components are integral to the structural frame system.

In designing this type of façade system, the architect is responsible for a significant part of the up-front design of the system by digitally making the bespoke elements of the cladding, the GRC outer skin of the building and co-ordinating them with the remainder of the façade system. This process is informed with the input of the project consultant team including façade consultant, structural engineer, project fire engineer, and also requires input from other façade specialists and manufacturers.

The precision in the employer's requirements afforded by the modelling of the building will provide the contractors delivering the unitised façade to deliver against the vision set out by the concept for this building. →

RIGHT
Royal Exchange Kingston

The role of the architect has evolved so that we now digitally make bespoke components in order to ensure that the visual aspiration of the design concepts are met, and that the buildings can be delivered on budget.

We are just about getting to the point of having 3D information to build from. As the early renaissance, the architect would have built a scale wooden model of a building. Builders would take the model, scale it up and then deliver full scale versions of it. We have seen how current construction methods have been affected by the architect's regained ability to communicate increasingly more complicated and intricate detailed design and construction information in three dimensions.

Front end design input is of paramount importance in informing the manufacturing process, as is a control over the interfaces between different products. The role of architect as digital craftsperson overseeing the manufacture of building components is very exciting and is evolving rapidly.

It is right that the RIBA has acknowledged manufacture in Stage 5. Perhaps there might be a nod to digital crafting in future iterations of the RIBA plan of work. Particularly because digital technology has led to a rapid resurgence of three dimensional detailed design communication and illustration which allows buildings to be truly conceived and delivered in three dimensions.

Further technological developments in three-dimensional printing and future material developments will only serve to give the architect ever more influence over the art of the possible in façade design. These innovations will deliver some very exciting times for façade design ●

1. RIBA. 2020. 2020 RIBA Plan of Work. RIBA

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> **“We were interested in exploring the possibility of standardising the design process; where buildings are instead perceived as manufacturable products, using templates of prefabricated components, that can be replicated on a larger scale.”**

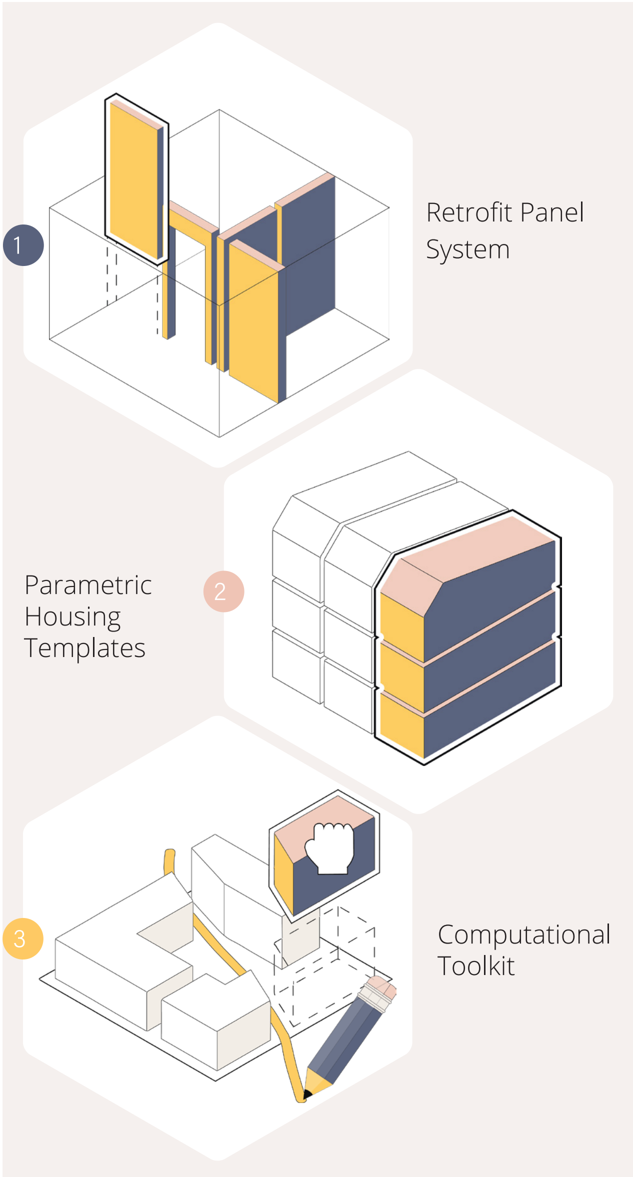
BELOW
The three core revenue streams

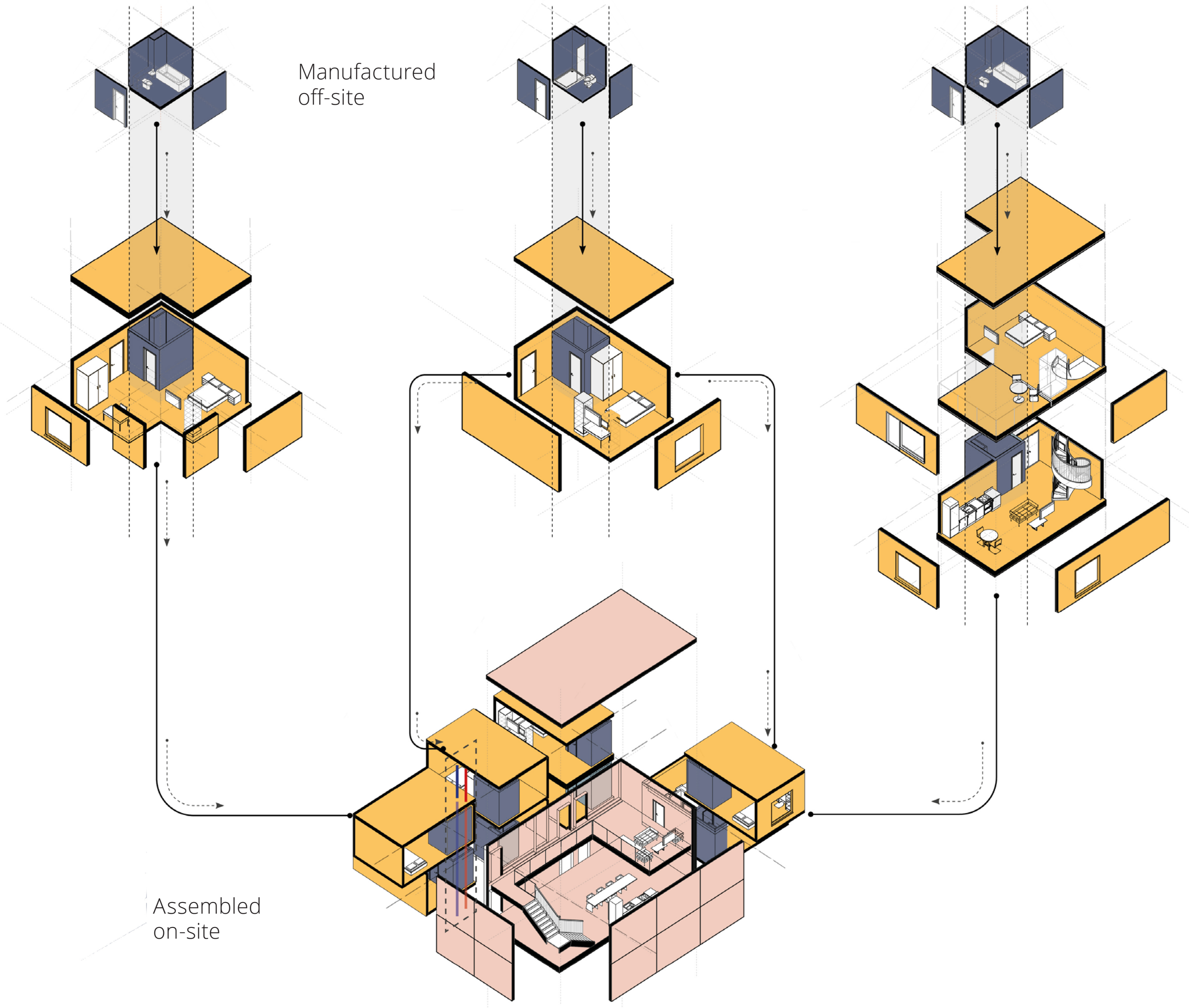
RIGHT
A standardised construction process

DESIGN PROCESS:
The Future of Construction: Taking Inspiration from the Manufacturing Industry?

For this thought piece, Design Delivery Unit’s experience on delivering visionary architecture meets Manchester School of Architecture’s Complexity, Planning & Urbanism (CPU) unit in a critical appraisal of the future of construction and new models of practice. Here a team of students with a shared interest in computational design and technology in architecture envisage an innovative type of “design and build” practice, Forge, that places the “build” process at the driving seat.

Manchester School of Architecture Professional Studies module leader: Stephen McCuster. Team Forge: Henry Baker (Project Lead), Menghan Chen, Crissti Dubina, Junjie Su, Michael Williams, Giselle Xie, Siyu Xie





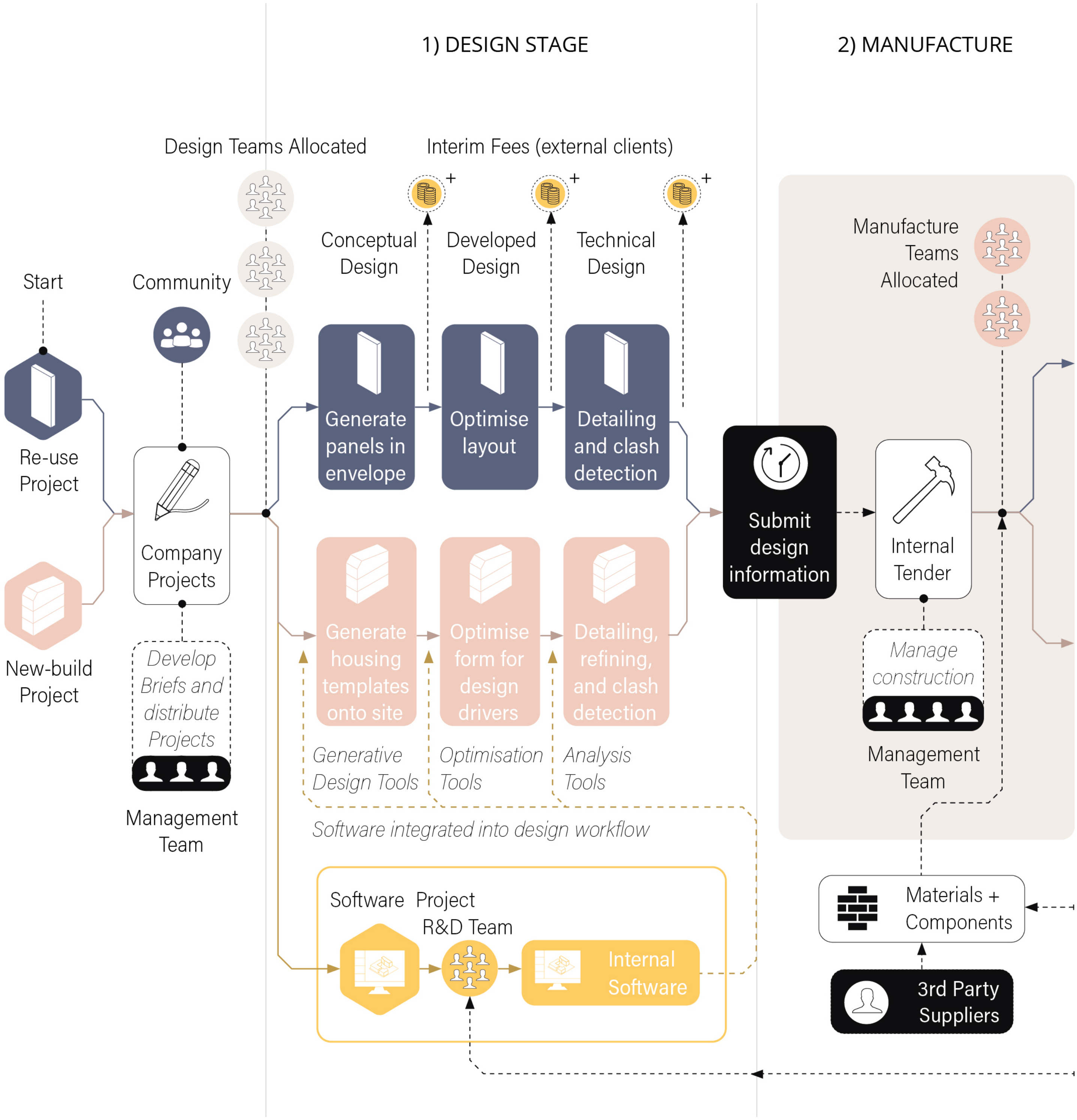
With a productivity growth of around 1% per year, the construction industry is lacking efficiency and innovation, especially when compared to an average productivity growth of 2.8% for the total world economy and 3.6% for the relentless productivity of the manufacturing industry[1].

This lack of productivity is exemplified through the UK housing crisis. With only 430,000 affordable new homes constructed in the UK since 2010 (as of Sept 2019)[2], the need to deliver high-quality outputs efficiently and reliably has become increasingly severe.

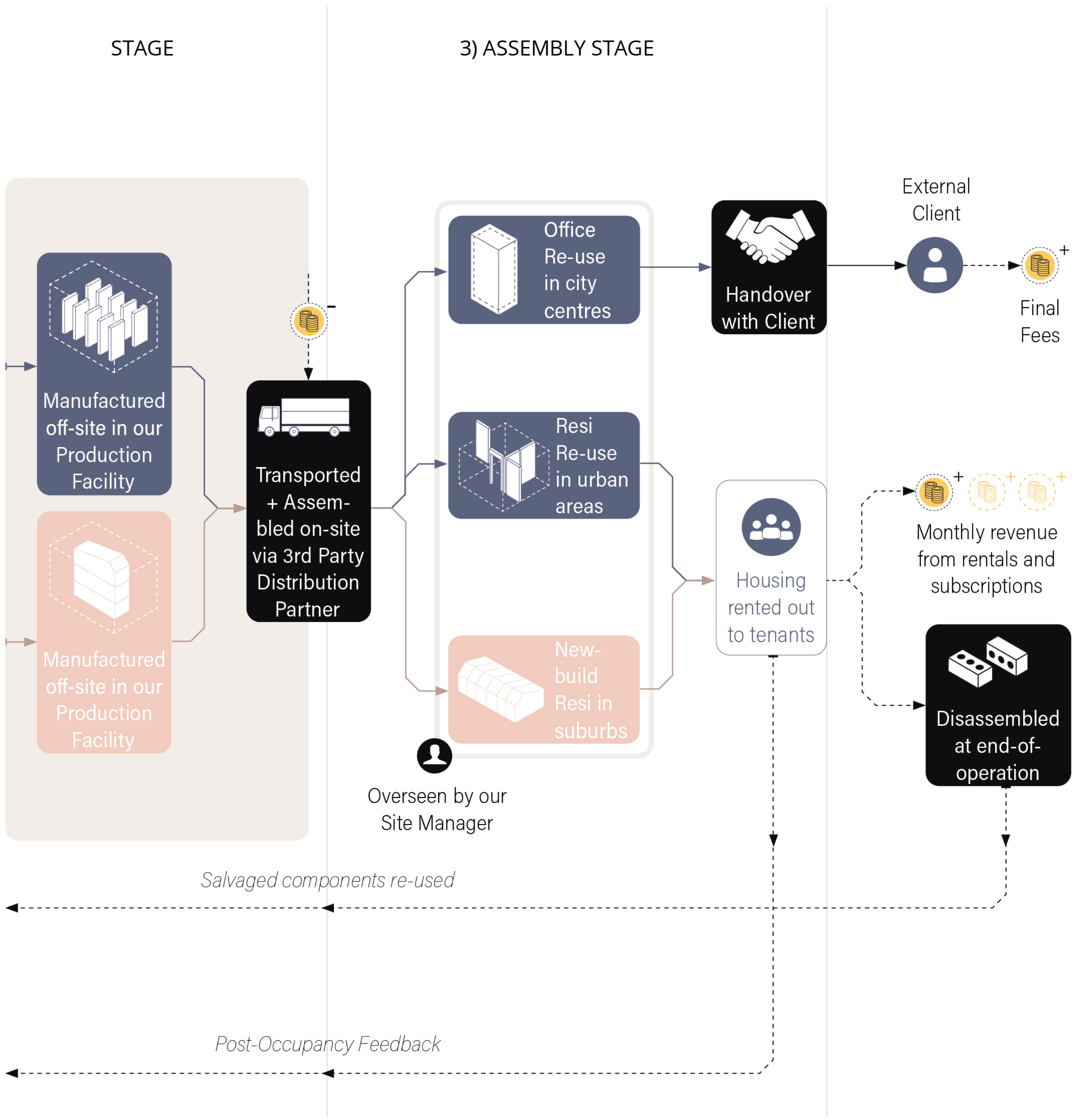
In this context, the question can be raised if techniques of standardisation and streamlining are being integrated into architectural practice at a sufficient level. For example, approaches such as DfMA (Design for Manufacture and Assembly) can realise improvements including a 20-60% reduction in construction time, 20-40% reduction in construction costs and a 70% reduction in on-site labour[3]. This positively contributes to government Climate Change Committee (CCC) targets, most notably to be net zero on all greenhouse gases by 2050, in addition to the RIBA's 2030 climate challenge targets, such as reducing embodied carbon.

As part of our Professional Studies at the Manchester School of Architecture, we were asked to put together a pitch for investment, proposing a fictional architecture practice, to be reviewed by a university panel of critics. The accompanying portfolio outlined the financial, ethical and marketing strategies that would enable our practice to become successful in the industry.

The thought-piece below sets out our approach as a group of seven, formed under the company 'Forge'. Our business plan, as an inter-disciplinary design collective, was developed around the core principles of digitalisation, standardisation and functionality. One that champions currently under-utilised communication and management skills of architects, by placing them at the forefront of design teams, and by diversifying revenue streams towards a passive means of income. →



ABOVE
A construction business taken into the Digital Era



THE 'BUILD WITH DESIGN' METHODOLOGY

The standardisation of construction processes into components built off-site, is well established as a modern building method in the industry. Whereas the design stages are typically a unique endeavour for each new project. The design of buildings are often executed in a linear fashion, from one party (such as the architect) to another (such as the MEP consultants), with an iterative design process that follows. This can be effective for ensuring quality, however it can also waste a significant amount of time and resources.

We were interested in exploring the possibility of standardising the design process, where buildings are instead perceived as manufacturable 'products' using templates of pre-built components, that can be replicated on a larger scale. These components, such as bathroom and utility 'pods', partition panels and full external modules would be continuously manufactured by a streamlined production chain, utilising standardised fittings and systems for ease of assembly, maintenance and disassembly. However, most crucially, the design itself is conceived with these components as the driving force from the very outset of the project. Therefore, templates are selected from a portfolio, essentially of different arrangements of the aforementioned components, and applied and moulded to the shape and constraints of the site, being developed on thereafter. →

We envisage a different, more innovative type of practice that has its own 'building systems', comprised of their own templates and how they build them. We call this the 'Build with Design' methodology and promoted this wholeheartedly in our business proposal. This type of company would have its own intellectual property, templates, components and building systems, designed to meet the UK's building regulations and space standards as a prerequisite.The company uses its own in-house software tools to generate, optimise and design, as automated and digitalised workflows allow for a greater level of interoperability between design and construction. This proposal was then presented to a panel of 'investors' to discuss the feasibility of such a practice, the advantages and disadvantages, and the feedback received was overwhelmingly positive.

A STREAMLINED, 'INTERNALISED' BUSINESS MODEL

The business model for this type of practice is based on the core principles of function-driven, standardised design, digitalisation and an inter-disciplinary personnel structure. Where the financing and revenue methods differ considerably from conventional practices; a fully internalised model, one where all aspects of the design of these manufacturable 'products' are undertaken under one company. A well-integrated structure would promote greater collaboration between different skillsets from the outset of a project, leading to a high level of communication and a streamlined workflow.

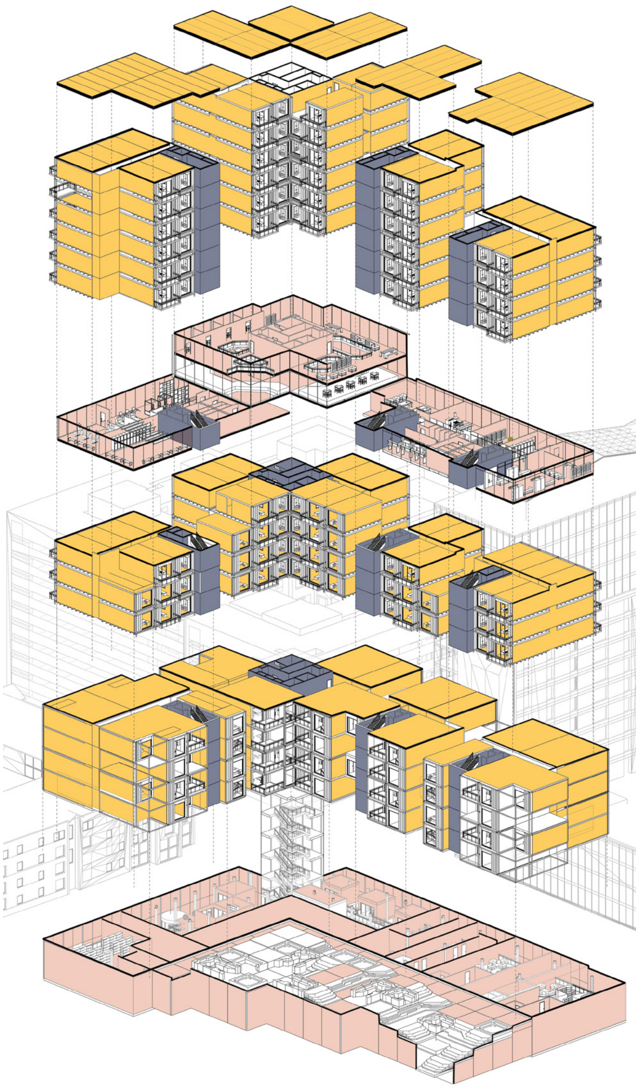
The driving force behind this type of practice are the company's internal assets; a library of parametric building templates, an internal retrofit panel system, or a platform of computational design tools. These assets provide the basis for the design methodology of the practice, and could also be 'loaned out' to external parties for further revenue, possibly even a subscription-based model. The focus becomes less about the project itself but more regarding the design of the assets, such as an entirely resolved bathroom pod, which can be continuously manufactured and sold to third-parties. This could in turn widen the brand's outreach, adapting it for the ever-globalised society. The business would have competitors such as IKEA and Airbnb,instead of traditional developers and architecture practices, as the company places itself at the centre of a vastly under-supplied housing market.

The company could acquire land and existing buildings for re-use, and execute the entire development, manufacture, assembly and retail of the buildings to the end-user, thus establishing a circular, internal business model. Revenue would be generated passively from rent and maintenance work, instead of unreliable lump sums. Automation and AI could be adopted throughout this process that further transforms the practice's workflow, and software tools developed in-house can act as an additional revenue stream. If utilising a portfolio of pre-designed building templates, streamlines the company's overheads, then passive revenue streams such as software subscriptions, rent, maintenance and disassembly work stabilise the company's financial future. Inevitably however, a business such as this would experience difficulties.

The initial incorporation of an internalised manufacturing chain would require a substantial amount of investment to initiate in the short-term, and a highly complex, organised system thereafter.

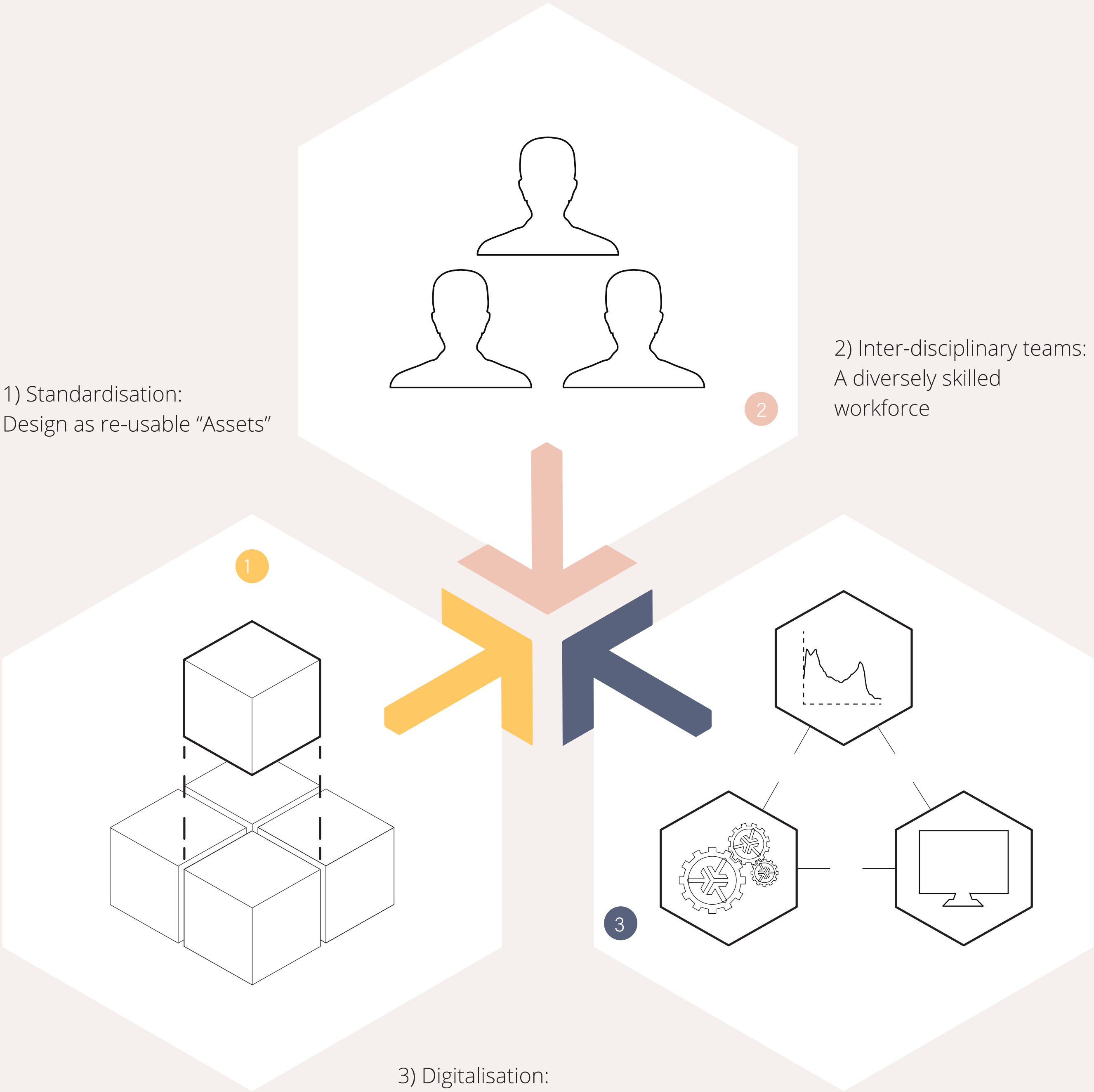
Although this business proposal comes solely from our perspective as part 2 students, it is centred around industry requirements and sustainability standards and targets. Therefore, we believe that efficient modern methods of construction, such as panelised systems and prefab housing templates, coupled with digital tools and holistic manufacturing processes, could become essential in the construction industry, and inherently linked to the success of future practices.

There is a critical need for the construction industry to re-position, and align itself with the design and operational strategies to re-position and become closely aligned with the design and operational strategies of the Manufacturing and Automotive industries, to thrust construction towards a highly-augmented, digitalised future ●



LEFT
Modular Housing by adopting these methodologies

RIGHT
The three core principles of the business



1. Barbosa. F et al., (2017). ‘Reinventing construction through a productivity revolution’, Mckinsey & Company.
Accessed: *www.mckinsey.com/business-functions/operations/our-insights/reinventing-construction-through-a-productivity-revolution*
2. BBC (2020). ‘None of pledge starter homes built, says watchdog’, BBC News.
Accessed: *www.bbc.co.uk/news/business-50296672*
3. Enzer.M, (2020). ‘DfMA; One of the keys to unlocking a more efficient industry’, Mott Macdonald.
Accessed: *www.mottmac.com/views/dfma---the-key-to-a-more-efficient-industry*

8

BELOW

Latent Façade by Jason Bruges Studios | Copyright James Medcraft

DETAIL: Plot 1-21 Cambridge Science Park Façade

Animating the face of the new gateway building at Plot 1-21 Cambridge Science Park, Latent Façade by Jason Bruges Studios is an exploration of image capture and computer vision. Here designer Jason Bruges describes the design and making process of this digital artwork.

What is the main concept for the installation?

Latent Façade is an exploration of computer vision techniques and the generative potential of mathematical systems. Inspired by the pioneering research undertaken on the Cambridge Science Park, the piece employs intelligent image capture and visual analysis techniques to record abstract traces of human movement. These provide inputs for a series of generative algorithms which drive dynamic patterns across the art installation's surface.

The cellular arrangement of the artwork's structure references the work of the Park's founder, Sir Nevill Mott, who first described "latent image" - the process by which light transforms hexagonal silver halide crystals within photographic film to record an invisible "trace".

Latent Façade captures activity in and around the park using two video cameras - the artwork's "eyes". These observe the buildings' surroundings and use algorithms to extract pedestrian and vehicular movements which are then recounted in real-time as animated patterns of light. At night, or during quiet spells, the artwork closes its eyes and 'dreams'. It samples a library of recorded movements randomly selecting one 'trace' at a time and using it as a seed for an ever-evolving display. →

Can you explain the design process?

Every project begins with an extensive period of research to properly understand the artwork context and to explore site specific narratives. It's important for us to spend time on site to observe how the space is used and think about what impact the artwork will have. We always investigate local histories, themes and influences while undertaking hands on material studies. Our approach is experimental, and process led, so it's important for us to test our ideas through prototypes and maquettes very early on. I'm a big believer in mistakes being avenues to inspiration and rely heavily on 'design by making' as the Studio's main approach. We also create digital visualisations and sometimes use VR / AR environments to assess how the piece will look once installed on site.

In this particular project, a great deal of time was spent on site after the physical installation of the lighting elements. We experimented and refined the generative software in order to create choreographies that complimented the activity, scale and variable ambient lighting conditions of the site.

We're interested to know more about the materials chosen, why these were selected and how they connect together?

The artwork is completely bespoke. Because we had a very particular form and function in mind, like most of our projects, it wasn't possible to use proprietary, off the shelf fittings. The modular light units we have used, have a very specific design that houses three LED strips. This gives the artwork its unique quality with two patterns of light appearing simultaneously. You have a strong linear line created via LED strips pointing outwards and a softer more volumetric choreography of light derived from the LED strips facing inwards, bouncing light off the building. The LED strips themselves are also custom made. They are particularly bright, so the light is visible in daylight, and they have a very fine pitch, so the light is perceived as a continuous line. The light levels adjust with the ambient light levels, so they be read perfectly within context.

"When studying architecture, I started to think about buildings as performative objects rather than things that are static. I observed the way people naturally animate urban spaces and wanted to draw attention to it in my art. Since then, I have always enjoyed creating work that responds to the activity and environment around it. It is this level of unpredictability and autonomy which gives the artworks a life of their own."

How is movement translated into the patterns of light that we see?

The recorded traces of visitor movement serve as 'seeds' for a selection of generative algorithms that drive the lighting displays. We take the raw data: relative positions and directional velocity of a moving person(s) or vehicle(s). Our mathematical systems then expand on this, autonomously applying rules that develop these movements in new and interesting ways. The artworks' software employs four different techniques, and it chooses which one to employ based on which is most suitable for the type of movement it is 'seeing'.

Latent façade is a great way to enliven the public realm. Do you envisage this technology being used elsewhere or for other purposes?

Absolutely, it already is. The computer vision and image capture techniques we have employed for this project were originally developed by scientists at the park and have been employed in creating a variety of smart spaces which interpret and adapt to their usage, including car parks, agricultural growing spaces and eco-efficient homes.

What do you hope people will take away from their experience of latent façade?

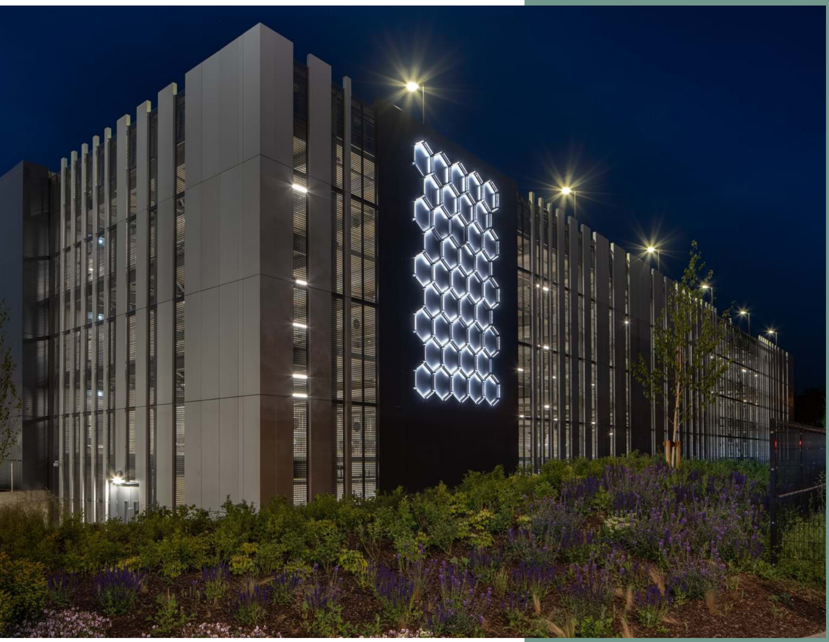
I hope it is a source of pride for people who study and work on the park. Like much of my work, Latent Façade is about connecting people with their environments. When people pass by, I'd like to imagine it wakes them up to the world around them, sparks intrigue and encourages a moment of contemplation ●

ABOVE RIGHT

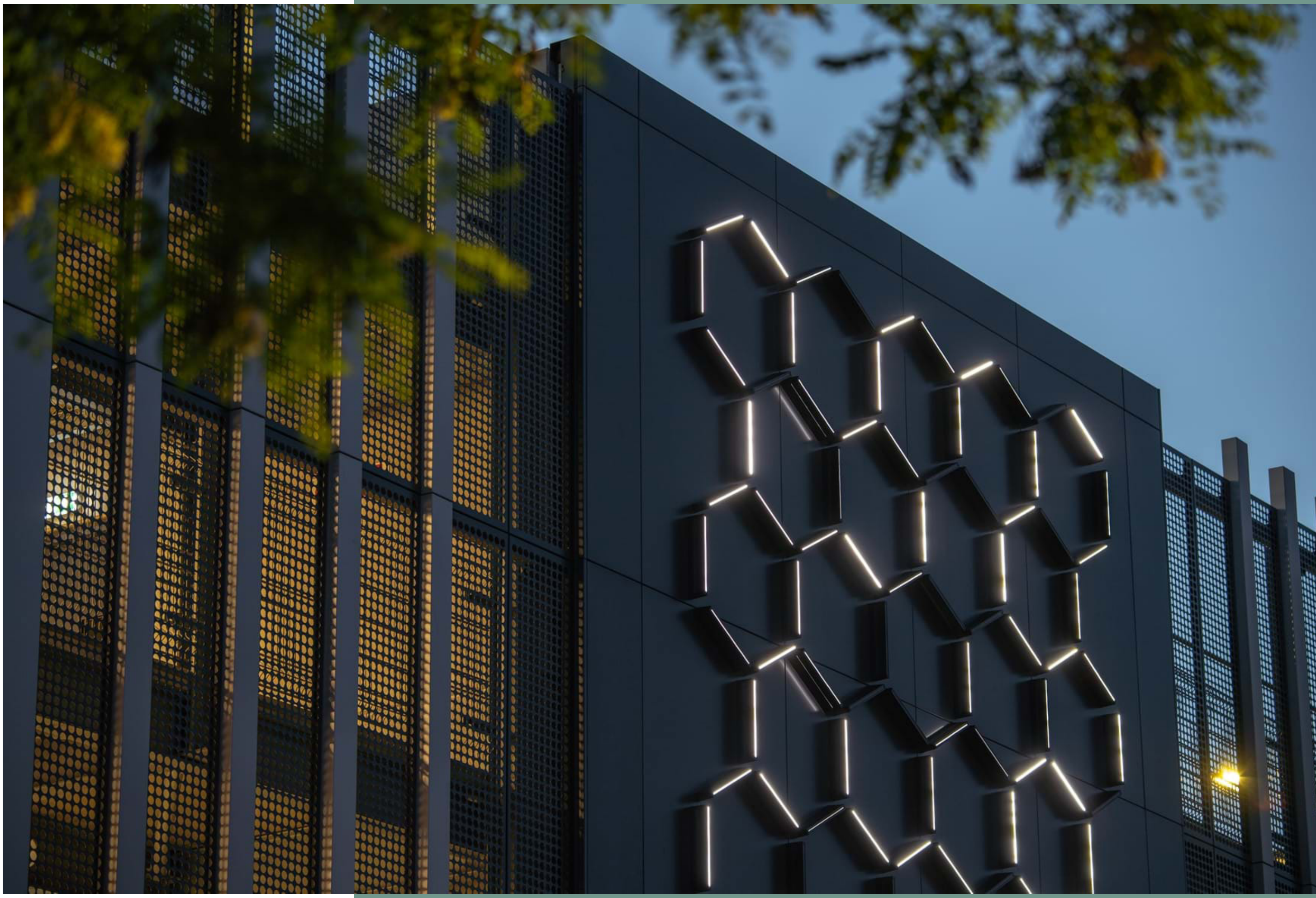
The installation animates the façade of the Scott Brownrigg designed 1-21 Cambridge Science Park | Copyright James Medcraft

RIGHT

Featuring custom-made modular LED light units | Copyright James Medcraft



“When studying architecture, I started to think about buildings as performative objects rather than things that are static. I observed the way people naturally animate urban spaces and wanted to draw attention to it in my art. Since then, I have always enjoyed creating work that responds to the activity and environment around it. It is this level of unpredictability and autonomy which gives the artworks a life of their own.”



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