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The Architectural Moment: Construction and disruption of the creative process

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ABSTRACT
Beginning an architectural project with the research-led detailed development of a threshold using physical models encourages early engagement with material-assembly, disrupting the familiar design process. This exploration of an architectural moment emphasises often overlooked temporal and experiential dimensions of space. This article reflects on eight years of employing the 'architectural moment' as a disruptive learning opportunity, illustrated by student work. Centring technology and materials as integral to studio practice, alongside structured opportunities for reflection, builds student confidence and supports more sophisticated design decision-making, placing ethics, human experience and architectural expression at the heart of the creative process.

KEYWORDS
technology, design studio, models, pedagogy, sustainability

Introduction

Developing a critical approach to construction and integrating it into a design process can be uncomfortable and intimidating. Architecture students often delay detailed design until the end of a project, viewing construction drawings as a 'discrete and subordinate task'.[1] This limits the potential for construction to impact the wider design process and leaves students tackling a problem they find difficult with limited time — cue panic! (Fig.1) Beginning to engage with how buildings are made, earlier, presents opportunities to consider the ethical impact of design decisions and holistically explore connections between construction techniques, architectural language and end-user experience.

In 2015, a twelve-week third-year undergraduate design project was restructured to start with the research-led design of a construction detail. As well as considering the detail through conventional sectional drawing, students were asked to model their detail in three dimensions, exploring the relationship between the construction components and the spaces that they enclose or mediate between (for example, the role of a threshold between inside and out). This was described as an *architectural moment*, emphasising its temporal and experiential dimensions or, as a student put it, 'technology combined with poetic expression'.[2]

We intended to disrupt the often-negative relationship students have with construction, reframing material assembly as an integral part of the creative process. Whilst technical competence is valued, our aim was to integrate a more confident and nuanced application of technology into the design process, prioritising this over the correct positioning of dashed lines in drawings, and emphasising the agency of students as autonomous designers whose material choices can have an impact on the wider environment, as

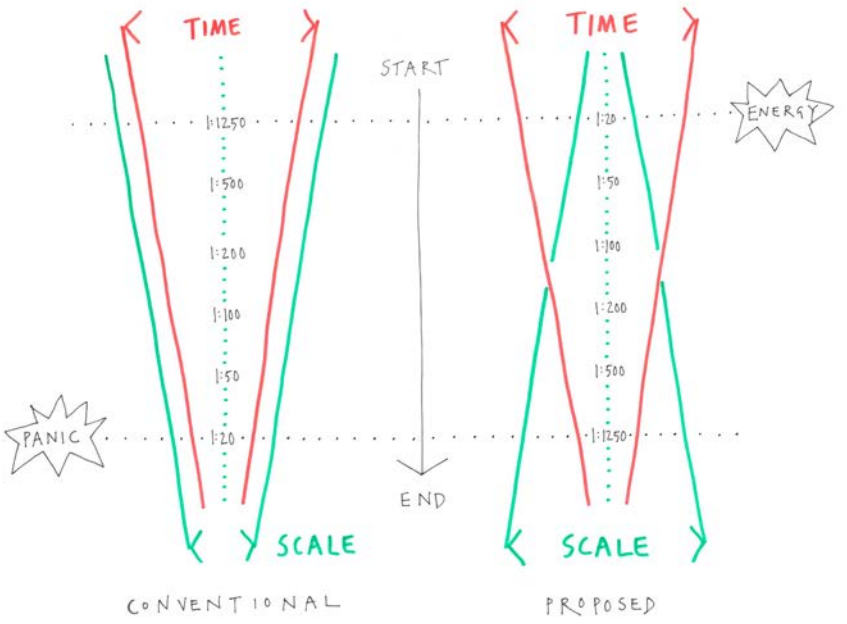


Figure 1:
Conventional architectural design process and the proposed process, beginning with the Architectural Moment, illustrating moments of panic or energy in relation to the project duration and designing at different scales (Paul Bower, Emma Curtin, Anna Gidman and Ranald Lawrence 2023).

well as human rights. Over eight years, this approach has been refined and expanded to incorporate passive environmental design principles and to integrate opportunities for engagement with real-world clients.

The strategy of designing an architectural moment before *zooming out* to design the rest of a building has encouraged timely student engagement with activities which enable higher-order learning; critical thinking skills such as analysis, evaluation, and synthesis of new knowledge.[3] Students recognised this in their feedback using terms like 'higher-level understanding' and 'advanced level' study.[4] Structuring teaching and learning plans to encourage these activities early on changes 'what the student does', with the potential for a positive impact on both learning and the quality of design.[5] Significantly, this occurs as third-year students with little professional experience in design are beginning to understand construction and explore its impact on creating different architectural experiences. Students typically enter the third year with some competence in making an architectural proposition and representing it. However, the ability to synthesise their learning across different subjects covered in the degree into their designs is only emerging at this stage. The architectural moments methodology has evolved in a live educational context to support and accelerate the emergence of these more sophisticated design skills, responding to the skills and needs of the third- year students we have worked with year after year. Some aspects of this approach have also been adapted for input into the first and second year, bringing them closer to this school's foundational year of higher education.

The ARB has proposed removing the requirement to complete an accredited undergraduate degree from the route to professional registration.[6] Currently, it takes an average of 10 years to gain access to the register of architects.[7] In this context, whilst the third year is the end of the degree, from a regulatory perspective, it is only the beginning of the journey to becoming an architect.

Pedagogically we consider this is also part of the foundational stages of architectural education, having observed it to be a critical moment where with support, students can begin to bring together skills and ideas in deliberate ways to come up with something more than the sum of the parts. Architectural design requires the interplay of a complex set of skills which continues to develop over a lifetime.

Students are encouraged to develop their architectural moment design primarily through a series of iterative models. Model-making creates opportunities for experiential learning, which supports students' developing understanding of tectonics alongside enhanced communication with tutors and peers.[8] Crucially models manifest the design decision-making process in physical form, encouraging ongoing reflection and nurturing individual development as a designer. Process models are hand-made to enable a fast feedback loop between brain and hand, and they vary considerably in scale, detail, quality of finish and materiality (Fig.2).

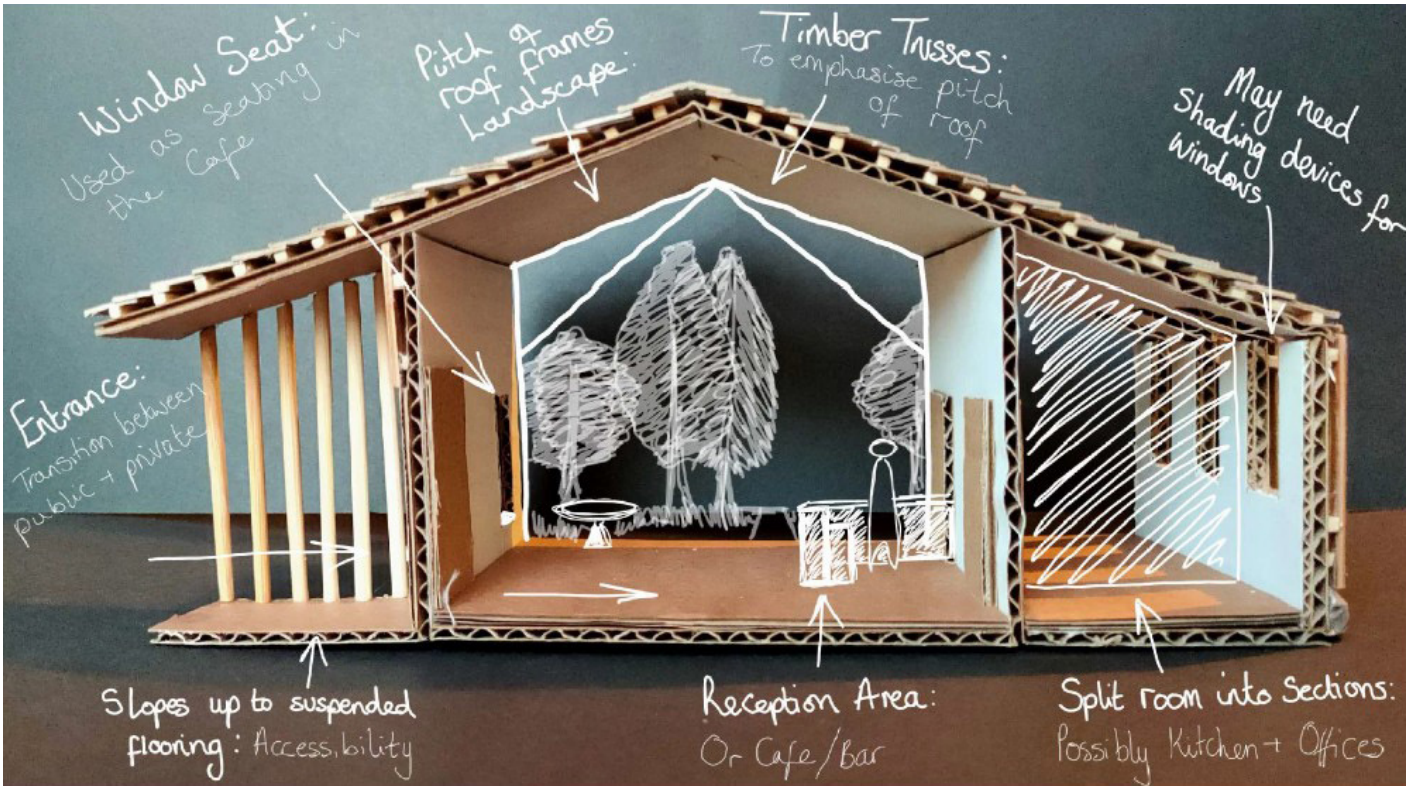


Figure 2:
Using process models for reflection - Amber Williamson. A section model extrapolated from the initial moment models and taken to site (Amber Williamson 2020).

This paper will reflect on the challenges, successes and wider potential of this constructivist approach through different iterations of the project across successive academic years, illustrated with examples of student work.

A constructivist approach

According to Sevinç Kurt, adopting a constructivist approach to architectural design education means that the evaluation of 'the difference between the level of design skill of the student from beginning of the process through the end of the process is essential for evaluating the success'.[9] This pedagogical turn to focus on the learning process raises questions about the design of that process and how it is structured – does a linear model (beginning with a programme brief and ending with a fully resolved and detailed architectural proposition) provide the most appropriate structure for learning? Or might subverting the traditional linear structure of the design process offer more opportunities for students to develop critical design and reflection skills that otherwise would take many repeat projects to acquire?

In 'The Tell-the-Tale Detail', Marco Frascari explored the idea of design from the detail as a counter-methodology to what he saw as the standard typological approach to design. His goal was to 'liberate the imagination' by delaying the introduction of programmatic or site-based exigencies to the design process.[10]

Typically, the linear structure of the scientific method (inductive reasoning) applied to design (Analysis – Synthesis – Evaluation) takes time, with research

of site and programmatic constraints and precedents leading to the synthesis of an *ideal* solution. Applying inductive reasoning, value judgments (consideration of what is important) may only be prioritised towards the end of the process through self and expert group evaluation. Pre-emptive judgement, or the early identification of preferred hypotheses, is discouraged. The advantages of this structured programme are the increased likelihood of achieving an objective result; however, in architectural terms, this may tend towards derivative solutions.[11] An alternative approach is the hypothetico-deductive method. A problem is identified, a hypothesis or tentative solution is proposed and interrogated (error elimination), and if the hypothesis stands, it forms updated circumstances from which future problems may be identified.

Michael Brawne explained the attractiveness of this model as applied to the architectural design process.[12] It describes the rapid formulation and interrogation of multiple design solutions, the most promising of which can be selected for further development. The formation of hypotheses also assumes the subjective application of value judgements concerning the design criteria to be prioritised. In Frascari's case, the refinement of a construction detail is prioritised and revisited as a *brouillon*, defined as a drawing to be revisited multiple times as circumstances evolve.[13]

In actuality, some compromise between approaches must always be made. For example, the resolution of the architectural moment (a form of architectural hypothesis) benefits from the analysis of material sourcing. Value judgements grounded in ethical practices are prioritised. Alternative solutions are encouraged, and the cyclical process of error elimination improves the design solution.

Ultimately, the goal is for each student to find the method that best works for them. Dogmatically imposing a linear course of enquiry (for example, beginning at the scale of massing and *zooming in*) discourages imaginative endeavour, while the arbitrary selection of chanced-upon solutions opens the designer to accusations of ironic play or nihilism.[14] Our method seeks to harness disruptive opportunities as they occur while giving students the confidence to embrace or reject different design paths based on their own priorities.

Task – the architectural moment

Students begin by researching a construction material to understand its relevant technology, architectural potential, and global impact. Through this research-led approach, students take an ethical position and develop expertise in a chosen technology. This phase of the project is supported by field trips and expert input.

The material research the students undertake includes tracing the use of construction components back to the extraction of raw materials,

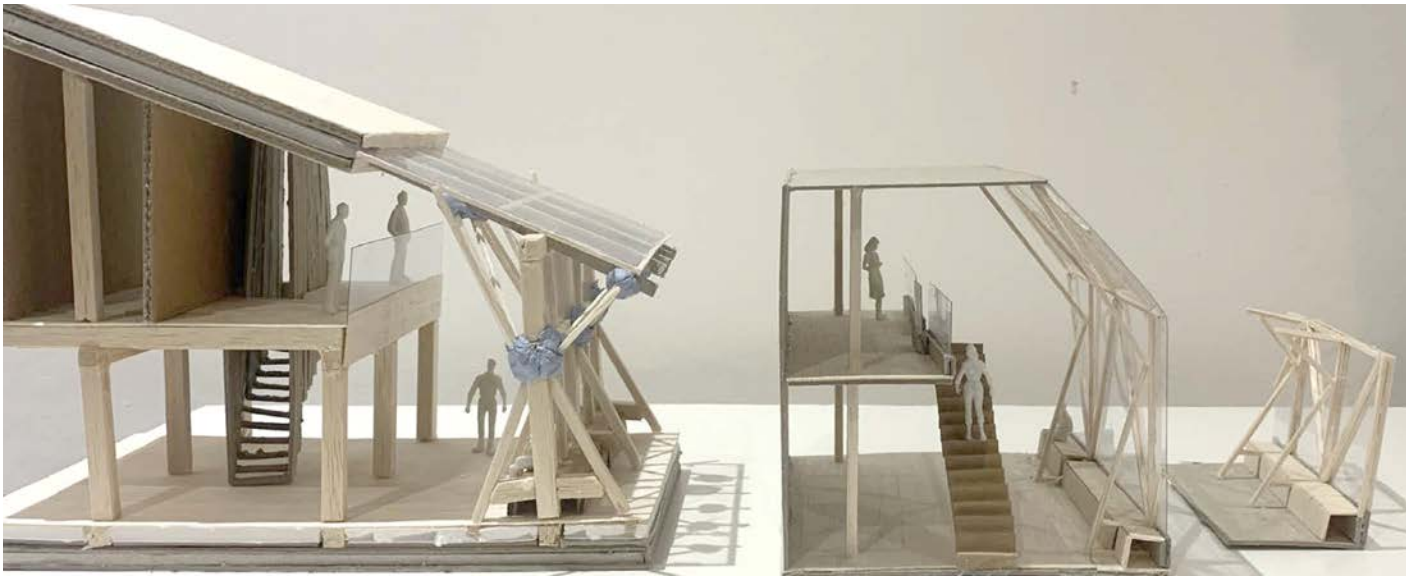


Figure 3:
Iterations of the *architectural moment* considered in section (Stefan Lewis 2020).

understanding processing and assembly in a factory or production line, and the sourcing of labour and energy. This has direct relevance to human rights (for example, identifying exploitative labour practices and exploring alternatives), as well as indirect impacts, such as quantifying the greenhouse gas potential of high-energy construction processes, and thinking about how these can be reduced or avoided.[15] Exploring these ethical questions in the design studio provides a forum in which problematic practices can be openly discussed and challenged without incurring real-world consequences, providing students with the skills they need to interrogate these issues in their future professional careers.

Applying their new knowledge, students design their architectural moment – typically a threshold – using a process of iterative model-making to encourage reflection-in-action.[16] At this stage, the location and programme of the project are known, but the site is unknown.

First, a series of models are developed, investigating a range of options or possibilities. One is then chosen for further iterative exploration at a scale of 1:50 or 1:20 (Fig.3 & 16). The models may be assembled from the chosen material or analogous materials, including waste such as packaging, reinforcing the idea that ethical sourcing of materials should be a primary consideration in design as well as construction. Students are encouraged to experiment with spatial proportion, aperture depth, qualities of light and material and human interaction as they simultaneously explore the construction method, testing the size of structural members, for example, or different fixing methods, and the impact of the relationships between primary, secondary structure and any infill or cladding. The opportunity to focus on atmosphere and experience at the human scale was highlighted in student evaluations.

Students analyse how their threshold might mediate between internal and external environments, considering which elements of the external environment

they wish to introduce to the space and which need to be tempered or controlled. How does the building fabric respond to diurnal or seasonal change? Can it be modified by people in the space? These design decisions also have an ethical dimension, encouraging empathy for the everyday experience of the building user and the provision of an environment which can assist their own ethical behaviour, for example, by reducing their dependence on applied energy for comfort.

Next, students are asked to extrapolate their architectural moment into a 1:50 section model, which imagines a slice through a complete building. Working at 1:50 enables engagement with the principles of construction using a specific technology, without technical details such as the positions of membranes causing unnecessary confusion. Confidence can be developed and design decisions examined in three dimensions before expanding to 1:20 to draw an initial section through a model. The 1:20 drawing is informed by the interpretation of published drawings from precedents and supports learning about different layers in the construction build-up. Even at this stage, however, the process continues to prioritise the exploration of the human potential of spatial inhabitation over technical accuracy.

Finally, the site is introduced, often a rural or park landscape. Collection and analysis of site information is accomplished in groups. Students take their models to the site and photograph them in situ to explore different contextual opportunities before situating their project within the landscape. Site analysis becomes less abstract when a tangible object is placed on the site. The relevant opportunities and constraints seem more obvious to some students when they are seen in the context of an existing design. A window, for example, can be adapted to face a certain view or solar orientation or topography. This ability to discern what is relevant is transferable to future projects where the site analysis necessarily comes before the design. One student's comments indicated surprise that alongside construction knowledge, this project had helped them learn about 'dealing with a site'.

The resolution of the final building design has to be completed fairly quickly (working within the constraints of an academic semester) to allow enough time at the beginning of the process for the architectural moment to be developed. Project briefs have been designed to promote fairly simple building typologies. Students are introduced to a range of strategies to support the rapid transition from a site-less fragment to a situated building and encouraged to share ideas through design workshops. For example, students are introduced to the idea of patterns in architecture: 'We recognise these archetypes beneath a variety of stylistic trappings. We respond to them and use them'.[17]

A project-swapping workshop known as Beholder's Share (an idea borrowed from Gombrich), has also become a key stage in the process, and an opportunity for creative disruption.[18] Students exchange projects in pairs,

Figure 4:
1:50 iterative models and collages exploring ideas about relationships with landscape before visiting site Buttermere 2015 - framing views (Xun He 2015).

briefing one another on the site and swapping models of their architectural moment. Each student quickly makes a massing model for their partner, suggesting how their moment might be developed into a whole building for the specific site. Using diagrams, they suggest a suitable typological arrangement for the plan and section. Finally, pairs of students present their models to one another and the studio, articulating the decisions they made during the swap and projecting what they might do next before returning to work on their own projects. The design of the workshop was informed by examples of co-operative exchange in other design schools.[19] This structured learning activity encourages students to communicate with each other to support higher-level learning.[20] In the remaining weeks, students develop a full architectural proposal appropriate to their level of study.

Reflections on the architectural moment

Communication

Upending the familiar routine of the design process – beginning with the site and working up to the scale of the detail – can cause anxiety. It is crucial to communicate to students the advantages of approaching design differently, as well as the uncertainties and risks. This includes explaining the advantages of experimentation in the pedagogical approach as well as architectural design, and treating students as equal partners in the learning process.

Site and programme

In contrast to how Frascari describes starting with the detail, the building's programme is emphasised from the start of the project.[21] This helps to place human experience at the heart of the design process. We have experimented with introducing client engagement workshops at different stages in the process. In Buttermere, students interviewed wild swimmers on site after designing their architectural moments. Recently we started projects in Sefton Park with a beekeeper talk and apiary visit. Working with relatively simple programmes has enabled students to focus on construction, user requirements and the relationship with the immediate context without having to resolve complex planning issues. In recent years we have begun to use architectural moments in re-use projects with more complex programmes, but rather than starting with the moment, it is introduced mid-way through the process as a means to explore the development of the building envelope.

Projects have been set around Lake Buttermere (2015, 2018) and Thirlmere Reservoir (2019) in Cumbria. Staying in and designing for the dramatic vistas of the Lake District National Park meant that whilst students did not choose their specific site until mid-way through the project, they were able to design with a relationship to the landscape in mind (Fig.4). These sites offered the opportunity for creative disruption in the form of an intensive design charrette away from the School of Architecture. This included visits to precedent buildings, talks, reading seminars, client engagement meetings, design workshops and site visits at different times of day and night. These opportunities for informal active learning, peer-to-peer engagement and building friendships have been observed to have a catalytic effect on the project.

In 2016 the brief was set within the dense urban grain of Delph, a historic village in Greater Manchester, in the context of the new Manchester Devolution Project. As usual, the architectural moment was developed in advance of the site visit. The complexity of a village context presented many different possible conditions. Staff identified three sites with compelling characteristics for students to choose from prior to the visit: flat riverbank, level change, and working with an existing 18th-century stone building. Once students had visited the specific sites, most stayed with their chosen condition. They surveyed and conducted site analysis in groups, creating shared section drawings and site models to test their architectural moments.

The Grade I listed historic landscape of Sefton Park has been a repeat location for the studio. Initially, we chose this iconic Liverpool location to offer the opportunity to design within a landscape setting local to the School of Architecture. During the pandemic, we used this site again as a location students were already familiar with and which those on campus could easily access. We worked with expert guests to bring the location and brief to life through online talks and workshops.

Figure 5:
The Electrical Engineering Building - Yorke Rosenberg and Mardall, 1965. Analytical model of the structure (Liverpool School of Architecture BA3 Students 2021).

Figure 6:
Section model through the façade of a proposal to re-model the Electrical Engineering Building (Sumaiyah Bashir 2021).

In 2017 we ran an intensive design symposium on campus with some success. We recreated some of the catalyst-effect of the earlier field trips with workshops and a shared evening meal. Later, working online, we could not recreate the intensity of a field trip, but we used regular meetings, more guest input and adapted workshops to enrich the online experience.

More recently, we adapted the architectural moment approach to a re-use project, examining a mid-twentieth-century department building on the University of Liverpool campus. The 1965 Electrical Engineering building, designed by YRM (Yorke Rosenberg and Mardall), has been earmarked for

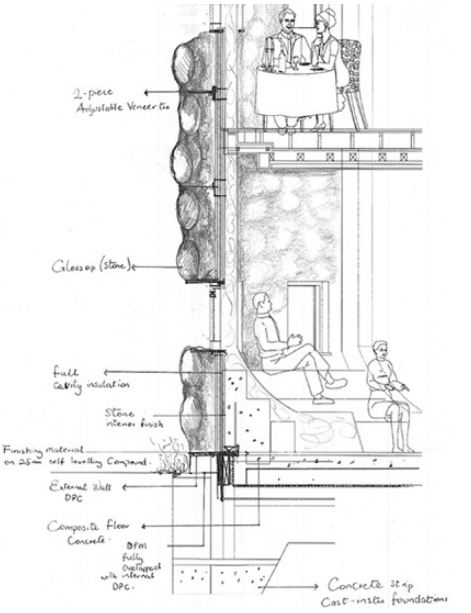


Figure 7:
Using models to explore atmosphere and technology (Paul Abu Mensah 2017).

redevelopment.[22] The studio explored possible strategies for retention of the existing structure, engaging with the need to reduce the carbon footprint of new construction (Fig.5 & 6).

The architectural moment methodology was first tested and developed on relatively small-scale design projects located on open sites, with the potential for dialogue with a natural landscape or a parkland setting. This helped to refine the approach and build familiarity with the problems that might arise; for example, anxiety about developing an architectural language of construction before understanding the immediate context. However, as tutors gained confidence and experience working with the approach and understanding how it could be adapted in different circumstances, it was found that it could also provide a new perspective in projects with more complex programmes on urban sites, such as adaptive re-use. Here, creative exploration at the scale of the construction offered a practical route into disentangling a series of interconnected knotty problems; such as how to evaluate the value of an existing structure in terms of its embodied carbon and remaining lifespan; how to justify appropriate strategies for intervention and repair; and how to reimagine the use of (and connections between) existing spaces and the environments surrounding them. Thinking tactically about how to make progress iteratively at different scales allows students to solve these problems one question at a time rather than becoming overwhelmed by the scale of the task. Student feedback suggested this intention correlated with their experience.

Materials

The design process of the architectural moment immediately acknowledges the perceived difficulty and fear of detailed design some students have and encourages inquiry-based learning through material study. As Kurt suggests, this enables everyone to develop and evaluate a starting point for their

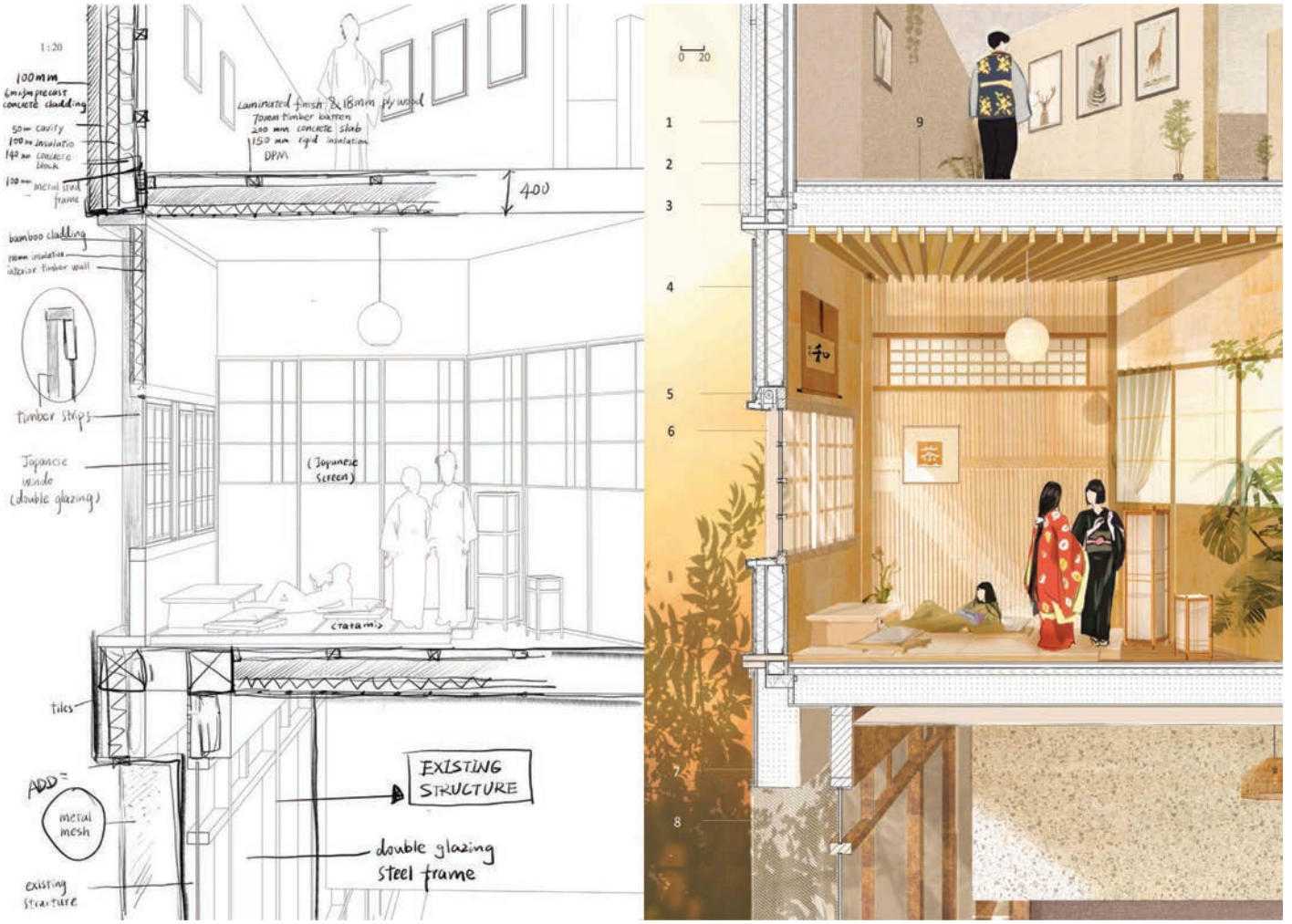


Figure 8:
Relationship between construction and atmosphere in detailed sections (Anan Tian 2021).

design and acquire an understanding of a particular material technology before attempting to design for a specific condition. This increases students' confidence about the technical properties and architectural applications of their chosen material, and frees them to consider the poetic opportunities it presents (Fig.7 & 8).

To support this research process, we have visited different sites of material production and extraction, creating opportunities for active learning. These have included: Tree Station, an arboricultural social enterprise based in Manchester that provides woodland management, wood fuels and timber; a Wienerberger brick factory; a small sandstone quarry; and a large slate quarry. Witnessing a scarred landscape, a glowing hot brick, or a working sawmill illustrated the relative embodied energy and physical properties of different materials, supporting students' understanding of the aesthetic, technical and ethical implications of their material choices.

Initially, students were given the freedom to choose their own materials. They responded unexpectedly with very specific materials such as copper or Green Westmorland Slate (Fig.9). In 2015, several students cited the dramatic Buttermere Valley as inspiration for their material choices. The following year, in Greater

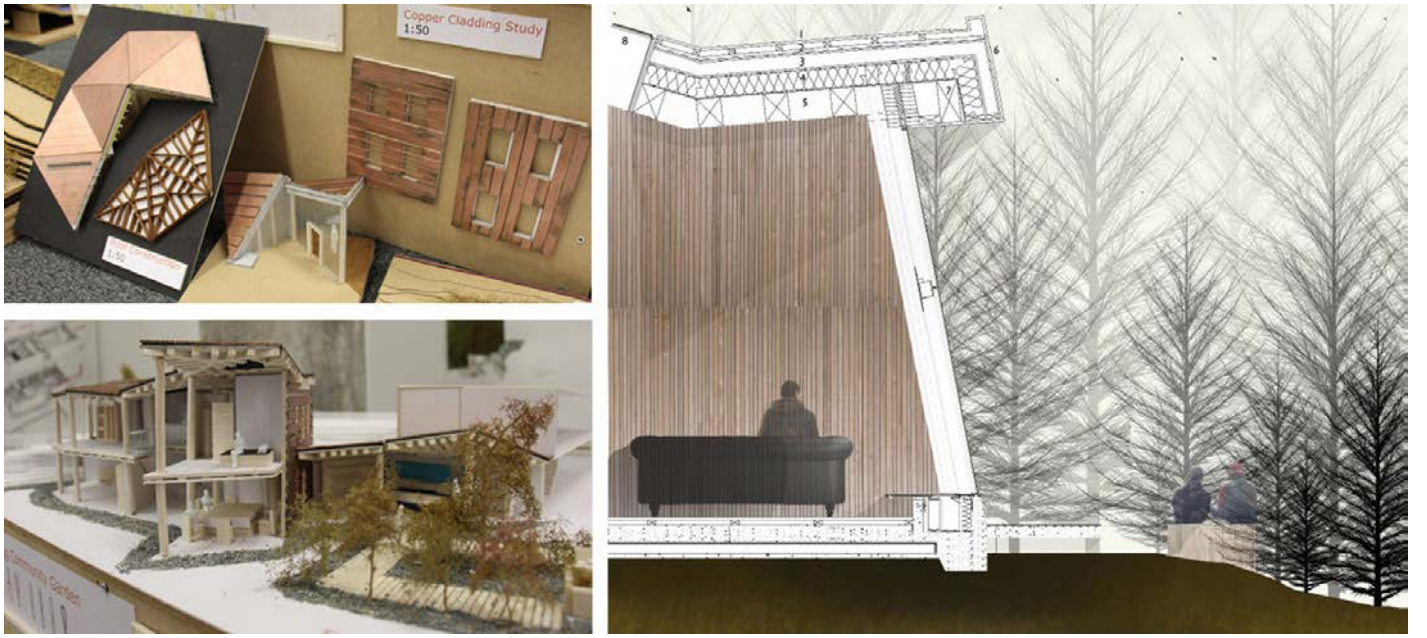


Figure 9: Initial moment models exploring copper tectonics and detail section developed ahead of site visit and final model completed at end of project (Vishnu Rajendran 2015).

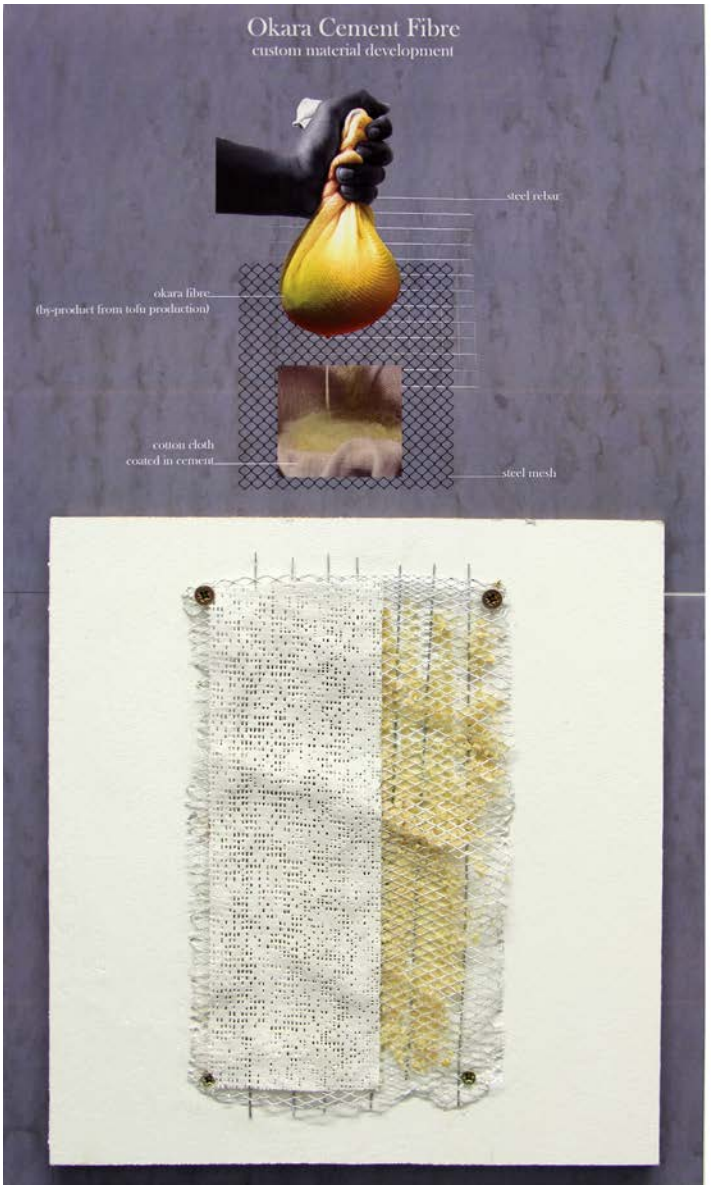
Manchester, students continued to make varied and interesting choices related to the brief. Examples included Bredstapel and Okara Cement Fibre (Fig.10 & 11). It was observed that offering a choice of materials tended to promote independent enquiry.[23]

The publication of the Fifth IPCC Report on Climate Change put the decarbonisation of the curriculum at the forefront of tutors' minds. In response, students were asked to work with stone or timber, both low-carbon materials contextual to the site. In previous years both materials had demonstrated their capacity to offer significant learning opportunities within our approach. Students defined the specific technologies they would work with, as well as considered secondary materials.

In 2019, the brief was partly inspired by the local tradition of the rural bothy or mountain hut in Thirlmere. However, unlike these stereotomic stone structures, the students were asked to design tectonic (timber or steel) demountable structures that would primarily accommodate small gatherings of school classes and weekend workshops relating to the annual Festival of Words and Ideas that takes place in nearby Keswick (Fig.12).

In later years, we restricted students' primary construction material to timber – a renewable material with low embodied energy that also enables carbon to be sequestered into buildings. Students found the experience of researching their preferred timber technology valuable: encouraging them to study a material to a more advanced level.

The earlier materials trips could not be replicated online in 2020 and 2021, but we worked with guests to try and make the process of research more engaging. Patrick Fleming of ETH Zürich introduced timber technologies early in the process and joined an online model-making workshop. One student



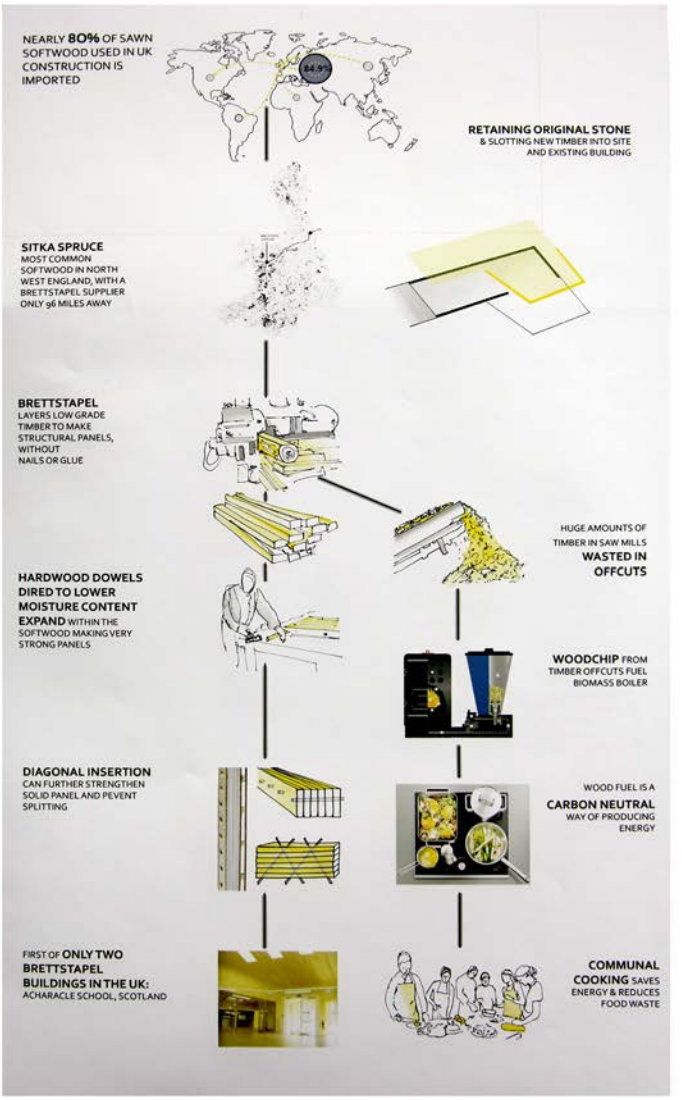


Figure 10:
Material research: Tofu Tower and Bredstapel construction (Shankar Saanthakumar and Lucy Lundberg 2016).

commented: 'making models by hand was a very special experience, something not experienced since the beginning of the pandemic'.[24]

Most recently, in 2022, students were invited to propose a renewable material of their choice to research and design, supported by a talk from Anna Gidman of the ACAN Natural Materials Group and a field trip. The intention was to offer some freedom, utilising curiosity to drive the project as in previous years, but with a strong emphasis on exploring ways of building with low carbon and natural materials. Choices included rammed earth, hempcrete, straw and timber. Teaching design skills with natural materials has been a positive challenge for staff with limited experience working with these technologies in practice.

In 2021 we asked students to calculate the embodied and operational carbon of their building design for the first time and to think of ways of expressing this visually for a client. This was simplified the following year, introducing the idea

Figure 11: Bredstapel at different scales, working with an existing building. (Lucy Lundberg 2016).

of embodied carbon within the initial phase of the project, where students were asked to calculate the embodied carbon of their architectural moment. The school's embodied carbon calculator tool has now been updated to include more natural construction materials, which will enable us to continue experimenting with this next year.

A focus on material choice has provided insights into design authorship and architectural expression. Discussion with students has revealed how the use of some materials, such as rammed earth, defined the spatial and atmospheric qualities of a proposal, while others, such as hempcrete panels, were less important as design drivers. The studio has experimented with offering students freedom in material choice with a diverse range of results but has always foregrounded the consequences in environmental terms (quantitative as well as qualitative). The most ambitious students have set their own agenda in this regard, underpinned by meticulous research. The result is a diversity of aesthetic representation across the studio, enhanced by rigorous material exploration and tested utilising physical models.

Creative disruption

The studio has created a structured design process to encourage student engagement through a series of prescribed tasks prioritising higher-order learning, such as analysis, synthesis and creation, necessary for successful architectural design. Built into this are opportunities for creative disruption,

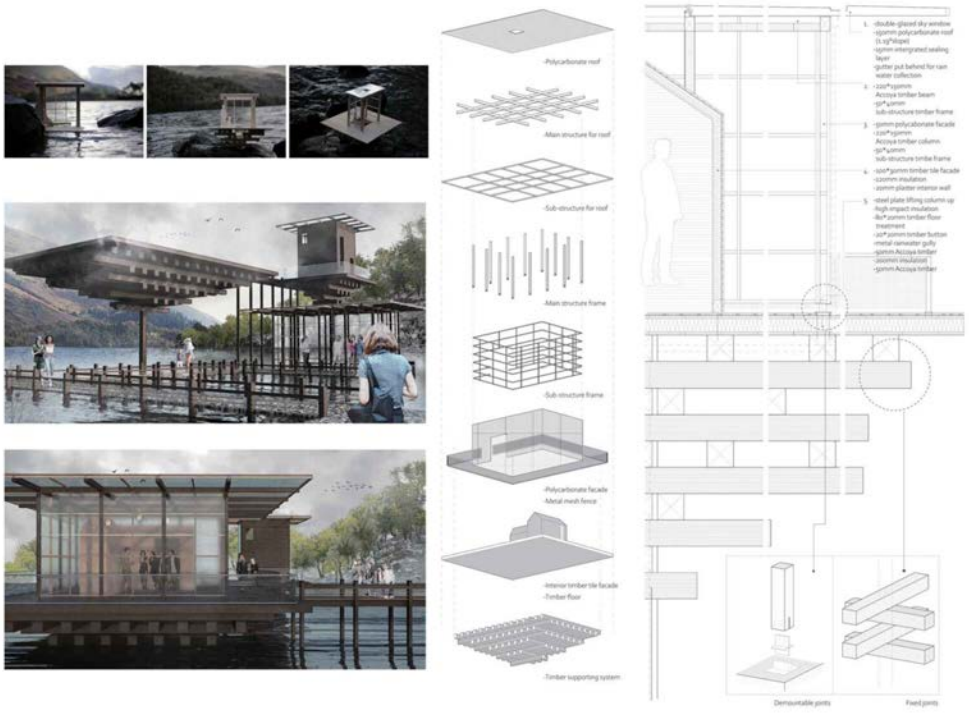


Figure 12:
One Story – Hidden in the Flow. A demountable structure at Thirlmere. Architectural moment exploration and detail (Zhu Qi 2019).

Figure 13:
Architectural moment facilitating the development of an architectural language (Grace Limani 2021).

including the design of the architectural moment and workshops such as Beholder's Share.

In spite – or perhaps because – of this structured process, a stylistic freedom is evident in the considerable architectural and representational variation of completed projects. This is reinforced when students develop an architectural language informed by their initial research. The architectural moment, like Frascari's detail, becomes a creative spark that facilitates design development (Fig.13).[25]

Activities such as the Beholder's Share workshop have created opportunities to engage with other students in reciprocal learning, another feature of a constructivist approach.[26] It was first introduced in 2016, informed by the experience of a collaborative design workshop held in Buttermere. It did not quite work as intended, as some students struggled to comprehend the idea of swapping projects, even temporarily, exposing their lack of experience of collaboration in practice; where no individual owns a project, and ideas are developed and shared as a team. Not all students completed the model-making exercise, although it was successful in orchestrating animated discussions and creating a deeper connection between students as they explained their projects to each other in detail. While in later years the outcomes of this workshop have been stronger, the quality of the dialogic peer-to-peer conversations that emerged from the exercise was in itself incredibly valuable. Students practised *reflection-on-action* as they considered and articulated the design decisions that they had made to each other.[27]

Working online in 2021, we persisted with an adapted version of the workshop to create opportunities for reciprocal exchange which could no longer happen casually in the design studio. Providing structure for these tasks was critical online. Informal direction is much harder when you are not in the same room, and even then, as we found previously, there can be misunderstandings. Setting up the tasks with clear instructions and using online infrastructure such as the Class Notebook plug-in for Microsoft Teams was important (Fig.14).

Our process consciously subverts the typical design process, prioritising detailed design and material assembly to give this challenging and sometimes neglected task more time, attention and energy (Fig.1 & 15). Making time for this in a project where students are still required to present a full architectural proposal necessarily requires speeding up of some of the other design stages, which relies on confidence gained through past experience. Prioritising different parts of the design process and zooming in and out between different scales also creates opportunities for students to try different approaches, which may be more or less suited to their different learning styles.

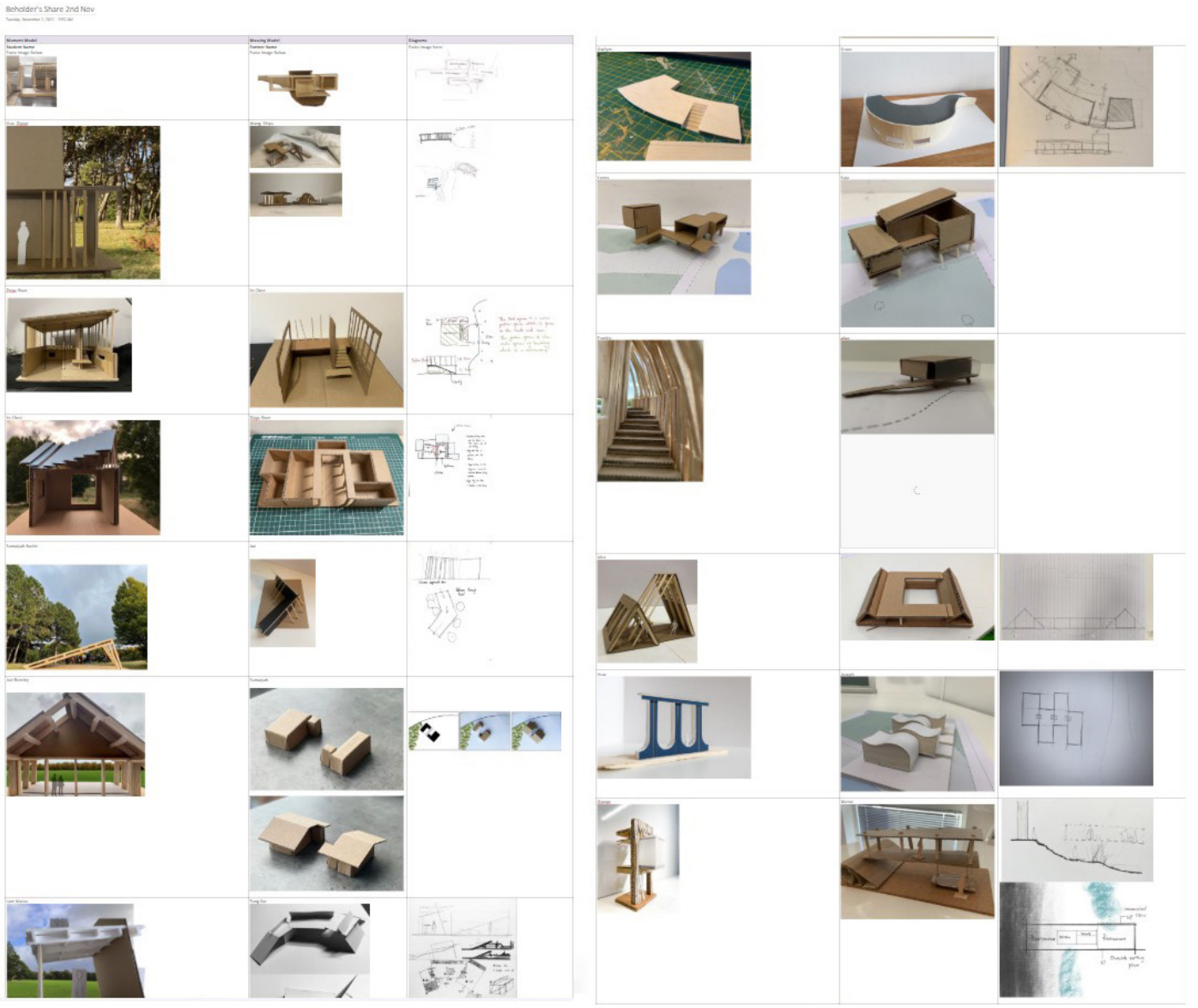


Figure 14:
Beholder's Share workshop – Class NoteBook on Microsoft Teams (Liverpool School of Architecture BA3 Students 2021).

A common theme across all iterations of the project has been the usefulness of breaking the traditional pattern of studio work with creative disruptions. Workshops such as Beholder's Share enable students to gain multiple fresh perspectives on recurring design problems. Taking models to the site and engaging with clients led to deeper conversations with consultants such as structural engineers and environmental specialists. Informal peer-to-peer learning appeared to reduce stress, and sharing in small groups promoted 'deep learning' through experience: students identified enhanced communication amongst themselves as a key benefit.[28] This was especially important during the pandemic when virtual workshops and physical model-making provided relief from the day-to-day monotony of remote learning.

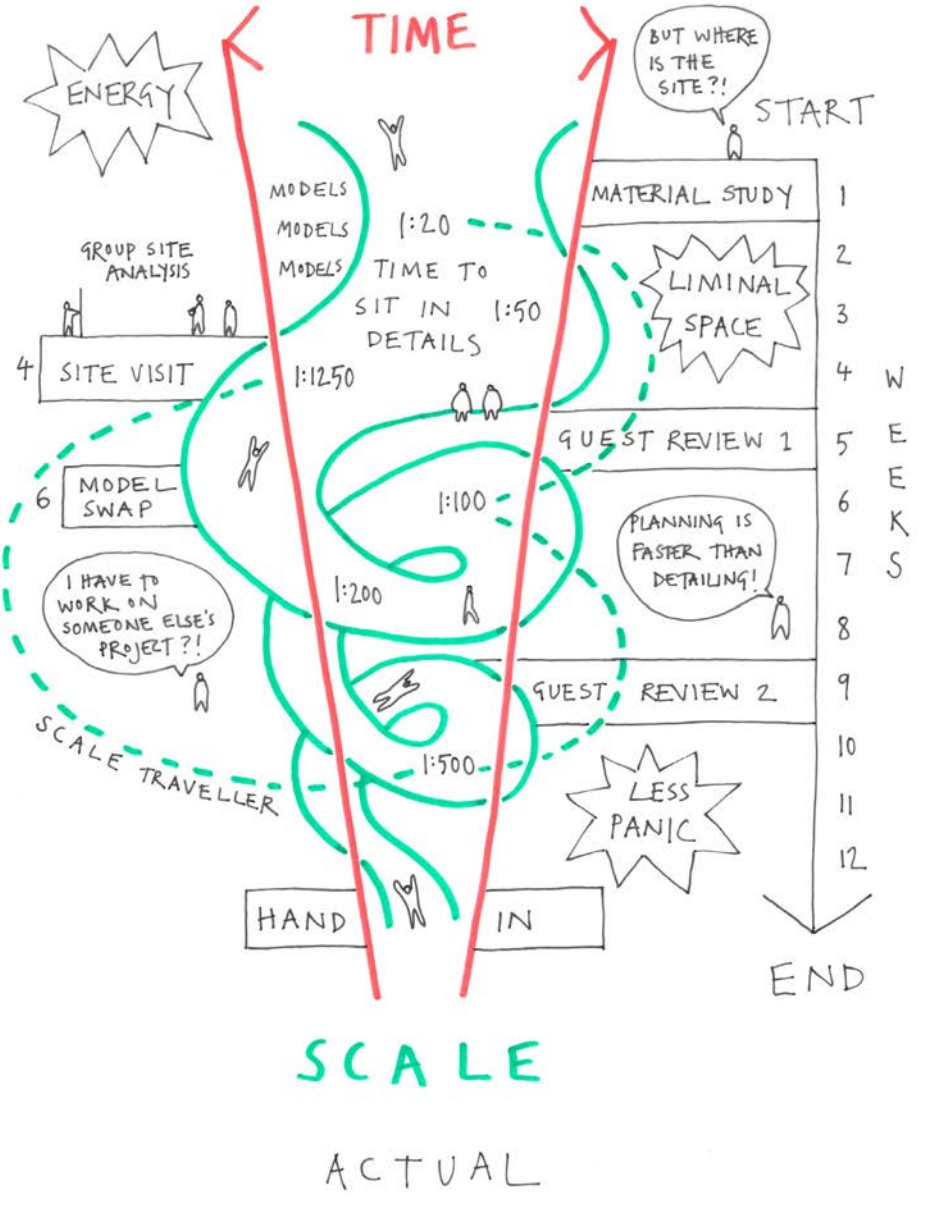


Figure 15: Architectural moments: the actual design process illustrating moments of disruption and an approach which tackles scale out of their conventional sequence (Paul Bower, Emma Curtin, Anna Gidman and Ranald Lawrence 2023).

Model-making

The development of the architectural moment method relies on hand-made models, which is sometimes resisted by students keen to engage with digital practices. However, simple and large-scale models have proved to be a powerful pedagogic tool, and we have maintained this approach even whilst working remotely.

We have observed the confidence gained through research and practical investigation, making technical design accessible to students with different abilities and learning styles. One explanation may be that the structured process and opportunities for creative disruption encourage students with different learning styles to engage in activities which support deep learning.[29] Students enter the design phase of planning their building equipped with an architectural language that they have developed through the design of their

Figure 16:
Testing model on site and a series of iterative models (Yangjie Huang 2021).

architectural moment. As a result, they tend to avoid common learning pitfalls, such as walls with no thickness or primary structure omitted from plans. They are already aware of the architectural impact of their chosen technology and the architectural language they have developed. Students themselves acknowledge this improved understanding.

Working in three dimensions with scale models creates clear opportunities for expanding understanding of technology and its architectural expression. Comprehending how the orientation of a beam affects its load-bearing capacity becomes obvious, and scenarios such as exploring different options for the architectural expression of eaves becomes more engaging. However, there are also benefits for the student experience of the design process itself. Making a series of iterative models allows experimentation but equally requires a commitment to design decisions for each model. In teaching, we sometimes describe this reflective process to students as a dialogue between – or conversation with – your models. Each model answers questions about the design and poses more (Fig.16). The architectural moment models are used in a similar way to Frascari's brouillon, but in three dimensions. Similar to his intention to 'liberate the imagination', students described this process as stimulating them to think differently and 'open their mind'.[30] We talk about physically constructing the problems you identify rather than ruminating on them. When you are uncertain if something will work, instead of waiting for a resolution before making a model, why not use the model-making process to test it? Whilst it might not work, the model-making process can articulate the problem and help you identify solutions. This can also be described as using the model to articulate a hypothesis which can then be interrogated in different ways (using the heliodon, for example) before making the next model. This resonates with Brawne's description of the hypothetico-deductive method in design and could also be considered a manifestation of Kolb's Experiential Learning Cycle.[31]

Uncertainty can result in a reluctance to make any decision. Understanding that when a model shows design decisions to be unsuccessful, these decisions can be adapted or rejected in the next version helps to break this paralysis. The manifestation of design decisions through physical modelling is particularly successful at addressing this when compared to sketches or digital modelling.

Another value of 'unprecious' working models is as a communication tool, helping students to express their intentions to tutors and peers, supporting a fruitful discussion in tutorials and workshops during the design process.[32] Looking back at old projects for this article highlighted that even simple models can be strong tools of representation. In the later stages, students have often moved onto other modes of representation, sometimes losing the sensitivity of the earlier phases in the final drawings.

Conclusion: reframing technology at the human scale

Designing with architectural moments encourages students to examine every scale without preconceptions. It disrupts a tendency towards linear thinking that occurs when students begin working at the scale of the masterplan, where questioning decisions that have already been made can be interpreted as a step backwards in the design process. Once a student realises that they can question design strategies by moving between scales, and the end result does not necessarily need to match an intuitive first step, they are freed to embark on a journey of exploration where the human scale – ergonomics, the tactility and tectonics of materials, atmospheric considerations – can be as instructive as the programmatic strategy at the scale of the site. Students themselves acknowledge this. The end result is a body of work that demonstrates learning through an iterative development of ideas, where the technical resolution is informed and tested by spatial and environmental ambitions at a range of scales. This results in a more valuable learning experience for students, who engage in higher-order reflection about the successes and shortcomings of the design process they have undertaken rather than fixating on the accuracy of individual construction details considered in isolation.

A necessary condition of this way of working is to place emphasis on the design process and its communication as the primary outcome of the learning experience rather than the final product (a finalised set of drawings of a building). With this pedagogical shift, the act of self and shared reflection (the construction of knowledge) is a more important contribution than visible evidence of success. This rebalancing of priorities is clearly appropriate in an educational setting but also offers valuable skills for a new generation of architecture graduates to import to professional practice, where ever-reducing timescales and other financial pressures impede the process of learning that should occur from one project to the next.

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