55/02 A SIXTEEN*(MAKERS) PROJECT MONOGRAPH

Sheil, Bob; Callicott, Nick; Ayres, Phil; Sharpe, Peter

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A MANUFACTURED LANDSCAPE

NORTHUMBERLAND'S KIELDER WATER AND FOREST PARK HOSTS THE UK'S LARGEST COLLECTION OF PERMANENT CONTEMPORARY ART AND ARCHITECTURE COMMISSIONS.

AT 650KM^2, KIELDER IS ENGLAND'S LARGEST FOREST. IT SURROUNDS KIELDER RESERVOIR, THE COUNTRY'S LARGEST ARTIFICIAL RESERVOIR, AT 200 MILLION LITRES, WHICH PRIMES ENGLAND'S LARGEST HYDRO-ELECTRIC PLANT.

FIRST PLANTED IN THE 1920S AND LATER UPGRADED TO A STRATEGIC POST-WAR TIMBER SUPPLY, THE FOREST NOW CONTAINS OVER 150 MILLION TREES THAT ARE MANAGED BY THE FORESTRY COMMISSION.

MOST OF THE PRESENT FOREST IS PLANTED IN CONIFEROUS TREES, WITH 75 PER CENT OF THE AREA PLANTED IN SITKA SPRUCE, 9 PER CENT IN NORWAY SPRUCE AND LODGEPOLE PINE, AND THE REMAINING 16 PER CENT IN SCOTS PINE, LARCH, DOUGLAS FIR, BIRCH, ROWAN, CHERRY, OAK, BEECH AND WILLOW.

550,000M^3 OF TIMBER IS HARVESTED ANNUALLY FOR PROCESSING INTO CONSTRUCTIONAL GRADE TIMBER AND TIMBER FOR PALLETS, PACKAGING, FENCING, CHIPBOARD, PULP AND FUEL.

THE RESERVOIR WAS PLANNED IN THE 1960S TO SUPPLY WATER TO THE INDUSTRIAL ECONOMIES OF TYNESIDE, WEARSIDE AND TEESSIDE, BUT BY THE TIME OF ITS OPENING IN 1981, IT WAS NO LONGER REQUIRED FOR ITS ORIGINAL PURPOSE.

IN THE MID 1980'S REGIONAL AUTHORITIES LOOKED FOR ALTERNATIVES TO SUPPORT THE LOCAL ECONOMY AND COMMISSIONED A TOURISM DEVELOPMENT ACTION PLAN WHICH LED TO ESTABLISHING THE KIELDER PARTNERSHIP IN 1994.

THE PARTNERSHIP REPRESENTS THE CALVERT TRUST, THE ENVIRONMENT AGENCY, THE FORESTRY COMMISSION, NORTHUMBERLAND COUNTY COUNCIL, NORTHUMBRIAN WATER, THE NORTHUMBERLAND WILDLIFE TRUST, AND LOCAL COMMUNITY GROUPS.

WITH SUPPORT FROM THE ARTS COUNCIL ENGLAND NORTH EAST, THE KIELDER PARTNERSHIP APPOINTED PETER SHARPE AS A FULL-TIME CURATOR IN 1999 TO LEAD AND COORDINATE A PROGRAMME OF VISUAL ART AND ARCHITECTURAL COMMISSIONS AND RESIDENCIES.

TO DATE OVER TWENTY ART AND ARCHITECTURE COMMISSIONS HAVE BEEN INSTALLED COVERING AN AREA OF 16 SQUARE MILES. WORKS INCLUDE THE 'SKYSPACE' BY JAMES TURRELL, 'BELVEDERE' BY SOFTROOM AND 'THE OBSERVATORY' BY CHARLES BARCLAY ARCHITECTS.

THE INVITATION FOR SUBMISSION OF EXPRESSIONS OF INTERESTS TO DESIGN A SERIES OF SHELTERS ALONG THE LAKESIDE WAY, WHICH LED TO SIXTEEN*(MAKERS) AWARD WINNING PROJECT 55/02, WAS PUBLISHED IN LATE 2007.

A MANUFACTURED ARCHITECTURE

SIXTEEN*(MAKERS) ARE A GROUP OF ARCHITECTS AND MAKERS WHO PRACTISE, TEACH AND RESEARCH DESIGN AS AN INTEGRAL ACT OF MAKING.

THEIR WORKS ARE DEVELOPED AS PROTOTYPES THAT EVOLVE IN DESIGN AS THEY ARE MADE, ALLOWING THE PROTOCOLS OF PRODUCTION AND CRAFT TO INFLUENCE AND BE EVIDENT IN THE FINAL PROJECT.

FOLLOWING A CALL FOR EXPRESSIONS OF INTEREST, 55/02 WAS COMMISSIONED IN 2008, ALONG WITH FIVE OTHER PROJECTS BY ARTISTS AND ARCHITECTS. ON THE BASIS OF A SET OF STRATEGIC DIAGRAMS RATHER THAN EXPLICIT FORMAL IMAGERY: SIXTEEN*(MAKERS)' PROPOSAL WAS SELECTED BY THE JURY AS A 'WILD CARD'.

THE BRIEF ASKED FOR SOME FORM OF SHELTER FOR UP TO FOUR PEOPLE WITH SEATING, AND SOME FORM OF ENGAGEMENT WITH THE KIELDER LANDSCAPE.

THE SITE ON KIELDER WATER & FOREST PARK'S LAKESIDE WAY, KNOWN AS COCK STOOR, WAS SELECTED ON A VISIT TO KIELDER BY SIXTEEN*(MAKERS) FROM A NUMBER OF OPTIONS OFFERED BY THE KIELDER PARTNERSHIP.

ITS ROBUST, ISOLATED AND PIVOTAL POSITION WAS SEEN AS A KEY QUALITY TO EXPLORE AND DEVELOP IN THE PROPOSAL.

THE NAME 55/02 IS AN ABBREVIATION OF THE SITE'S COORDINATES AT 55° 11.30 N, 02° 29.23 W, EMPHASISING THE WORK'S RELATIONSHIP TO ITS SPECIFIC PLACE.

55/02 IS A PROTOTYPE IN DIGITAL CRAFT AND DIGITAL MANUFACTURE.

IT WAS DESIGNED AS A COLLABORATION BETWEEN ARCHITECTS SIXTEEN*(MAKERS) AND STEEL FABRICATION SPECIALISTS STAHLBOGEN GMBH OF BLANKENBURG, GERMANY.

USING BOTH DIGITAL AND ANALOGUE TOOLS, THE DESIGN EXPLORES NEW CAPABILITIES IN SOFTWARE AND HARDWARE THAT EXIST AT THE TIME OF ITS CONSTRUCTION.

55/02 WAS FULLY ASSEMBLED IN THE FACTORY BEFORE IT WAS SHIPPED TO SITE FOR INSTALLATION BY THE SAME TEAM OF MAKERS.

55/02 IS ENTIRELY MADE FROM STEEL; IT WEIGHS 8.1 TONNES, AND CONSISTS OF 21 DISTINCT ELEMENTS.

ITS RAL COLOUR REFERENCE IS '2002-VERMILION'.

IN 2011, THE PROJECT RECEIVED A ROYAL INSTITUTE OF BRITISH ARCHITECTS DESIGN AWARD.

JANUARY 2008
THE KIELDER PARTNERSHIP COMMISSION THE WORK

MAY 2008
PRE-PRODUCTION DESIGN COMPLETED

OCTOBER 2008
PLANNING PERMISSION IS REFUSED

17 DECEMBER 2008
RESUBMISSION IS GRANTED PERMISSION

FEBRUARY 2009
PRODUCTION DESIGN AND MANUFACTURE BEGIN

26 MAY 2009
55/02 IS COMPLETED ON SITE

SIXTEEN NUANCES

I have never been told the reason why a group of people – originally two or three and currently (I think) five – should have the wit or effrontery to be sixteen? Yet contemplating their output stimulates the idea of looking into it from the position of one who has always believed that architecture should never be seen or evaluated from a single perspective – or even as few as three or five perspectives. It is too fascinating a business for that and too rich in qualities of discussion or experiment to be left to the obsessive moralist observer, the theoretical observer, the art-bedazzled observer or even the collector of gossip-as-culture.

So one might as well look at it from sixteen perspectives: a scattering of all the above plus more.

PETER COOK
BRISBANE-SINGAPORE-LONDON
OCTOBER 2010

SIXTEEN*(MAKERS) AS TEACHERS

For much of the time Sheil, Callicott, Ayres and Vercruysse have been teaching. The work comes out of a combination of three very important streams within the Bartlett School: the workshop and Units 14 and 23. I will return to these later. The predicament that the teacher-designer finds himself in is the best kind of predicament: subconsciously competing with his best students, but having the continual incentive and multiple inspiration from them that is missing in an independent office or studio.

SIXTEEN*(MAKERS) AS EXPERIMENTERS

In the great British tradition of concocting funny bits and pieces such that no-one else quite knows what they are. Creating the mandate for any one bit or piece to emerge as the key motivator or reference for the next bit or piece.

SIXTEEN*(MAKERS) AS CONSTRUCTORS

Much advanced by the decision by Nick to follow his lady – Kristina Ehlert – to East Germany where her family's steel-working 'fabrik' could engage with computerised fabrication on a real environmental scale: suddenly the good old British 'funny toy' could be a toy no longer.

THE PASK INHERITANCE AND UNIT 14

Stephen Gage, the 'daddy' of Bartlett Unit 14, will be the first to admit the lineage of ideas from the late Gordon

Pask (inventor of 'joystick' control-interaction, robots and one of the founders of cybernetics), concerning what is loosely called 'robotics' in the work of the Unit. That Phil and Chris and Emmanuel came out of this infects the Makers' work with a special departure from the statically sculptural trap.

THAT AESTHETICS ARE UNASHAMEDLY THERE

The potential 'nerd' factor is eschewed by such memories I have of Bob's student work: just really beautiful, aesthetic drawings. Home conversations with his wife, Caroline Rabourdin – an intellectual who also makes beautiful pieces – must serve to revitalise this stream. Nic, Phil and the rest are also out of a visual tradition, though they might not admit it.

MESSING ABOUT IN THE MUD

Some early stuff – in south London allotments and on Dartmoor – were, necessarily, small in scale. They seemed to enjoy being a sophisticated object co-existing with the mud and vegetation.

THE SCALE SEEMED TO EFFORTLESSLY METAMORPHOSE FROM SMALL TO LARGE

The effect of the Ehlert works has been to release the work from the 'finickiness' that sometimes attends the 'Bartlett machine' tradition.

SUCH WORK REACHES TOWARDS 'BUILDING' BUT IS NOT YET 'BUILDING'

Such a thought refuses to go away: where is the possible symbiosis between the 'constructed object' or 'installation' and the building proper?

IF THERE IS GADGETRY, DOES THAT OBVIATE 'ARCHITECTURALNESS'

The work of sixteen* (makers) – since it oscillates between the gadget, the installation, the proto-robot and the enclosure, stimulates such a discussion. Is its resistance to building categorisation a form of 'art statement'? Is it a refusal to be drawn down the slippery slope of 'function' and 'manners'?

BOB PROBABLY HAS A LOVE/HATE RELATIONSHIP WITH HIS BOLTON STREET (DUBLIN) ROOTS

Yet that school has a more than respectable tradition of producing good architects. Furthermore, it has given him a down-to-earth wing in his creativity, and the chunky steel things are perhaps more assured because of his sure-footedness in construction.

THE WORKSHOP HAS BEEN THE GEM OF THE POST-1990 BARTLETT

Thus creating another 'bedrock' to the Makers' activities.

CHRIS CONCENTRATES, PHIL ARTICULATES

The two wings of the 'inter-active' flank of the 'Makers' display wide differences of character – that is their strength. Now in the milieu of the Copenhagen Academy, Phil will no doubt be tempted in the direction of that Danish tastefulness that sometimes creeps into (even) the most theoretical or substantial work.

BUT BOB SAILS

As we know from a certain wing of British architecture from Wells Coates to Norman Foster, the pitting of the body against wind, air or wave has had really creative and inventive results.

EVEN A TREE HOUSE INVESTIGATES

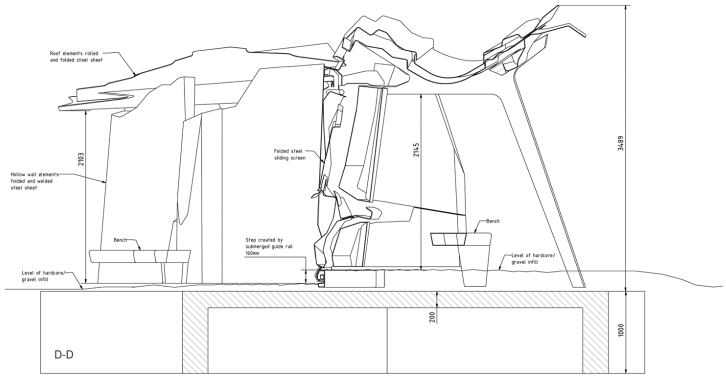
It's rather OK for a sophisticated design group to think of the tree house – indeed very much in the news with the efforts of Mr Fujimori.

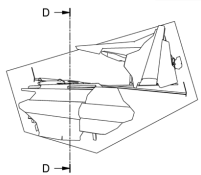
REASSURING THEIR STUDENTS

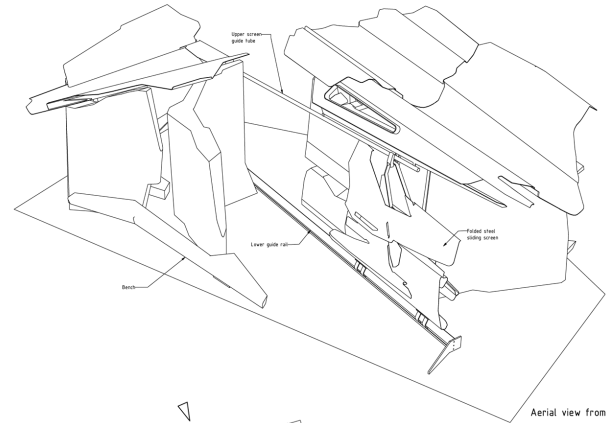
With beautiful and sometimes funny and sometimes puzzling creations. It is not enough to just talk about these things to students.

SO *DOING* IT IS THE KEY

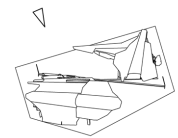
And – like all good groups – getting off on the differences as well as the similarities of one anothers' authorship.

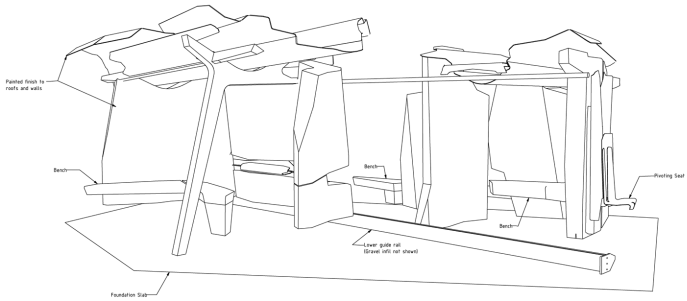




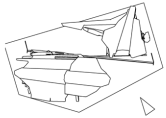


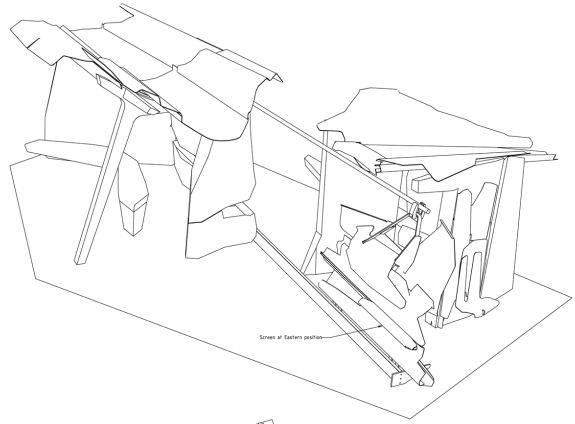
Aerial view from West North West



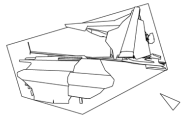


View from East South East





Aerial view from South East



A PARTNERSHIP IN KIELDER
PETER SHARPE


Kielder Pride

Kielder Water & Forest Park lies at the heart of a remarkable Northumberland landscape where very often things are not quite what they seem. Absent are the scenic vistas of the Lake District and the rolling hills of the high Cheviots, but instead, perceptions are challenged, scale hides intimacy, monoculture conceals richness and variety; and both artifice and nature mingle in a sweeping and apparently wild terrain that was almost wholly constructed less than 50 years ago.

Within the 250 square miles of this sparsely populated landscape, the Kielder Partnership has spent 15 years commissioning artists and architects to create work in response to the uniqueness of this place. In such a expansive setting grand gestures are often unsuccessful, so projects tend to be focused, drawing attention to some particular quality or place, encouraging visitors to look again at what they had take for granted. Ten sculptures were initially created, some close to visitor centres, others positioned to draw visitors out into the landscape. While many of these pieces still exist, Chris Drury's camera obscura *Wave Chamber* (1996) on the Belling peninsula is the most prescient, a forerunner of commissions that make up the art and architectural theme of today. Others include Softroom's *Belvedere* (1999) and James Turrell's *Skyspace* (2000).

Kielder's relationship with sixteen*(makers) began in 2001, eventually leading to an architectural residency and the evolution of the 'assembling adaptations' project, installed on a remote site at Kielder throughout 2006–07. The residency programme was initiated as a way of increasing understanding of creative working processes, enabling artists and designers to spend extended periods of time on site with the potential to explore ideas in depth and on site, ideas not necessarily expected to result in permanent outcomes. To that end, sixteen*(makers) were a perfect fit, evolving and testing many iterations

of their proposals over a four-year period and providing the knowledge and sensitivity to the Kielder landscape that eventually underpinned the development of 55/02.

The proposal to build 26 miles of multi-user track circumnavigating Kielder Water in 2006 provided the springboard and funding to create six primarily architectural commissions that would offer visitors 'seating, shelter and vantage points' along the most remote stretch of a project that came to be known as the Lakeside Way. Adverts requesting expressions of interest resulted in the selection of five design teams: Chicago-based artists' collective SIMPARCH, and four architectural practices, Ryder, Adjaye Associates, Studio Weave and, for their experimental ethos, sixteen* (makers) as a 'wild card'.

A variety of sites were identified to ensure that structures would be spread out along the length of the path with designers choosing locations to suit their ideas. Locations were chosen on the basis of the latent qualities they possessed – access to some hidden intimacy in the landscape, a turning point in the topography, the framing of a key vista – although without awareness of the constructions that would eventually occupy them.

The brief to designers was kept to a minimum; a choice of site, the necessity to address the 'seating, shelter and vantage points' criteria, and a budget to meet fees, design and construction costs that was exceeded in every case but one. The project timescale was determined by funding constraints, with all work needing to be completed by April 2009, 20 months after project start. However, with site visits difficult to arrange until after the winter, time was always going to be a critical factor. Following a period of proposal development, design work was only finally signed off and planning applications made in August 2008.

All six Lakeside Way commissions started from the same brief but ended up in very different realisations. Ryder Architecture's Glulam rotating *Janus Chairs* sit on a narrow peninsula with water on three sides, SIMPARCH's *Silvas Capitalis*, a giant wooden hollow head brooding in a forest clearing, watches the world turn, close to the lake but hidden, *Freya & Robin*, Studio Weave's pair of cabins face each other across a mile of water and embody the two very different characters in a story written by the designers after their first visit to Kielder, and Adjaye Associates, *Specere*, an austere black timber shelter and viewpoint set 1900' above the lake close to a military radar installation on Deadwater Fell, has distant views across the whole park.

And what of sixteen*(makers)', project? 55/02's design, with its uncompromising form, lack of familiar visual language and very bright colour, was always going to be a challenge for the District Council Planning Committee. A difficult ride through the planning process saw its first application refused but a reapplication approved just before Christmas 2008. In mid May following an intensive construction process in Germany and with the foundations in place, the building's parts arrived at Kielder. The following week the installation team arrived and 55/02 was assembled at Cock Stoor.

55/02 can be described as many things: shelter, seat and vantage point as intended, but also focal point, plaything, sculpture and climbing wall as well, its colour, complex design, and materiality no barrier to engagement. Visitors do not have to be told what to do with a structure like this: use its bright red-orange visibility to measure distance and your progress towards it along the lakeshore track, choose a place to sit depending on the time of day, direction of the sun, wind or rain, or ride the door along its rail, an option favoured by younger visitors.

55/02 is a snapshot of sixteen*(makers)' practice circa 2008–09, a successful collaboration between Kielder's art and architecture programme and a group of inventive designers and makers where each party brought different and crucial elements to the commissioning process. A willingness to take risks, trust that the design team would deliver in time, support for innovative ideas and, crucially, a shared desire to communicate and continue to share ideas throughout the entire project were the essential elements of a process that eventually led to the realisation of an innovative and striking addition to the Kielder environment.


D.G. WALTON
Tel: 01670 775 233
Mob: 07712656630
KOMATSU
D.G. WALTON
Tel: 01670 775 233
Mob: 07712656630

MAKERS OF ARCHITECTURE

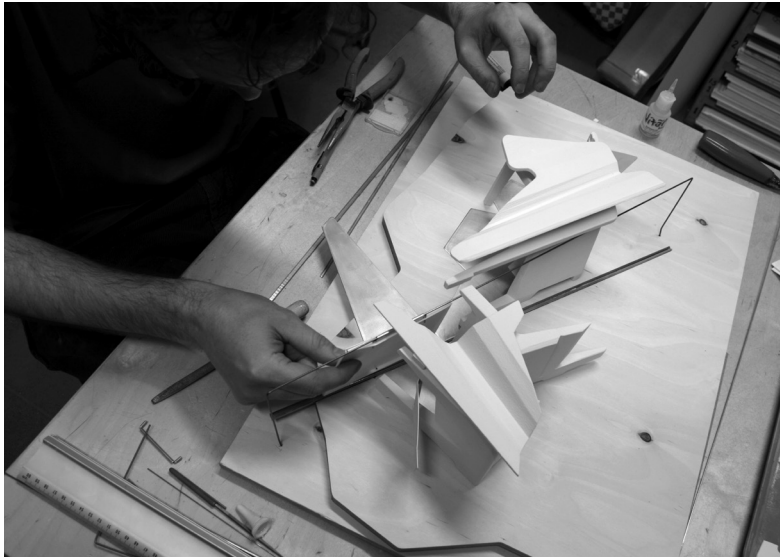
Let's begin with the name. Why would a group whose core has always consisted of trained architects, architectural researchers and architectural educators distinguish itself as *makers* rather than *architects*? The question is important because the distinction between maker and architect points to significantly different traditions, methods of practice and instrumental procedures related to the converting of intention into physical tangible stuff.

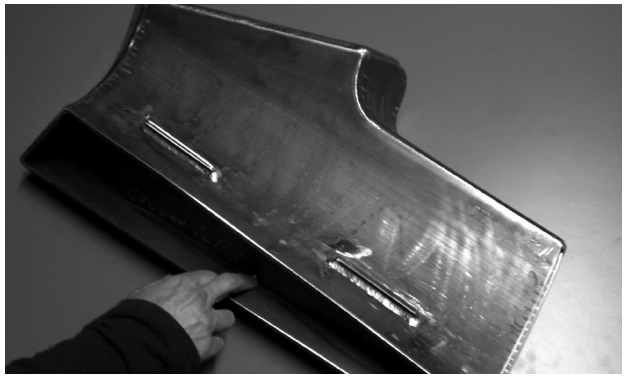
The core differentiation is clearly articulated by Robin Evans in his seminal essay 'Translations from Drawing to Building'. Evans observes that the architect does not deal directly with the object under investigation, but always does so through some intervening medium – principally the drawing. This leads to the assertion that a principal role of representation is to provide a 'complete determination in advance'. From this perspective the architect's practice is rooted in the making of information which is the pre-condition to the making of things, and the making of things is done by others.[1]

This definition of the architect's practice is quite different from the way in which our projects tended to be developed and conducted. For us, the procedures of making acted as the principal instruments for speculating. Work was always produced from a direct engagement with material and generally with consciously limited reference to preceding representations. This was not an avoidance tactic or a means to short-circuit the rigours of the design activity, but a method of working developed from a critique of practice that had isolated itself from what we considered to be a significant operational and contributory domain of activity.

The late Stephen Groák (an early mentor of sixteen*(makers)) describes the activity of drawing

1 Evans, R. (1997) *Translations from Drawing to Building and Other Essays*. AA Publications (AA Documents 2), London. p.156





as a method of thinking, 'not merely a record and presentation of a thought already completed'.[2] We understand making in precisely the same terms, and that is why I think the distinction *makers* is a useful one. I haven't a clue about the *sixteen** part.[3]

EXTENDING THE SPACE OF OPERATION

Haptic engagement constructs a cybernetic space in which maker and material are simultaneously steering and being steered. Control is passed and shared. Informing becomes a bi-directional process negotiated through action and feedback. It is a conversation in the rigorous Paskian definition of the term.[4] This was a familiar and fluent class of conversation for us, with most evenings and weekends reserved for the intimate ones – our own work. But the very directness of this class of conversation also placed significant constraints upon the outcomes largely related to scale. Addressing a different magnitude of scale would require a significant shift in our roles as direct manipulators of material – representation and instruction would have to become more centred within our practice.

One of the discourses surrounding CADCAM concerns itself with the way in which this technology permits a renewed proximity to material engagement through digital representations that can be used to 'directly' interface with multifarious methods of production and manufacturing. Considering that our practice originates from material engagement, our agenda with CADCAM has had different motives. As we began to investigate its potentials in the late 1990s we quickly recognised that it was not simply a route towards addressing larger scales. More fundamentally, it offered the potential to re-engage with a world of representation without isolating a body of tacit knowledge related to the making of things, because the making (CAM) is predicated upon a pre-condition of description (CAD). However,

2 Groák, S. *The Idea of Building*. London: E & FN Spon (1992). 150–151.

3 My defence is that I joined sixteen*(makers) together with Chris Leung in 1998 after its founding by Nick and Bob.

4 Gordon Pask was a cybernetician concerned with the mechanisms of learning. His *Conversation Theory* formalises concepts (such as *agreement*, *interface* and *environment*) , participants and outcomes to account for the construction of individual and social understanding. Interaction and feedback are central to this process.

the status of these descriptions, at least for any distinct procedure, must be of the nature described by Evans – a 'complete determination in advance'. The central question, therefore, became how to integrate these procedures into a practice such that the space of fabrication is maintained as one that is instrumental and contributory to the design dialogue rather than an isolated phase of activity that produces records of 'thought already completed'.

FILE TO FACTORY – A CONVENIENT MYTH?

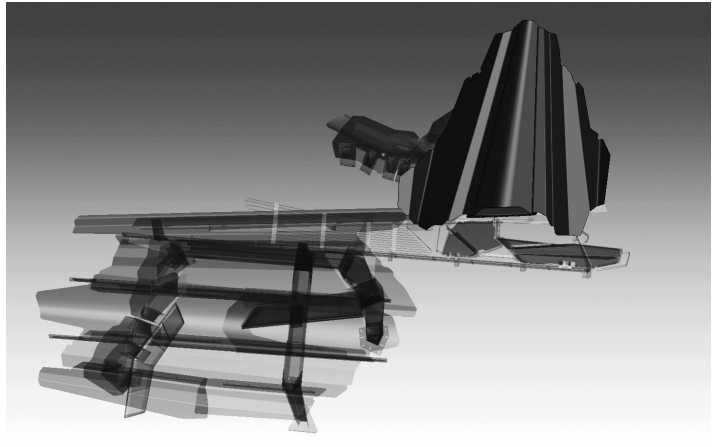
In his essay 'Is the Scientific Paper a Fraud?' Peter Medawar draws a distinction between science as reported and science as conducted.[5] I would argue that a similar distinction can be drawn in relation to the world of digital fabrication. Much of the published work related to digital fabrication in an architectural context, and authored by architects, employs the rhetoric of seamless continuity in which intention flows directly, without interruption or corruption, into physical outcome. However, anyone who has engaged directly with such procedures will be fully aware of the necessary iterations between the digital and the physical that are an integral part of the translation from intent to a constructed artefact of even marginal complexity. Furthermore, CAM procedures almost certainly require supplementary data that is rarely encodable through proprietary architectural CAD packages alone – the implication being that a significant domain of attribute specification, thus authorship, lies beyond the scope of the *file*.

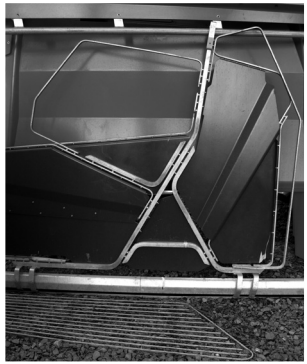
This gap reinforces the role of the architect as instructor and assumes that the architect either has the faculties to specify this supplementary data directly through full awareness of the process, its possible nuances, tectonic implications and aesthetic opportunities, or has an agreed and

5 Medawar, P. "Is the Scientific Paper a Fraud?" *The Strange Case of the Spotted Mice*. Oxford: Oxford University Press (2006). 33–39

tested nomenclature for instructing others in the specification of particular and achievable effects. Either way, it is evident that both positions are derived from a dependency on feedback from the productive tension that exists between intention and the made.

Therefore, taken at face value the term *file to factory* suggests a linearity that misrepresents a cyclic and iterative activity, certainly in its initial stages. More perniciously, if taken as an axiom, *file to factory* perpetuates a myth in which the architect's intent can pass without interruption or corruption, by material or process, into the constructed artefact. In opposition to this 'idealised' context I would argue that the reality of 'file to factory' only makes conceptual sense if positioned within an iterative dialogue which interrupts the idealised linear flow of intention and informs it in relation to material and procedure.



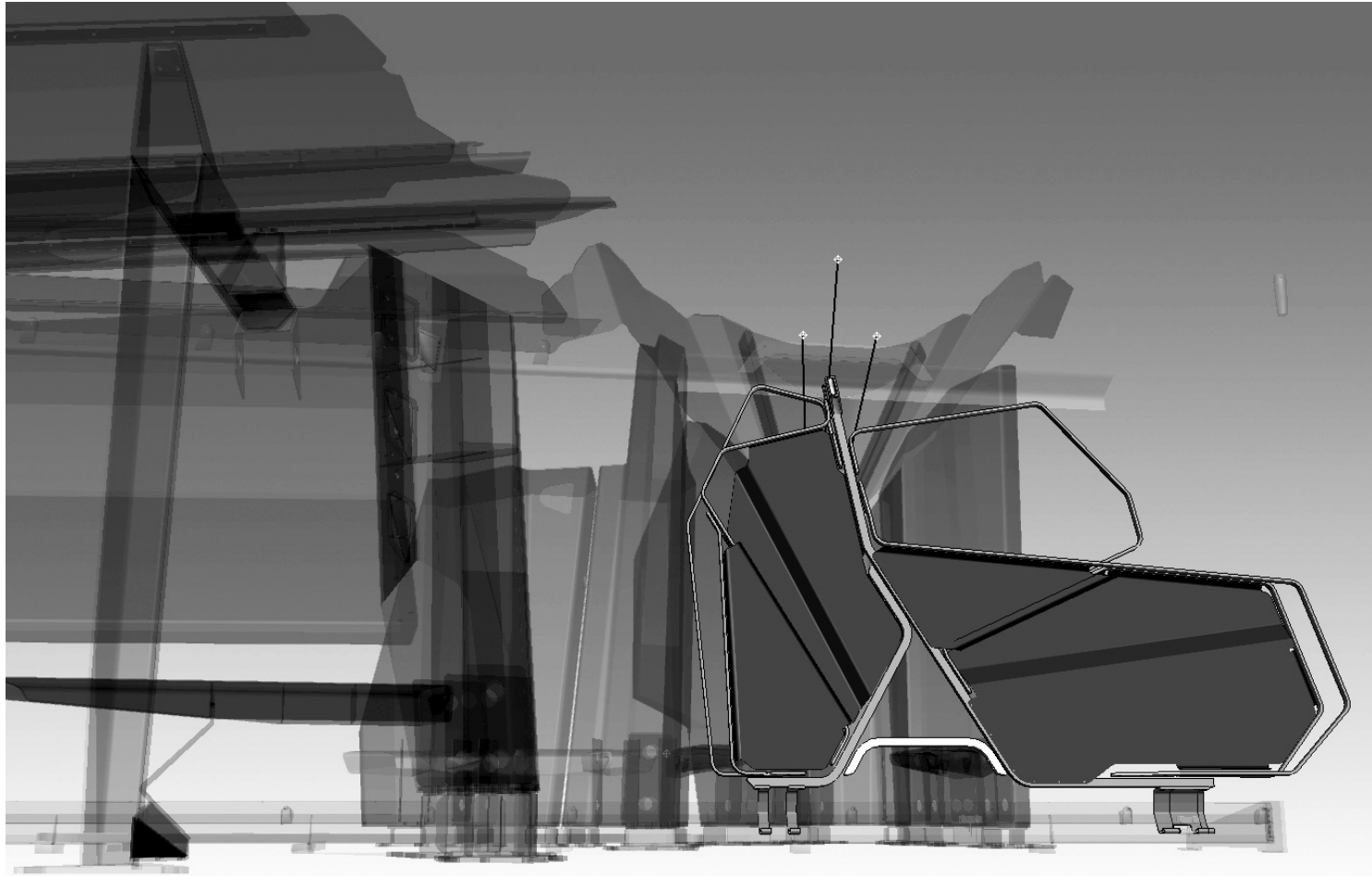


FACTORY TO FILE – THE NECESSARY COMPLEMENT

The voluminous depth of the Stahlbogen GmbH floor recedes in perfect single-point perspective from the mezzanine eyrie of the glazed office. This elevated vantage point provides a complete overview of the various projects under fabrication – a factory silencer, a replacement kiln for a local soda works, casting formwork for wind-turbine foundations, two clusters of irregular volumes with highly articulated sheet lids.

This last project stands in stark formal contrast to the large-scale platonics surrounding it, but in terms of material procedures it is one of the family – cutting, folding, welding are the standard methods of engagement here. This is where the tacit knowledge lies.

Much of the design of 55/02 was conducted in the space of its fabrication. The importance of that spatial proximity, and the collaboration with Stahlbogen that it relied upon, cannot be overestimated. This accessibility permitted the construction of a broad class of physical prototypes – always at 1:1. These fragments had a simultaneous status in that they acted as both verifications and speculations: verifications of digitally encoded design intent intrinsically coupled to procedures of production, and speculations of spatial, material and formal attributes. Their role was to enable a *feedback* into a domain of representation, supporting and informing a further iteration of encoded design intent (the making of information) from knowledge gained on the factory floor (the making of things). The idea of 'making as a space of thinking' was therefore fully integrated within the design cycle rather than being considered as a distinct phase of activity occurring only after production of a 'complete determination in advance'.



EXTENDING DESIGN SCOPE – THE COLLABORATIVE MODEL

There exists a tradition of designer builders in which novel forms of construction have been developed through a fundamental understanding of the relationship between design and making. Candela, Prouvé, Nervi, Brunelleschi, all implicated issues of fabrication and assembly as central drivers within their design scope.

As today's architect is unlikely to be in possession of such a thing as a flexible manufacturing facility, proximity to such processes is more likely to exist through establishing collaborations. The collaboration between sixteen*(makers) and Stahlbogen is very privileged. Stahlbogen is owned and run by two kindred spirits – both Nick and Kristina are alumni of the Bartlett School of Architecture. Nick also happens to be a founding partner of sixteen*(makers). It is no surprise then that there was high degree of fluidity and fluency within the design conversation, willingness to test experimental forms of practice and a concern that the scope of design should extend to incorporate the consideration of not just fabrication but logistics and assembly on site as instrumental parameters. Evidence of this is identifiable through numerous attributes of 55/02 – from its prefabrication to the scale of individual components to their spatial arrangement in plan and elevation.

The collaboration has permitted the testing of a design method in which the common distinction of design, fabrication and construction as discrete phases of activity has been significantly challenged. In its place we have developed a process that forces iteration, and constructs a productive dialogue between the generative capacities of representation *and* making, resulting in an architectural artefact at a scale that our work has not previously enjoyed.

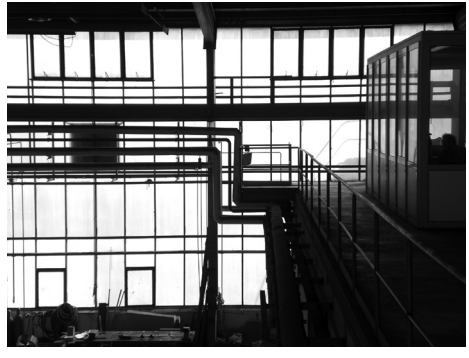
THE POINT OF PRODUCTION
NICK CALLICOTT AND BOB SHEIL

THE POINT OF PRODUCTION

The digital age has dissolved many of the barriers that impede the flow of information from consultant to consultant, and designer to contractor. With its origins in the 1950s, the present mainstream availability of Computer Aided Design, Computer Aided Manufacturing (CADCAM) has opened up vast and powerful potential to build more complex, more dynamic and more precise architectural systems. Central to this opportunity is the need to recognise the designer's dependency upon the tacit knowledge and skill that supports making. While digital fabrication technologies are undoubtedly illuminated by designers' dexterity and imagination in making drawings, it is their appropriate expertise in the complex business of translating ideas into physical matter that becomes exposed. In this regard, the necessary hybrid skills in design and making are understood not only as a means to deliver ideas, but as coexistent and inseparable disciplines in the process of creating architecture. Here, founding partners of sixteen*(makers) Bob Sheil and Nick Callicott reflect on some of the key moments in the evolution of 55/02 as an exploratory collaboration with manufacturers Stahlbogen GmbH, a steel fabrication firm set up by Callicott and his partner Kristina Ehlert in 2004, where Callicott is director of production.

The combined nature of a speculative brief, remote site, small project scale, constrained budget and adjacent award-winning art and architecture commissions presented the impetus for an experimental and radical approach. From the outset, it was determined that the work would reflect our response to place and time and, in this regard, exhibit-specific qualities to its location and the period in which it was built. Many of the recent commissions have engaged with its evolving status as a destination for leisure; however, Kielder Forest and Water Park is also

a manufactured landscape with an associated history of industrial production. It was this aspect that we were drawn to most of all, and the idea of engaging a manufactured landscape with a manufactured architecture took hold early on. Keen that the finished work should portray not only its purpose and relationship to site but also how it was designed and built, the project was approached as a collaboration between the architects sixteen*(makers), including Bob Sheil, Emmanuel Vercruysse, Phil Ayres and Chris Leung, and Stahlbogen GmbH, a steel fabrication firm led by former sixteen*(makers) co-founder Nick Callicott and his partner Kristina Ehlert, who moved from London to Blankenburg to set up the firm in 2004.



"It can be argued that the documentation of modern building technology is always obsolescent because the industry changes so rapidly. The knowledge of experienced craftsmen may be similarly limited. It follows that the only place to discover and understand current methods is at the point of production – on the site or in the factory."

Steven Groák, *The Idea of Building*, E &FN Spon (1992)

For the designer, the ability to see what is being made from where it is designed is a rare strategic asset. Despite every consideration, design intent does not always correlate with the means for the idea to be executed. Sometimes this is down to a conflict in how design information is produced and interpreted, and occasionally it is an inability to fully anticipate results before the work appears at full scale. More often, however, it is a matter of contextual and disciplinary disconnection between the space of design and the space of production. In conventional practice, on the rare occasions where the two coincide, the ability to make immediate adjustments to either the design or the manufactured component is both an invaluable tool and a rare affordance. It has been a founding objective of sixteen*(makers) to establish and develop their work on this core relationship, and to be involved throughout the entire duration of project production and be responsible for decisions at full scale as the work was made. Thus when access to the large-scale facilities and expertise of Stahlbogen came into the equation early, the prospect for a fully collaborative design exchange between designer and maker led to an immediate exchange of speculative design ideas between London and Blankenburg in the form of drawings, models and full-scale tests. On this basis fabrication commenced before an entire proposal was settled upon, and the emerging results were constantly reviewed for their physical and spatial qualities at full scale. In this sense the collaborators were not merely


WA1
P1
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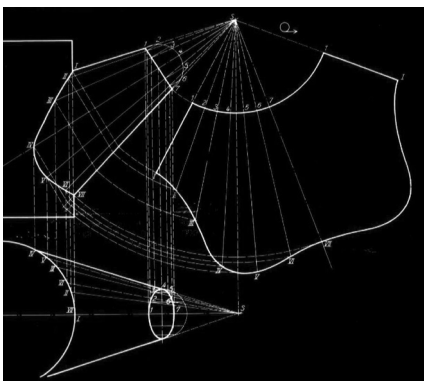
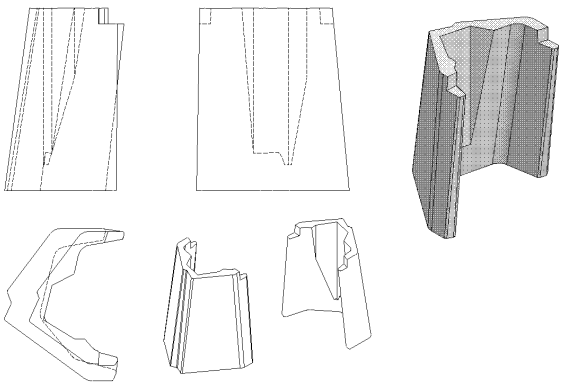
building the drawing, but approaching the making of 55/02 as a speculative design process comparable to initial acts of drawing.

When it was first established, sixteen*(makers) was a fledgling business proposition, where slowness in the mid-1990s economy was seen as an opportunity to test various means of operation as both designers and makers. Over a decade its path took several turns, ultimately navigating its way into education and research, in which time its membership grew and diversified. Several publications ensued that underscored the group's attitude to design practice, including Callicott's *Computer Aided Manufacturing in Architecture: The Pursuit of Novelty* (2001), and Sheil's *Design through Making* (2005), and *Protoarchitecture* (2008). As a shared project, therefore, it is important to make the point that 55/02 is a particular collaboration between a speculative practice based in an experimental architectural academy, and a steel manufacturing firm led by two alumni and a former colleague. Hence the partnership, and in some ways also the project, opened up a number of discussions on the similarities and differences that exist between these realms.

One such conversation is focused around CADCAM, where within the context of architectural academia it is largely approached as a provocative, experimental and speculative tool. These environments are concerned equally with the representation of ideas and the manufacturing of objects, what might be called the 'inbetweenness' of the ideal and the real. However, within manufacturing industries, CADCAM is not yet deployed to any great extent for its capability to manage complex forms, but rather to ensure consistency. For the most part, manufacturing industries utilise digital technologies not to speculate but to execute, where 'difficulties' are overcome by deploying the technology to preview and guarantee fabrication quality. After all,



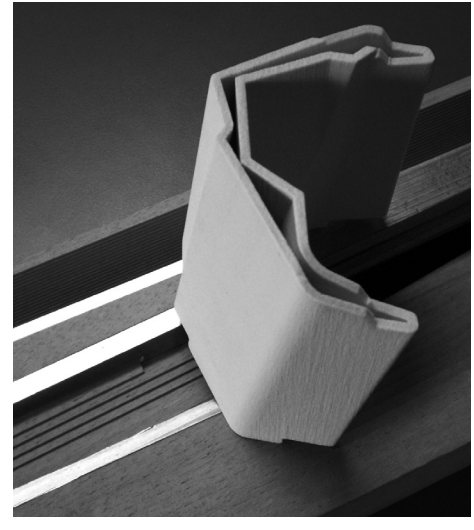


most manufacturers are not commissioned to evolve the design of a project, but 'simply' to make it. Underlying this condition is a present disparity between the relatively unrestricted nature of digital tools for the designer, that concentrate on image and geometry rather than materiality and behaviour, and the relatively more constrained array of similarly charged tools at the disposal of the maker. What is required to narrow this gap and exploit the full potential of digital tooling as a powerful design and making technology is for software developers to evolve mutual working environments that are powerful, informative and visually integrated feedback agencies for both realms.

> "Since nearly all sheet metal articles are hollow bodies, the metal sheet might be regarded as constituting the 'surface'. This surface is rolled or worked into form from the flat sheet, and to ensure that the finished form shall be correct to given dimensions, the pattern cut from the flat sheet should be true in shape and size from the outset."
>
> A. Dickinson, *The Geometry of Sheet Metal Work*, Longman (1967)

From the outset of this collaboration, it was understood that the budget could not justify investment in any new tooling or plant by Stahlbogen. Subsequently, one of the central aims was to exploit existing processes, equipment and expertise in ways that were not routinely utilised. Stahlbogen has a large repository of tooling that supports its four primary activities, CNC plasma cutting, CNC rolling, CNC folding and assembly including semi-automatic welding. Few projects are entirely fabricated using only digital technologies, and some are more effectively fabricated by 'manual' operation of our machinery such as the tapered conical form (see page 49). Although it appears to have been rolled, this form is generated by many hundreds of close proximity folds (page 49 lower image). Such tacit knowledge on ways

to manipulate conventional tooling for unconventional results was a key resource of the collaboration. Central to all of this activity is the flat pattern drawing and its role in developing and configuring what type of surfaces it is possible to realise. In the image on page 52 the flat pattern and intersection in elevation for a tapered cone intersecting a cylinder have been constructed using a method of radial lines. 55/02 was constructed as a 3D solid model where such 2D information was extracted from the model automatically via the software. Thus specific drawings reveal only what information is necessary for the task at hand (see page 50). All other information is superfluous as the part has been generated from a common model. In this regard, the final digital model of 55/02 was both a means of design representation and a fabrication rehearsal.



"Craft knowledge is genuine knowledge. To possess it in any form is to see the world in an enriched way compared with someone who does not possess it."

Peter Dormer, *The Art of the Maker*, Thames & Hudson (1994)

The decision to design 55/02 entirely in steel was not a foregone conclusion. Early conversations over initial sketches sent between London and Blankenburg, discussed a variety of materials including concrete and timber. It was through Stahlbogen's expertise in making steel precision formwork for concrete structures that the idea to approach 55/02 as a series of interlocking and adjacent 'tanks' took hold. A speculative digital sketch (see page 50) was quickly translated in to a 3D print (see page 52) at the Bartlett's Digital Manufacturing Centre, which in turn led to the fabrication of a full-scale test piece at the factory in Blankenburg (see page 53). The tactic to resolve skin, structure and form through manipulation of standard sheet material was a highly efficient way to reduce waste, save time, and minimise specialist tooling. In addition, although complex forms were generated, structural performance through finite element analysis was very straightforward. This exercise informed at least one significant design modification in that the number and radii of folds in the final iteration of 55/02 were revised against those in the speculative model for structural and aesthetic reasons.

Once beyond the very initial stages of evolving a site and contextual strategys 55/02 was almost entirely designed in 3D as digital or physical models. On gaining planning approval, these models progressed from a purely representational or prototypical mode into design information for production. In this transition, the role and significance of the model changed from visual feedback to an instruction to make, and thus became a means to partially assess feasibility for manufacture.

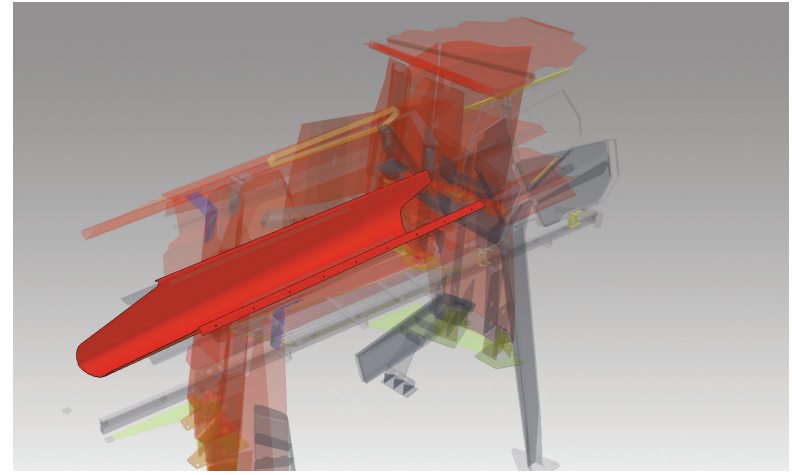

G.WALTON

"It is never easy to say where workmanship begins and design ends, for the simple reason that workmanship is design."

David Pye, *The Nature and Aesthetics of Design*, Herbert Press (1978)

For the purposes of conventional communication of design intent, 2D drawings were published for the client and others, but were not part of the information package released to the shop floor. Instead, all production drawings were extracted from one single 3D model in which every component was extracted and tested for makeability by digitally folding and unfolding the part. Associated with this exercise, but not a feature of the software, was our knowledge of the physical constraints of the factory's tooling. Trips between the drawing office and shop floor to measure the physical limitations of plant and to converse with our most experienced fabricators were frequent. Although some aspects of the design remained to be resolved through fabrication, when a sufficient degree of certainty was assured by the digital model that components were makeable, specific drawings were generated for each part.

Constraints on both the supply and the behaviour of materials are an everyday consideration for fabricators of all kinds. For many designers, the same considerations uphold in principle, but in the nature of a largely representational discipline, such 'real' constraints can be switched on or off and it is often very useful to do so. Being a hybrid design and making project, the dimensional and behavioural constraints of sheet steel were positively exploited in 55/02. Its dimensions are in many ways provided by standard sizes of raw material, and its formal language is in many ways determined by the limits to which the sheet can be manipulated without failing, or by the technique or equipment deployed in forming it.




FASTRAC

"I was saying: learning to weld, I learned everything, more or less."

P. Levi, *The Wrench*, Abacus (1987)

We were keen to allow these decisions to be read in the final outcome, which led to the decision to expose all vertical welds. In this regard, maintaining a perfectly straight line while seaming sheet steel over 2.5m is a task beyond even the best welders. Hence, a semi-automatic system was deployed using a trolley to steady the craftsman's torch (left). Similarly, where digital or automatic techniques were not required, some ancient techniques were put to use such as forging the 40 x 40mm frame to the sliding screen (see pages 64–65). The only digital component in this exercise was a CNC cut jig welded to the workbench against which the bar was formed.

One of the obvious design considerations was to incorporate a strategy for how 55/02 would be assembled on such a remote and exposed site as Cock Stoor. The facilities of the factory in Blankenburg greatly outweighed those on site and means of transporting and lifting 55/02's components into place remained an unresolved issue until a matter of weeks before assembly. Six miles of woodland track separated the site from the holding depot at Kielder Water where the parts would be offloaded by international road transporters. Thus the precaution was taken at an early stage to fragment the design of 55/02 into a number of discrete parts. The scale and configuration of these parts was determined by visual estimation of site photographs, conversations with forestry commission staff, packing limitations and weight. As the fabrication of 55/02 neared completion, referencing to the virtual model became less relevant. Many of the final additions such as seating and connection components were designed and fitted directly to the emerging

construct. Some of these elements remain absent from the final iteration of the virtual model. There are also a number of others that remain on the virtual model but were removed after first fit for aesthetic, structural or constructional reasons.

> "Learning a skill is not the same as being an expert. Being an expert in a body of craft knowledge means living that knowledge... In a way tacit knowledge contains within it the germ or the test of a severe morality. It is not what we say about skills that matters because what we say will always be incomplete – or even mendacious. What counts is what we do. The moral principle within craft is that each action shows that we are what we know. Each action might also show how much we care and what we care about."
>
> Peter Dormer, *The Art of the Maker*, Thames & Hudson (1994)

To conclude, the intentions behind 55/02 stem from the client's open brief to 'engage with the landscape' and provide 'some form of shelter'. Those that venture into this landscape know that it is a wilderness of extraordinary beauty, diverse use, eclectic history and potential risk. To conclude, the intentions behind 55/02 stem from the client's open brief to 'engage with the landscape' and provide 'some form of shelter'. Those that venture into this landscape know that it is a wilderness of extraordinary beauty, diverse use, eclectic history and potential risk. They also know that it is a landscape with a growing reputation for hosting interventions of experimental art and architecture. For us, 55/02 is an attempt to embrace all that surrounds it and to prompt questions on the meaning of this place. These questions are embedded in the way the shelter was designed and made; and they are questions that address the relationship between the way things are seen and the way things are done. For us, as designers and makers, 55/02 is an architectural prototype that

represents the specific time and unique place of its inauguration. It seeks to express the manner of how things are designed and made in the early twenty first century, and speak of how such mutual decisions have the capacity to reshape the built environment in a creative and exciting manner.

"Learning a skill is not a mechanical activity but an emotional as well as intellectual and physical process."

Peter Dormer, *The Art of the Maker*, Thames & Hudson (1994)

WAYS OF SEEING/WAYS OF DOING
BOB SHEIL

In this essay I wish to explore the liquid and illusive role of representation in making 55/02, where the ideal circumstances of a fully interdisciplinary design team allowed the project's fabrication to be approached with the same level of speculation as its depiction in drawing.

Architects do not make buildings; they make information that is used to make buildings. This information exists largely in the form of drawings and specifications, but also letters, contracts and on occasion verbal instructions. Together the compilation operates as a negotiable design template for fellow consultants and makers to follow, or where appropriate, to interpret. The skilled designer will understand and accommodate the skills of the maker who is tasked to translate geometric lines and text into various composites of material, form, structure and construct. Skilled designers will carefully design their information, paying appropriate attention to how the information is used and filtered from managers to craftsmen. It is a delicate exercise where a considerable array of external influence may contaminate the desired symbiosis between drawing and artefact, designer and maker. Subsequently, all buildings are contingent on how well this relationship survived and it can be argued that all buildings exist as a portrayal rather than a reflection of design intent.

The digital age has brought about a radical shift in this critical relationship and with it a grand challenge for the design and construction industries to exploit its potential. Through the protocols of computer numeric controlled machinery (CNC) and the embedded code of computer aided design (CAD), design information of the 21st century now includes the capacity to directly feed manufacturing processes. Thus the information that designers generate has been promoted to core production data and in a short space of time designers have become inextricably linked to the direct production of buildings.

This is both exciting and worrying. On the one hand, computer aided design, computer aided manufacturing (CADCAM) explodes the potential for manufacturing complex and previously inhibitively expensive parts; on the other hand, it challenges the expertise and skills of designers as makers.

Structure and form through manipulation of standard sheet material was a highly efficient way to reduce waste, save time and minimise specialist tooling. In addition, although complex forms were generated, structural performance through finite element analysis was very straightforward. This exercise informed at least one significant design modification in that the number and radii of folds in the final iteration of 55/02 were revised against those in the speculative model for structural and aesthetic reasons.

Once beyond the very initial stages of evolving a site and contextual strategy, 55/02 was almost entirely designed in 3D as digital or physical models. On gaining planning approval, these models progressed from a purely representational or prototypical mode into design information for production. In this transition, the role and significance of the model changed from visual feedback to an instruction to make, and thus became a means to partially assess feasibility for manufacture. For the purposes of conventional communication of design intent, 2D drawings were published for the client and others, but were not part of the information package released to the shop floor. Instead all production drawings were extracted from one single 3D model in which every component was extracted and tested for makeability by digitally folding and unfolding the part. Associated with this exercise, but not a feature of the software, was our knowledge of the physical constraints of the factory's tooling. Trips between the drawing office and shop floor to measure the physical

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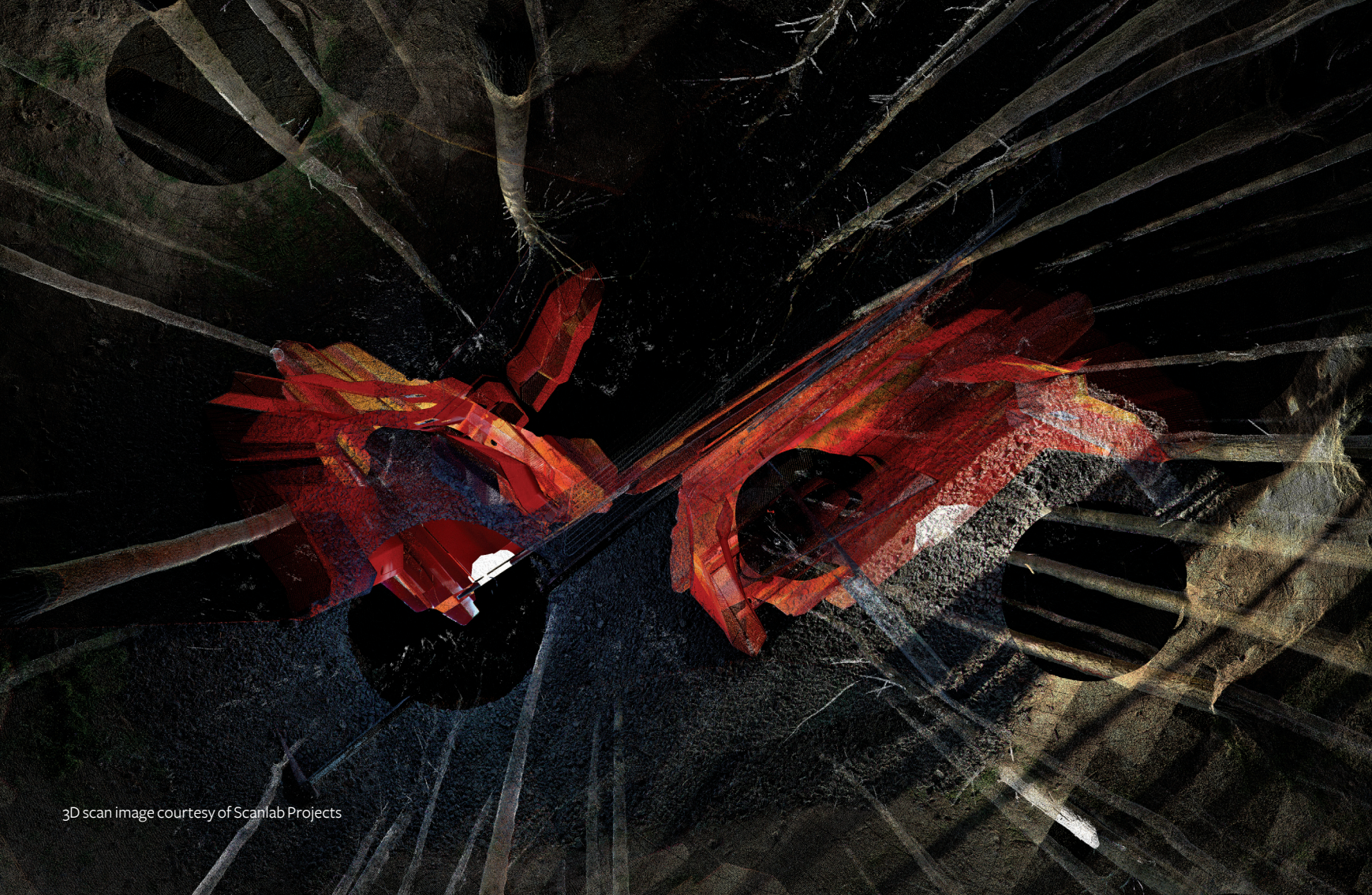

3D scan image courtesy of Scanlab Projects

3D scan image courtesy of Scanlab Projects


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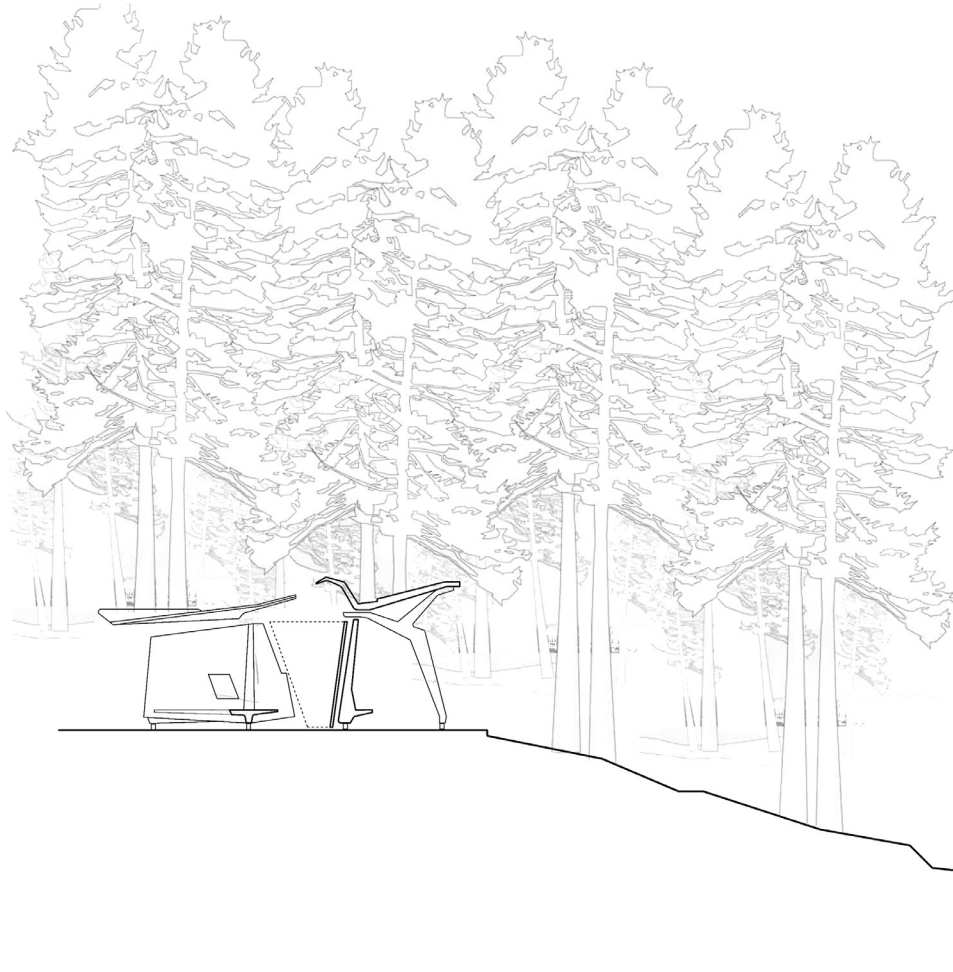
The photograph opposite of a medium-format reflex camera with 55/02 reflected in its viewfinder was taken by a digital SLR as the building was nearing completion. As an image it represents many of the issues this building is engaged with in a single frame. Instead of been captured on celluloid film, the image you see here was stored on a light sensor chip as a code that can be broken down numerically. Within this image is another image about to be captured by a light-sensitive chemical coating on film nearing its expiry date. The resolution of the chemical image is higher than its digital counterpart, yet the latter's multi-functionality though technologies such as photogrammetry make it a more powerful tool. The game being played relates to many of the experimental qualities of 55/02 and what it represents as a hybrid investigation of the analogue and digital. As an artefact it is undoubtedly solid, robust and real. Its steel skin is hot in summer, cold in winter. As the surrounding spruce trees inevitably decline and fall, 55/02 will survive intact. Its geometries and folds echo those being played out in the distant landscape as the forestry mosaic is manicured, harvested and replanted. 55/02 looks as if it was made by machines, and this is largely true. But what instructed the machines to pleat this skin the way it is was a three dimensional digital design model which generated the complex array of parts for a team of experienced craftsmen to assemble. Much of the reasoning behind the work is to exploit this transgression from the ideal to the real, where the role of various modes of representation in designing and making the building was of central importance to its manufactured production and ultimately its meaning.

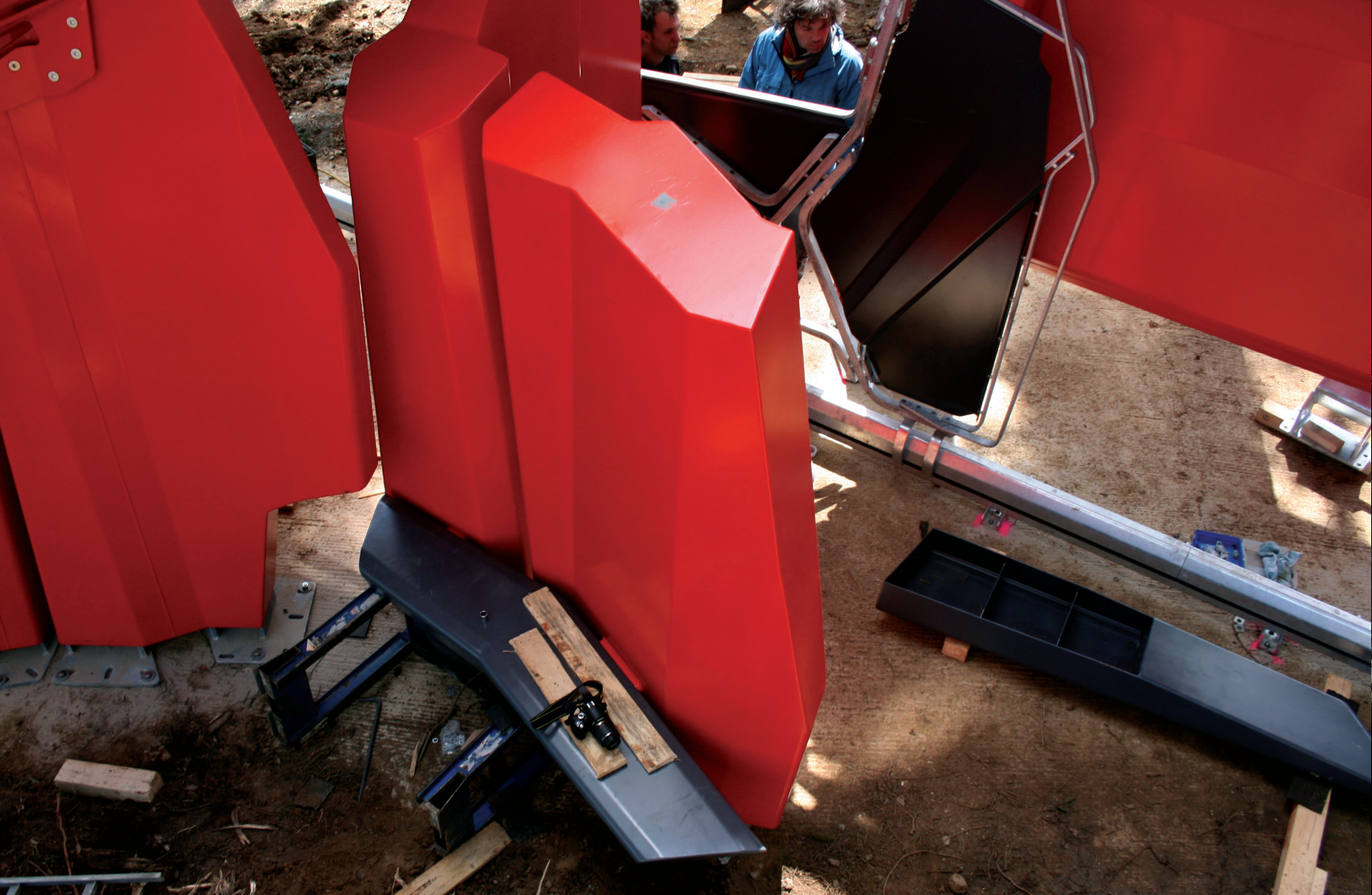
Some observers have remarked on the quality of our digital images that 55/02 looks like a photorealistic montage, and because this is such a well-crafted discipline that has recalibrated our visual senses, they had not realised at first that the image was of built work. Although we would like to claim intent for such a

fascinating and contemporary illusion, sadly we cannot. Nevertheless, this has become an apt reminder that on account of its remoteness, it is likely that more of an audience will see this work through images alone than by visiting the site, and thus what a great part images will play in evaluating the work. To some extent this was considered in its design, most prominently in the animated debate to coat most of the building in a single colour. The decision to do so was led by an argument for cohesiveness and abstraction: the former to bind the array of complex parts with a single wash so that the structure's physical language would communicate the choreographic outline of it's ornately cut edges; the latter to distance 55/02 from an association with the conventional separation of architectural 'parts', such as wall, roof, etc. Thus 55/02's largely monochromatic tone is used in much the same way as its singular use of one material. It concentrates and unifies ideas on place, spatiality, form and the building's reference to its surroundings.

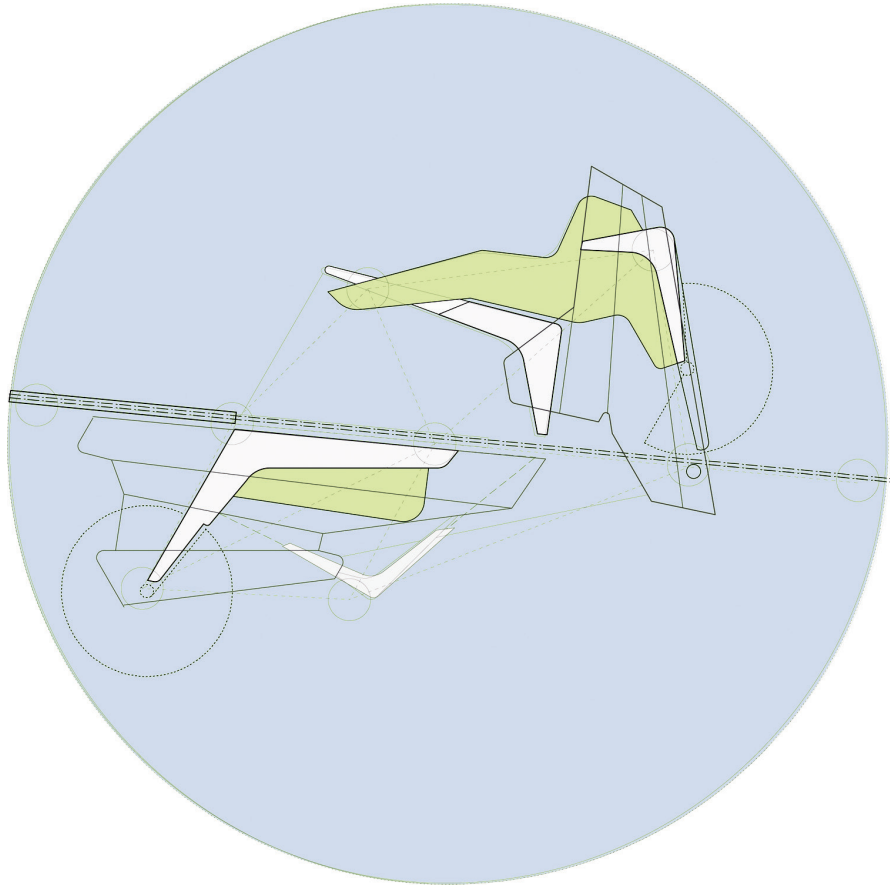
Sixteen*(makers) was formed at Sunbury Workshops in Shoreditch, East London, by Nick Callicott and Bob Sheil just as they graduated from the Bartlett in 1994. They were joined in 1998 by alumni Phil Ayres and Chris Leung, and ten years later by Emmanuel Vercruysse. Throughout this duration, sixteen*(makers) have operated in practice, academia and a hybrid of both.

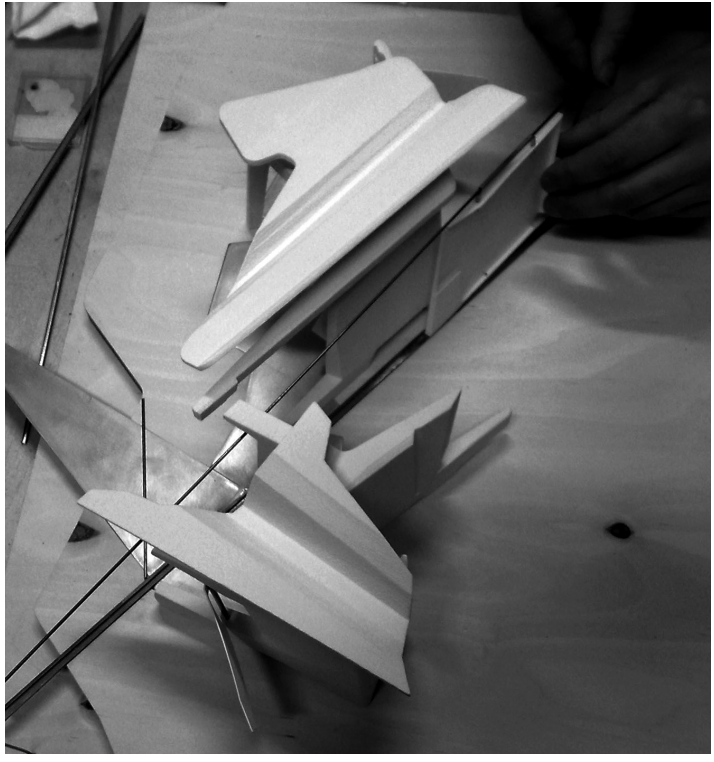
Like many students of architecture, it was our interest and ability in drawing that gained us a passport to progress though the system, which in its beginnings for Callicott and Sheil's generation did not involve any use of CAD. Our frustration with our education's prolonged postponement of any serious engagement in making things beyond models led to a change in direction particularly after attending a Peter Salter lecture at the AA on the Kamaichi Mountain Pavilion in Japan.





3D scan image courtesy of Scanlab Projects

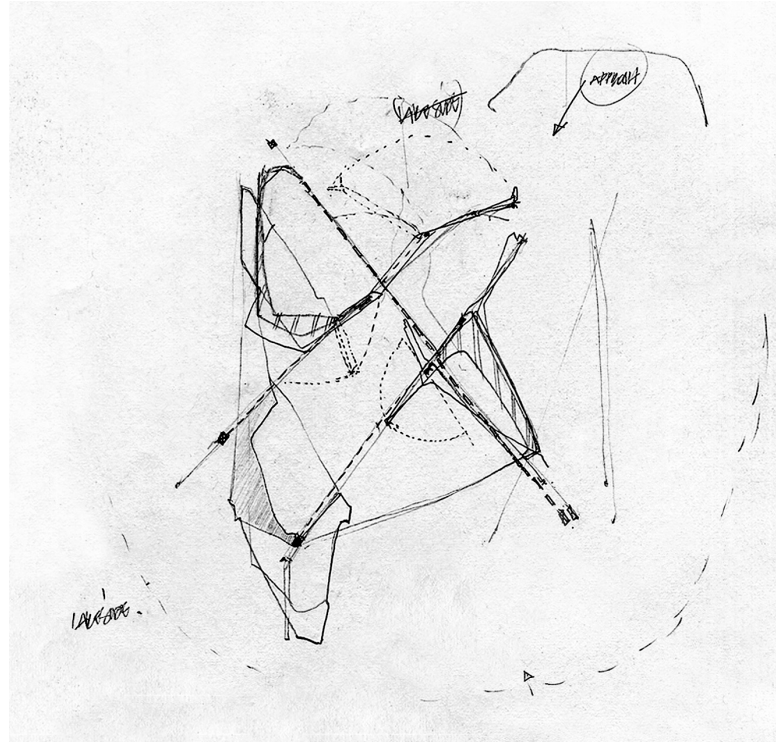




Salter, who remains an inspiring influence for sixteen*(makers), talked about the considerable differences between architects, drawings and finished buildings, how it is understood that they perform different roles and so on, but at the same time how substantial changes happen in the translation from one to the other. To fledgling designers with a passion to build, Salter's frank and open discussion was deeply refreshing, and coming from someone with considerable skill and knowledge in making, the resulting gravitas was all the more profound. Since that time, sixteen*(makers) have sought to be fully engaged with such moments of translation, not only as makers of architectural representation, but as the designers of what is made.

Over 20 years on there have been many changes, many of them in relation to the use and potential of new technologies, but also many have emerged in relation to renewed potential of ancient practices and traditions. In the first instance, by adopting the common protocols of digital technologies, the disciplines of design and fabrication have narrowed the gap of interdisciplinary communication. Now design files have a direct influence upon manufacturing outputs, forming a basic score to industrial choreography. A vast and exciting resource of previously unmakeable ideas, including complex and exuberant forms, or materials embedded with behavioural qualities, has been untapped and its potential is exciting designers worldwide. Such enthusiasm is highly positive, yet it can only be fully exploited when it is recognised that the business of making buildings requires knowledge not only in the world of making information, but in the world of making things.

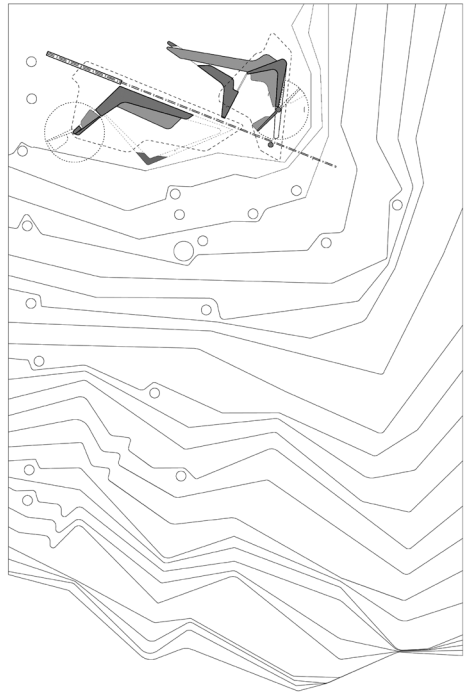
Transforming an idea into built form is a delicate, skilled and somewhat mysterious operation; it relies on a tacit expertise that is familiar with the tactile and the physical it is an expertise that goes beyond the architectural

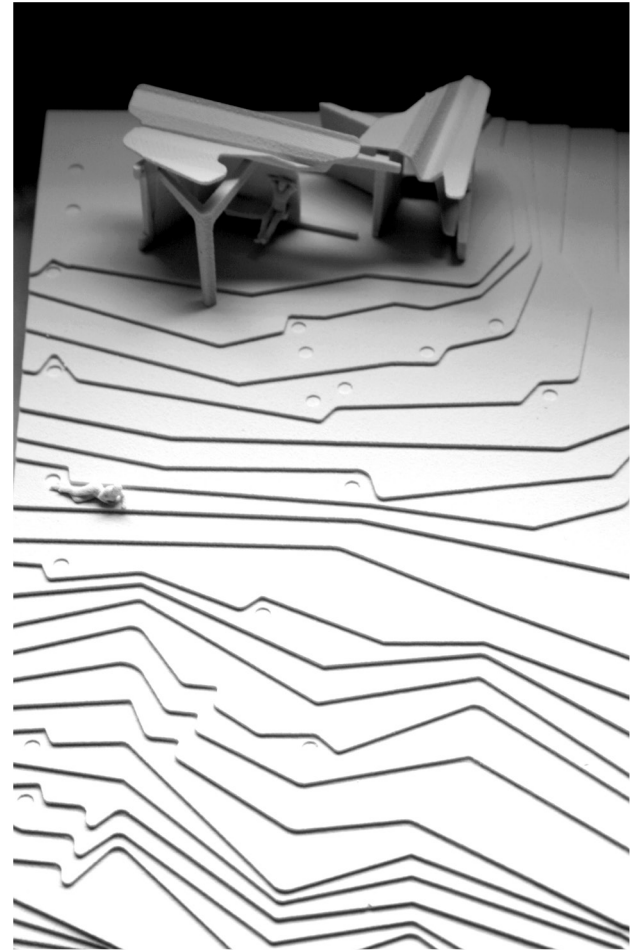


drawing and an expertise that sixteen*(makers) continue to investigate. Although a small building, 55/02 represents many of these concerns and it is possible to read it as a demonstration of these transitions.

The selection of images in this chapter relate to periods or instances where the design of 55/02 oscillated between various modes of representation including drawings and models. As is common in everyday design practice, these shifts varied from the need for immediate feedback to the design team, communication with clients, consultants and local authorities, to meeting the needs of manufacturing or installation requirements. What I wish to explore here as a complement to the other chapters in this book are the design consequences following these shifts, and how 55/02's final iteration can also be read as an exploration in representation. This has become an all the more significant aspect of the work with the introduction of high-resolution 3D scans taken a year after completion of the shelter. First, though, a short summary of the very initial stages of establishing 55/02's final form beginning with a set of strategic diagrams submitted to win the commission. As Peter Sharpe outlines, a total of five projects were commissioned beginning with an invitation to express interest. The second stage involved submission of two A3 panels in response to a hypothetical site. For two reasons our tactic was to present design strategies rather than a singular formalised proposal: first it was not possible to visit the site which for us would always be a fundamental experience in deriving a response; and second, knowing we would want to develop the proposal by design through making, we did not wish to be bound by agreement to a specific image that later we would certainly wish to alter. Hence the panels presented diagrammatic plans and sections indicating various zones and forces of influence that would act upon the plot and inform the shelters design. These included

3D scan image courtesy of Scanlab Projects





sun paths, topographical features, key views, prevailing weather patterns, proximity to access, etc. Diagrams indicated a construct with variable spatial potential and alternating degrees of enclosure and permeability. They also suggested a complex geometric form whose appearance was somewhat reminiscent of the man-made cuts and trenches in the Kielder landscape, wayward edges of its formal planting grid, and the intersection of aircraft vapour trails in the overhead sky. The panels also illustrated a number of additional contextual qualities that would inform the final work. These included images of dew, vapour trails (the site is located under an active military flight path), exposed reservoir edges, vegetation and ground textures. In addition, the panels contained a small array of images from previous works, which illustrated experimentation with digital craft and manufacturing techniques.

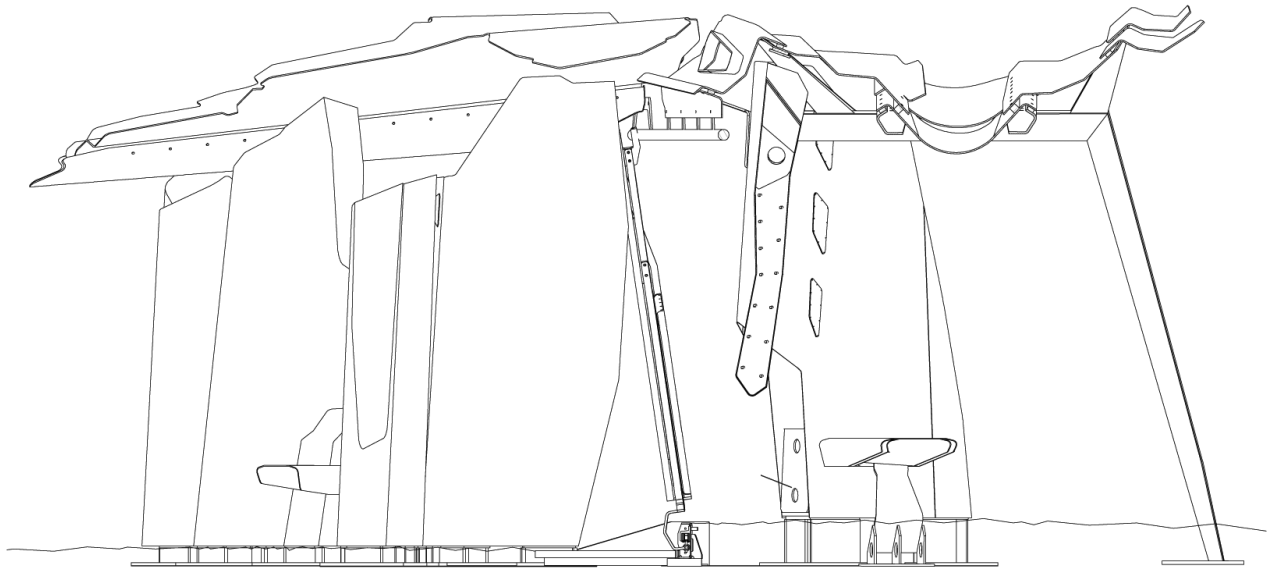
Once past this stage and the commission agreed, design reverted to a series of hand-drawn sketches regularly scanned and emailed between Nick Callicott in Blankenburg, Phil Ayres in Copenhagen, and Bob Sheil and Emmanuel Vercruysse at the Bartlett in London. These were approached as visual conversations on how the project would proceed and summoned up a tentative cloud of formative, literary and technical ideas. They led to verbal conversations that were not distinguished or separated into autonomous categories of design, construction, procurement or logistics. It has long been a characteristic of sixteen*(makers) as a practice to bridge the territories between Art and Craft, and Architecture and Building. In this instance works by Fabrizio, Lewerentz, Matta-Clark, Pichler, Prouvé, Rural Studio and the collaborators Charreau, Bijvoet and Dalbet became early terms of reference. Likewise, soundings on the paintings of Anselm Kiefer, the drawings of Lyonel Feininger, the sound of John Cage and the coachwork of Sir David Brown were included in

3D scan image courtesy of Scanlab Projects

speculative design conversations, as were lengthy and expansive conversations with Peter Sharpe on his vision for the entire programme of works at Kielder and his repertoire of local knowledge.

What emerged from this series was an interest in pursuing ideas of alternating spatial enclosure and openness, of developing the fragmented and dynamic language suggested by the plan, and of homing in on the dispersal of key seating positions as pivots to reading the landscape's mosaic of cuts and folds. Upon these ideas a conceptual jig to commence factory experimentation was formed and key steps in 55/02's design were accelerated by 1:1 prototyping, in particular the decision to form its structure and skin from folded sheet steel, a commitment from which all subsequent strategies stemmed. Elsewhere in this book, we explore this issue as a turning point in the design's physical properties; however, in terms of how it changed our approach to representation the effects were equally great, for this was the first engagement with information that transgressed the boundaries of representation and fabrication. Stahlbogen's 1:1 folded speculative prototype not only stood as a design breakthrough, but also provided the project's co-designers with a digital file to manipulate and explore alternative scales and contexts both in drawing and in 3D printing. In this instance, the project became truly collaborative, with core files being shared between the manufacturer and their co-designers for discrete and common purposes.

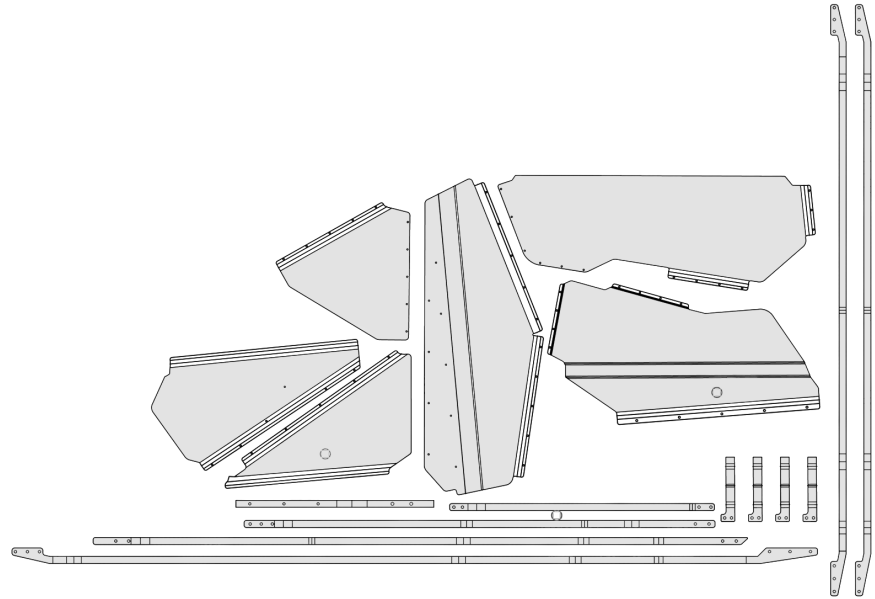
Based upon these core shared files, busy exchange between Blankenburg, London and Copenhagen continued as second and third prototypes were being built in one place, and 1:20 and 1:100 models in another. Factory visits by the entire team ensued, where similarity and difference were assessed for their potential to influence the final iteration. The immediate issues of scale difference were not



surprising; however, it was around considerations of detail and the performance of surface undulation that aspects of some design intensions had become lost or diluted in translation. It can be argued that there is only one scale in CAD and that is 1:1. With a few rolls of the digital draftsman's scroll, the viewer can zoom in or out ad infinitum, allowing the digital designer to jump the scale of a single drawing back and forth. There are advantages and disadvantages to this facility, but a significant difference remains between 1:1 CAD and 1:1 made artefacts, and notions of a seamless and linear exchange from 'file to factory' are misguided. An example of this surrounds 55/02's folded quality which stems from the dual strategy to stiffen its skin of sheet steel for structural purposes and to array the same folds for purposes of architectural quality.

On completion of the first prototype it was apparent that the architectural qualities we were seeking to achieve were understated at 1:1. In structural terms the prototype was entirely satisfactory; however, some of the formal and aesthetic qualities expressed in the digital model failed to translate. The radii of fold lines for the final iteration, for instance, were determined by examining the prototype as graphic representation on the digital model struggled to convey the desired subtlety of directional shifts on 55/02's surface. Consequently, the array, number and direction of folds were revised against how they looked at 1:1, and although the revisions occasionally looked strange on the digital model, it was the 1:1 fabricated version that had the final say. This is a key point in understanding that subsequent to laying down the strategic spatial and positional plan through early 2D diagrams, plans and sections, 55/02 was entirely designed in 3D and evolved via feedback between 1:1 fabricated elements and the digital model.

This method evolved to such an extent that the 3D digital model became a 'design simulator' for decisions taking



3D scan image courtesy of Scanlab Projects

3D scan image courtesy of Scanlab Projects

3D scan image courtesy of Scanlab Projects

place on the factory floor. As a consequence, 2D plans and sections of 55/02's final iteration are entirely derived by dissecting the 3D digital model at selected planes; in other words, they are instantaneous exports of the 3D model generated to examine specific dimensional relationships across the selected plane. Conventional 2D drawing techniques can produce the same data but never at the same rate or with the same ease. 2D drawings produced in this way portray the work's full complexity, and often as a result look confusing or unexpected. Nevertheless, as they are fully integrated with the 3D model any changes made in 2D are automatically adopted in 3D. Thus as a habitual product of architectural representation, the 2D production drawing has shifted its role from that of a primary driver of the work to that of a rapid and incisive design tool to cross-examine 3D decisions.

Related to these issues and around three months into designing 55/02, the need to develop two parallel strands of representation emerged; one for production and the other for communication with clients, consultants and the local planning authority. Both strands were tied back to the core model, but early iterations in 3D, which were focused on ideas related to construction and fabrication, were initially too raw to present for design review. Paradoxically, the strength of 3D digital modelling is also to some extent a restriction at such a stage; its composition of unresolved complexity was understood as a necessary progressive stage to the design team, but to present such an image to an external audience could offer a distraction from overarching design intentions. As a result, a 1:20 model and a series of 2D and 3D illustrative drawings were generated so as to round off the relative complexity underway in Blankenburg and convey these attributes as design intentions in a manner appropriate to the medium in hand. It was from this set that planning approval was sought, and as Peter Sharpe reports elsewhere, this was

achieved after the second attempt when the scheme was presented as a photographic collage rather than plans, sections and perspectives.

On the team gaining approval in December 2008, Nick Callicott set about building an entirely new 3D digital model for final production to incorporate many of the revisions made in the course of developing its pre-production 'prototypical' partner. Now taking on the role of manufacturer as well as co-designer, his responsibility to ensure 55/02 was efficiently and successfully delivered took precedence. In effect, this version was consistent with the practice of developing shop drawings, in that the process of their setting out and geometric construction was approached as a rehearsal for making. By necessity this version was more thoroughly resolved and tested than its predecessor and thus exposed every issue that required final design resolution either through drawing or on the shop floor. However, rather than wait until the latest model was entirely complete, fabrication on 55/02 commenced as soon as discrete elements were resolved, and the first to appear at full scale were the wall sections of the eastern end. Nick's position as simultaneous designer and maker at the site of production was put to full effect where production progressed through a sequence of looped operations between drawing and making.

Once the eastern end walls were erect, Nick set about finalising the overhead canopy to this area on the model as a series of interconnected folded parts. When these were made and assembled, the canopy was suspended in position from the overhead crane; and following a visit by other members of the design team, ideas for how the two would connect and be spaced apart were finally resolved. The completion of 55/02 in the factory followed this binary pattern throughout, allowing undrawable factors such as gravity and material performance, as well

as understanding matters of parallax and visual feedback to play a central role in determining its outcome. In a manner that reiterated the peculiar reversal of conventional design methods that digital technologies offer, setting out templates to aid re-assembly of 55/02 on site in Kielder were generated from the 3D model towards the completion of fabrication. Generated from the origin model, they ensured that final assembly was fully consistent with design and prefabrication iterations.

Returning to the photograph of the photograph and the peculiar space in the digital world between visualisation and realisation, further manifestations of the fluid properties of digital representation were explored by capturing 55/02 a year after completion with a high-resolution 3D laser scanner. This technology became available in March 2010 through a loan agreement between the Bartlett, UCL and international computer aided measurement systems manufacturer FARO. Historically, the market for 3D scanning has predominantly been in civil, aeronautic and industrial engineering. Less is understood about its implications for design, other than obvious benefits as an advanced surveying tool. In this instance, scanning represented an opportunity to conduct a forensic autopsy on 55/02's integration with is surroundings, and to inaugurate a sequence of detailed studies on how it behaves over time. As the laser measures points of a recorded surface in space to an accuracy of >1mm, we are provided with a fresh 3D model of the work in situ. In a way that is not surprising but is fascinating all the same, the scan produces a digital point cloud file many hundreds of times larger in size than the 3D manufacturing file that generated 55/02. What is made becomes a reference to explore and construct alternate realities, and the loop between what is ideal and real begins again.

SIXTEEN*(MAKERS)

Sixteen*(makers) is a collaborative group of industry practitioners and academics who share a common fascination with the concept of 'design though making' in all its forms. It is an assembly that is formed around mutual interests while individuals pursue parallel investigations that guide our collaborations. Its members include: Phil Ayres, Nick Callicott, Chris Leung, Bob Sheil and Emmanuel Vercruysse. We each enjoy architecture as a fluid and dynamic discipline where a multitude of imposed and passive ingredients design its physical and tactile character. Central to our method is the production of speculative prototypes to discover, evolve and adapt ideas, some of which begin as a hunch or curiosity. In support of this pursuit, we are great believers in tacit knowledge and the often surprising expertise that is acquired through experience and practice. In recent years we have developed an intimate understanding of digital and analogue manufacturing processes, time-based realities, responsive systems, environmental behaviours and design that adapts to change. For more than two decades, our skills have evolved by adopting techniques from the hand-made to the digitally crafted. Outputs span across buildings, installations, furniture, research constructs and numerous international publications.

55/02 received an RIBA Award in 2011

WWW.SIXTEENMAKERS.COM

PHIL AYRES

is an architect, researcher and educator. He joined the ranks at CITA (Centre for Information Technology and Architecture, Royal Academy of Fine Arts, Copenhagen) in 2009 after a decade of teaching and research at the Bartlett School of Architecture in London, and completing his PhD in Denmark at the Aarhus School of Architecture. He has also been a partner of sixteen*(makers) since 1998. His research explores the potentials that lie at the intersection between digital and material practice with a current focus on free-form metal inflation and developing supporting digital design environments. Much of his research has been exhibited and published internationally. Phil is also the editor of the title *Persistent Modelling – extending the role of architectural representation* by Routledge in 2012.

NICK CALLICOTT

is a Director of Stahlbogen GmbH, a founder member of sixteen*(makers) and former Director of Computing at the Bartlett School of Architecture, UCL. He is the author of *Computer Aided Manufacturing for Architecture – The Pursuit of Novelty* (Architectural Press, 2001). He began his teaching career in 1995 in the Bartlett workshops and led BSc design unit six with Sheil between 1997 and 2003. Callicott was responsible for first introducing digital fabrication technology to the school, and was the founder of the Bartlett's CADCAM facilities. In 2003, he left London to establish Stahlbogen GmbH with Kristina Ehlert in Blankenburg, Germany, where they live with their two children Martha and Magnus. By merging their extensive experience in advanced design technologies with those of digital manufacturing, Callicott and Ehlert exploit the evolving threshold between complex 3D design and robust industrial methods.

CHRIS LEUNG

is an architect who has worked in private architectural practice and environmental engineering for ten years. He has worked on funded research projects at the Bartlett UCL that investigated innovative technology for low-energy and passive buildings. He has been involved in two inventions with patents pending for devices that integrate building fabric with passive responsive systems. His research explores how buildings and their envelopes can have dynamic responses to changes in the physical environment that surrounds them. His research work is pursued in a doctorate at the Bartlett sponsored by Haque Design + Research Ltd due for completion in 2010. He has been a partner in sixteen*(makers) since 2001.

EMMANUEL VERCRUYSSE

is a designer, fabricator and educator. Having previously studied furniture design in Belgium, Emmanuel completed his Diploma and Masters Degree at the Bartlett School of Architecture. He is currently running the CADCAM fabrication facility and is Diploma Unit 23 tutor at the Bartlett. Emmanuel's research work explores narratives of landscape and notions of wilderness through exploratory drawing and intuitive modes of design and fabrication. His work has been published in a number of journals. Emmanuel's passion for hand-drawing combined with an in-depth knowledge of both

traditional and digital fabrication techniques developed into preoccupation with the role of the digital as an augmentation of the analogue, and he continues to explore the production of highly crafted architectural elements designed intuitively through a combination of drawing, craft and digital technology.

BOB SHEIL
is an architect, founder member of sixteen*(makers), and Senior Lecturer at the Bartlett School of Architecture UCL, where he is Director of Technology and Computing, and has taught for over 17 years. He was programme director of the Graduate Diploma/MArch in Architecture between 2005 and 2009, and runs MArch Unit 23 with Emmanuel Vercruysse. In collaboration with his colleagues in sixteen*(makers), his teaching partners, research assistants and students, his work explores the evolving processes of production, digital technologies and craft. He has published a number of international peer-reviewed papers, and has lectured extensively in North America, Asia, and throughout Europe. In 2008 he led a £1m investment at The Bartlett setting up UCL's first Digital Manufacturing Centre. In 2011 he co-chaired the International conference FABRICATE at UCL, with Ruairi Glynn. He has edited two editions of Architectural Design, firstly *Design through Making* in 2005, and *Protoarchitecture* in 2008. In 2012 his reader on prototyping and making architecture with 18 essays by world-leading pioneers in the field, entitled *Manufacturing the Bespoke*, will be published by Wiley. His ongoing research *PerFORM* is to lead another full scale prototypical fabrication project, on this occasion to develop an experimental mobile performance space for the Central School of Speech and Drama in London.

PETER SHARPE
is a curator responsible for the art and architecture programme at Kielder Water & Forest Park in Northumberland. After graduating from Cardiff College of Art in 1982 he practised as a sculptural ceramicist, then taught in Gateshead following a move to the North of England. Since 1999 he has worked for the Kielder Partnership to deliver a series of high-profile commissions that investigate the overlap between art and architecture and the landscape, including James Turrell's Kielder Skyspace and Charles Barclay Architects' Observatory. A recent series of projects on the theme of shelter have included contributions from David Adjaye, sixteen*(makers) and American arts collective SIMPARCH. He contributes to the Arts Council's Turning Point Advisory Group and is also a member of their artistic assessment team.

SCANLAB PROJECTS
Whilst students in MArch Unit 23 at The Bartlett, UCL, Matt Shaw and Will Trossell pioneered the use of 3D scanning as an innovative visualisation media. Starting with their own home made kit, and later as approved users of a Photon on loan to UCL from FARO, both executed the first 3D partial scan of 55/02 (see p87) in June 2009 a year after the shelter was completed on site. They later returned and captured the entire structure in colourised data, from which the stills in this book are generated. Scanlab Projects were formed soon after and a vibrant enterprise was born that now works in collaboration with clients such as Vivienne Westwood, BBC, UKGov, Channel 4, The Science Museum, and many more. (scanlabprojects.co.uk)

55/02: PUBLICATIONS/ARTICLES/ EXHIBITIONS TO JULY 2010 / 55/02
A Manufactured Architecture in a Manufactured Landscape, A Photographic Exhibition / The Bartlett School of Architecture, UCL, 25 January–5 February 2010 / The Building Centre London, 22 February–12 March 2010 / University of Nottingham School of Architecture, 25 March–14 May 2010 / Sheil, B. 'sixteen*(makers)' in *Digital Architecture – Passages through Hinterlands* Glynn, R. and Shafiei, S. (eds) pp 96–101 / Spiller, N., 'Mathematics of the Ideal Pavilion' in *Architectures of the Near Future* (*Architectural Design*) Clear, N. (ed). pp124–125 / Pallister, J., 'Telling Stories' in *The Architects Journal* [27 August 2009 pp 22–29] / Stathaki, E. 'Refuge Collection' in *Wallpaper Magazine*. September 2009 Issue p63 / Stacey, M. 'Folding into the Landscape' in *Building Design* (Issue #1880 14 August 2009 pp 16–17] / Jones, W. 'Unconventional Shelter' in *A10* [#28 Jul/Aug pp 55] / Jones, W. 'Shelter '55/02 Kielder Park' in *Blueprint* [July 2009 pp 54–57] / Waite, R. 'First Look: Adjaye and others design new Kielder shelters' in *The Architects Journal* [7 May 2009], Sheil, B. From Making the Bespoke to Manufacturing the Bespoke in Sheil, B. Manufacturing the Bespoke. An AD Reader Wiley (2012), Dunn, N. Digital Fabrication in Architecture. Laurence King (2012), Armengaud, M. Abbattre son jeu. In D'Architectures , Paris (2010).

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