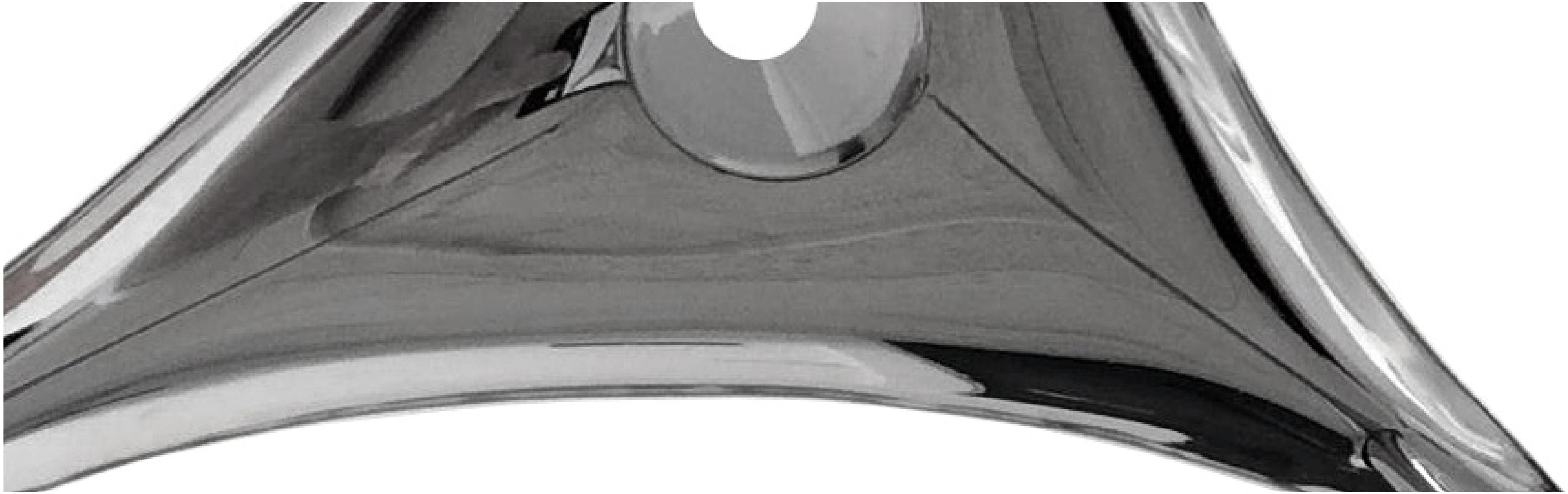

Northumbria University Architecture Portfolios

TETHERED CLOUD
HYDROFORMING A MONOCOQUE

Sebastian Messer RIBA

Northumbria University
NEWCASTLE

Designers (competition stages)	**Sebastian Messer (SM), Matthew Glover (MG) & Taylor Grindley (TG), with Stephen Newby (SN)**
Realisation	**Sebastian Messer with Stephen Newby**
Title	**Tethered Cloud**
Output type	**Design**
Venue	**n/a**
Curator	**Peter Sharpe, Kielder Art + Architecture Curator**
Function	**Sculpture + Landscape**
Location	**Kielder Waterside, Kielder Water and Forest Park, Northumberland, UK**
Client	**Kielder Forest and Water Park Development Trust ("the Trust")**
Competitors (stage 2)	**'Timelapse', David Rickard**
Practical completion	**5 February 2021 (anticipated)**
Dates	**April 2018 - February 2021**
Funding source	**Northumbrian Water**
Budget (competition stage)	**£14,000.00**
Budget (landscaping)	**£48,000.00**
Area	**50 sq.m**
Consultants	**Brian Rickman, Structural Engineer**
Collaborators	**Stephen Newby, fullblOwn Ltd.** **Martin Kay and Chris Wigmore, Bespoke Concrete Products Ltd.**
Contractor	**D.G. Walton**
Support/acknowledgements	**Adam Cosheril, Digital Lab, Northumbria University**
URL	**www.northumbriaarchitecture.com/research**

The Trust is a charity with directors/ trustees from Northumbrian Water, Forestry England, Calvert Kielder, Kielder Observatory Astronomical Society, Northumberland County Council, Northumberland Wildlife Trust and Northumberland National Park Authority.

Introduction

The "Tethered Cloud" sculpture was designed as a 'waymarker' in response to a two-stage, open competition organised by the internationally-renowned Kielder Art and Architecture (KA+A) programme on behalf of the Kielder Forest and Water Park Development Trust (hereafter "the Trust").

The proposed design was a response to the particularities of the site and reflective of the wider context of KA+A; from narrative(s) and precedent; and through dialogue in creating a team able both to design and fabricate the sculpture, defining and achieving the aesthetic objectives, within the client's budget.

The **original research** is in developing a new technique: this portfolio describes the process of technology transfer of the mould-less hydroforming manufacturing process(es), and 'scaling-up' to use in an architectural context. This research is distinctive as hydroforming has not previously been used in the construction industry for structural elements.

Rigour is demonstrated through an appropriate methodology; iterative-experimental model-making and prototyping, material and manufacturing testing, empirical observation, and evaluation. This method is a fundamental and systematic aspect of knowledge generation in art and design disciplines, and especially the case where the research imperative arises through an engagement with a material or a process (technology), as in this instance. This process is *evidenced* throughout the portfolio and the sculpture has achieved the purpose, as the largest, single-volume, mould-less, hydroformed structure fabricated to date.

The **significance** of the novel technique(s) developed by this research are:

1. in the practical *applications* for the fabricators/specialists (fullblOwn Ltd. and Bespoke Concrete Products Ltd.) who are expanding their ranges and the distinctiveness of their product offers.

   The potentia*l influence* of this research would be further experiments in structural uses of this lightweight technology in building components.

2. The *impact* [will be[1]] the sculpture installed at Kielder, near the Waterside Park at Leaplish, where it will be experienced by 40,000+ annual visitors. The design development has been documented on the KA+A website.
3. The design process has informed the ethos and mode of the author's Masters of Architecture design studio at Northumbria University. ◘

1 *The sculpture was originally planned to be installed in time for Easter 2020, but was postponed due to the first Covid-19 national lockdown. Installation has been rescheduled for first quarter of 2021.*

Research Imperatives

The research detailed in this portfolio describes the technology transfer and 'scaling up' of the manufacturing process(es) from their previous applications to an architectural context.

This leads to the first Research Question:

Research Question 1: *Can mould-less hydroforming be up-scaled to manufacture structural components?*

The technical aspects of this research cannot be taken in isolation, purely as an engineering problem and separate from the aesthetic requirements deemed of importance by the design team for the realisation of this sculpture.

The second part of this portfolio is a reflection on the designer's process, the artefact as an embodiment of knowledge and site-specificity, and of 'audiencing'.

This leads to the secondary Research Question:

Research Question 2: *How can a site-specific artwork be reconceptualised when it is placed in another context?*

Practice Research: Research through Design

Design as a method of research is a process of synthesis; an application of abductive inference (or 'best guess' approximations) as much as [or even more than] hypothesis testing (deduction) or of observation and extrapolation (induction). Abductive inference can be described as a cycling of intuition, reflection, and iteration (Wood, 2000: p. 52). Design then is the process, and result, of prioritising, judging, and forging connections (Kolko, 2010: p. 21).

Whilst the following portfolio addresses aspects of the design process under separate headings, in reality they occurred in parallel and dynamically weighed against each other in the *re*solution of those parameters in the final sculpture-artefact. ◘

Research Question 1:

Can mould-less hydroforming be up-scaled to manufacture structural components?

Research Context

The process of hydroforming is similar to inflating a single-skin[1] pneumatic structure, although for safety – and as described by the prefix 'hydro-' – water is used in preference to air[2] (the root 'pneu-' meaning lung or to breathe).

In commercial hydroforming, a negative/ female mould is used to shape the component, which is made by stretching the flat, metal sheet into the mould using differential pressure.

In industrial-engineering applications, larger hydroformed components are created by immersing the mould and the metal sheet to be shaped into a pool and using a small explosive to create the hydraulic pressure in the standing water. A similar process has also been used, to an extremely limited extent, to form decorative (non-structural) cladding panels for buildings.

As only one mould is used, rather than both male and female moulds required for metal-pressing of complex forms, the tooling can be cheaper, and the process can be used cost-effectively for more limited runs. However, use of a mould stretches the metal, unequally thinning the gauge of the metal in its final form (i.e. the more it is stretched, the thinner that resultant section of the metal).

1 pneumatic structures can be classified as either single or double skin. A single skin pneumatic structure is air-inflated, the pressurised air is contained within the volume. A double skin pneumatic structure is air-supported, that is the pneumatic element(s) are structural components which support a separate skin that creates the volume.

2 the pressures required to deform metal sheet are much greater than those required by flexible fabrics or films and, unlike air, water does not compress. Therefore any failure during the hydroforming process is just messy rather than explosive!

The fabrication of "Tethered Cloud" uses a *mould-less process*, unlike the commercial uses of hydroforming described above. In the mould-less process, the metal is not stretched, but gains its strength (just) through the three-dimensional deformation.

Pneumatic structures require the (differential) air-pressure to be maintained or the fabrics or films of which they are made will return to their flat form. Metal sheet(s) used in hydroforming retain the desired form when the pressure is removed. ◘

Originality

The originality in this research is in the application of the mould-less hydroforming process at an 'architectural scale', to form a single, structural component.

The concept of hydroforming is not itself new, indeed it is used as a cost-effective way to mass-produce complex structural components, such as door pillars and safety roll-cages in the car industry. However, that is a different manufacturing technique which uses a negative/ 'female' mould into which the metal is deformed.

The mould-less process was evolved by fullblOwn to produce sculptures and furniture. In some instances, these have been combined as self-similar components to form larger-scale sculptures, but it is the form of these in combination (as, for example, a sphere or a torus) which enable the structures to be self-supporting. It is not the inherent capacity of the three-dimensional forms of the components to act structurally [which is what is meant (above) by 'architectural scale'] and is which demonstrated by the "Tethered Cloud".

The Technical Parameters

The design of pneumatic structures all tends towards the spherical, in which the air pressure applies to the surface equally and the largest volume is contained by the smallest surface area. A sphere is not necessarily the most appropriate or practical volume to occupy and, as for example with a world map (fig. 1), it is difficult to (dis)assemble a three-dimensionally curved form [to, or] from two-dimensional planes. Consequently, pneumatic structures diverge from the spherical 'ideal' to a greater or lesser extent to meet their functional requirements and the manufacturing constraints for forming the skin(s). As fabrics and films are flexible, when joined together they do not have to remain flat (two-dimensional) surfaces when joined/ seamed.

The skin of the Tethered Cloud sculpture is formed from two flat sheets of steel, joined by a continuously welded, edge seam. Therefore, the final, three-dimensional form is purely the consequence of the two-dimensional cutting pattern and the hydraulic deformation of the metal in three dimensions. We have termed this 'flat to form' geometry.

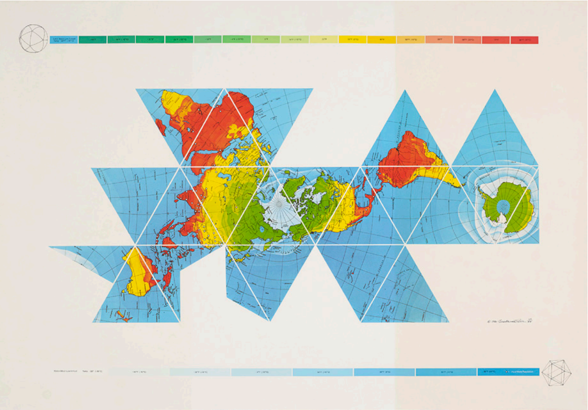

Fig. 1 Richard Buckminster Fuller (1980) Dymaxion World Map

Buckminster Fuller first published the Dymaxion World Map, a projection onto the surface of an icosahedron, in Life Magazine (1 March 1943).

image: https://www.atlasofplaces.com/cartography/dymaxion-world-map/

The Aesthetic Parameters

The initial, aesthetic objective was to minimise or eliminate the appearance of edge 'crimping'. This occurs when there is 'excess' material in the cutting pattern which then ripples as the form is inflated.

In much of fullblOwn's previous work, this crimping effect is actively and intentionally sought, as integral to the aesthetic effect of the finished object. For "Tethered Cloud" we aimed to create as smooth a surface as possible to emphasise the reflections rather than drawing attention to the reflective surfaces.

However, we also wanted the sculpture to be 'self-explanatory', i.e. for the fabrication and assembly process(es) to be part of the finished artefact's aesthetic, rather than disguised or hidden. This sensibility is carried through into the second element of the landscape ensemble, the concrete seats, cast in a two-part mould taken from a hydroformed steel positive.

The Mould-less Hydroforming Process

The process of 'form-finding' (of the 'flat to form' geometry) is analogous to tailoring, where a 2D material is cut to fit around a three-dimensional body. The final form results from the cutting pattern, which defines the shape in two dimensions and limits the extent to which it can deform in three dimensions, and by the pressure applied differentially to the inside and outside faces; the latter moderates the rate of expansion. Applying an external pressure ensures the metal deforms evenly, as the irregular (plan) form would otherwise offer differential resistance (the corners, with the least material/ surface area, being the most resistant/ least malleable) risking stretching/ thinning areas of the metal skin.

Originality (continues)

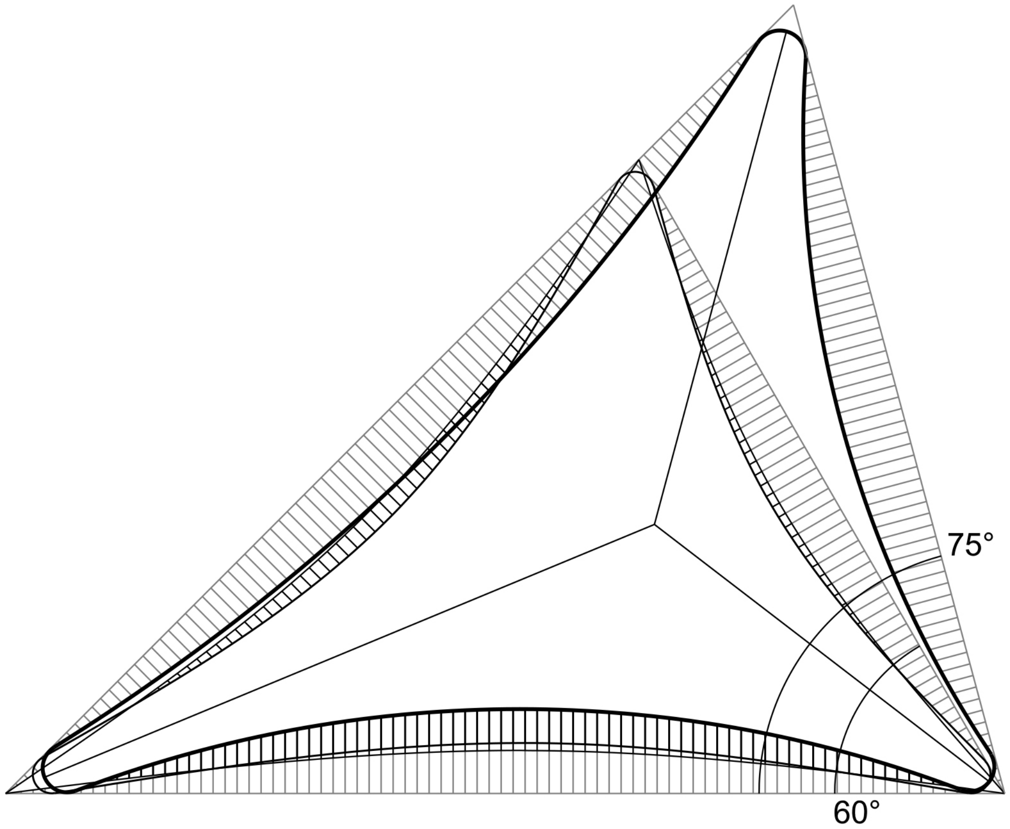

Fig. 2

Fig. 3

Fig. 4

As the volume is inflated, the welded, edge seam is on the neutral plane (in this design that then forms a horizontal datum, or the 'false horizon', above which the sculpture reflects sky and below which it reflects what is on the ground and around it). This seam is subject to the hydraulic pressure pushing the two sheets of metal apart vertically, and is deformed horizontally, being pulled inwards towards the centre of the volume. Therefore, the metal is prone to 'crimping' where excess material gathers.

The cutting pattern for Tethered Cloud was refined through a series of iterations and scaling-up to remove 'excess' material and therefore create the least visual distortion in the reflections for the proposed shape (figs. 2 & 3).

It is this process which gives us the 'flat to form' geometry (see Prototyping).

The consistency of the continuous welding can also introduce weaknesses and stresses; where the weld is thicker it is more resistant to deformation than the metal on either side of it which is exaggerated as the volume inflates. Consistency is more difficult to achieve in mild steel than in stainless steel, so the welds on the maquettes/ prototypes are both more apparent and likely to introduce visual 'faults' – such as bulges or puckering in the surfaces immediately adjacent to the welded seam (fig. 4) – than in the final stainless steel version.

Fig. 2 (top left) evolution of the cutting pattern (SM)

Fig. 3 (bottom left) first 1:8 scale stainless steel maquette showing distortion caused by excess material in cutting pattern. (SM)

Fig. 4 (bottom middle) 1:2 scale mild steel maquette showing puckering along the weld seam. (SM)

Future Applications

The initial limitation to increasing the scale of mould-less hydroformed objects are the standard sizes of metal sheet forming the top and bottom skin. Oversized sheets can be obtained with thicker gauges, although a bright polished finish is not available as standard in oversized sheets. If this were an aesthetic requirement for future components, it would require labour intensive hand polishing post-fabrication.

fullblOwn Ltd. constructed a new, larger rig with which to apply the external pressure to the full-sized sculpture. The ultimate parameters to 'scaling up' are therefore the ability to generate the balancing pressure and to be able to apply this to the volume during inflation to ensure the internal water pressure deforms the entire volume evenly rather than stretching it at the point of maximum deformation/ least resistance. This was demonstrated by deliberately continuing to inflate the 1:2 scale maquette until it 'failed'; the weld at the convergence of the standing seams (the point of maximum deflection) proving the weakest point (see figs. 33 and 34, page 15).

Bespoke Concrete Products Ltd. specialise in the production of short runs of high quality, architectural and sculptural concrete, and casting street furniture. The most significant element of cost in one-off and limited production numbers is in making the moulds. Several materials are used to produce moulds depending on their durability/ re-useability and lifespan, and the detail/ complexity of the design. The positive – from which the mould is cast – therefore is a major investment as new/ replacement moulds are made from it repeatedly. The hydroforming process offers the opportunity for lightweight, 'organically'-shaped, positives to be made efficiently.

A number of approaches were initially considered for making the mould from the "Tethered Cloud" maquette, including:

- A one-stage process, making the mould directly using the hydroformed steel original. This was discounted because of the amount of work required to modify the steel positive – grinding away the edge weld to separate the top and bottom halves, and welding clamping tabs to the two parts; concern about the halves 'spreading' – the monocoque construction gains strength from the stress in the skin; and the thin gauge of metal used for hydroforming may not be able to hold the weight of liquid concrete.
- A sand box is a traditional two-stage process. However, the mould is remade for each casting and the process is less accurate.

The adopted solution is illustrated on pages 13 & 14.

The primary concerns about transferring of the form to a different material and process were:

- Air would be trapped, or the liquid concrete would not flow into the extremities of the form and the casting could be incomplete.
- The proportions of the form could cause the mass (unreinforced) concrete to break when it was removed from the mould.

To reassure the client, design team and Bespoke Concrete about the appropriateness of the process, materials, and quality for proceeding to the full-sized version, these concerns were dispelled through the half-scale prototype. ◘

Rigour

Rigour is achieved in *practice research* principally through the empirical-iterative process which, in this instance, was primarily through physical, three-dimensional prototyping (pp. 7 & 9-15).

Prototyping

The structural engineer, Frei Otto, at the Institute for Lightweight Structures, pioneered research in tensile and pneumatic structural design through an empirical approach, making physical models and then deriving generalizable principles from analysing the models. The experimental, iterative methodology, prototyping, material and manufacturing testing, analysis and evaluation, informs the "Tethered Cloud" design development.

The design process proceeded empirically; from paper maquettes to find the initial form and the 2D cutting pattern, this was then further refined at each increase in scale, trimming increasingly smaller radius arcs into each side to minimise visible crimping (page 9), thus advancing an intuitive understanding of the 'flat to form' geometry and the relationship of the 2D cutting pattern to the 3D form. The gauge of the steel sheet was also tested empirically, and to scale, as the metal's thickness partly determines its resistance and therefore the pressure(s) needed and consequently the final form it achieves.

For the Stage 2 Competition presentation, a 1:8 scale model was made using a bright polished stainless steel (fig. 5). This demonstrated the the production process could satisfy the aesthetic objectives.

Following the commission, mild steel prototypes of increasing scale (1:8, to 1:4, to 1:2, to 1:1) were fabricated prior to the final version in stainless steel.

To achieve the full-scale production for the "Tethered Cloud", the top and bottom faces are assembled from multiple sheets joined with welded 'standing' seams, perpendicular to the plane of the metal skin (page 12).

Fig. 5 Competition Stage 2
1:8 scale model (SM + SN)

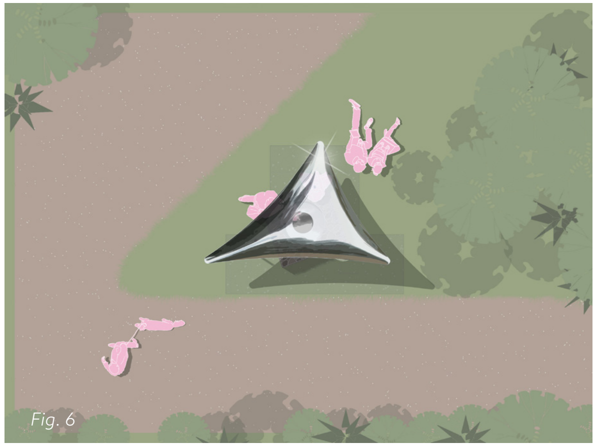
Fig. 6

Fig. 6 (above) Competition Stage 2 plan showing the form of the 'Tethered cloud' derived from the original competition site. (MG)

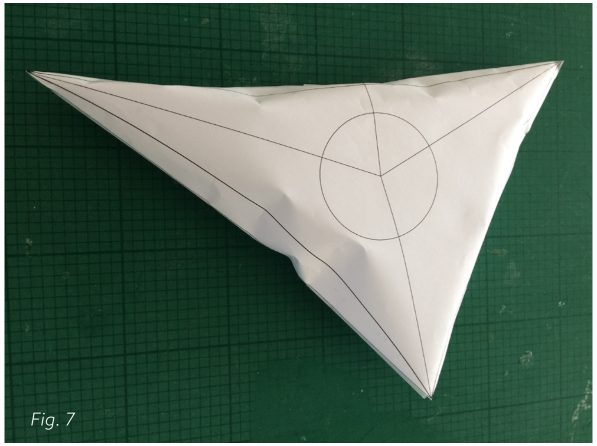
Fig. 7

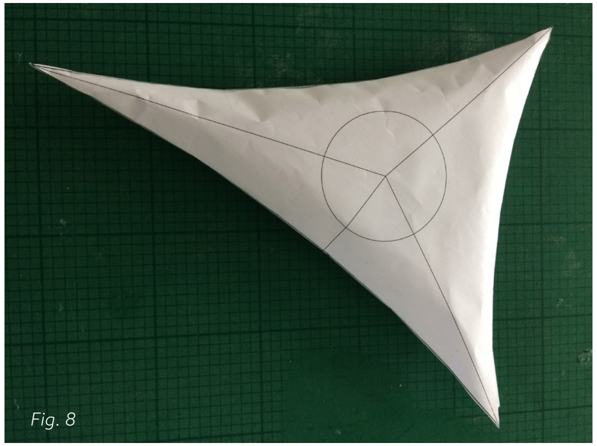
Fig. 8

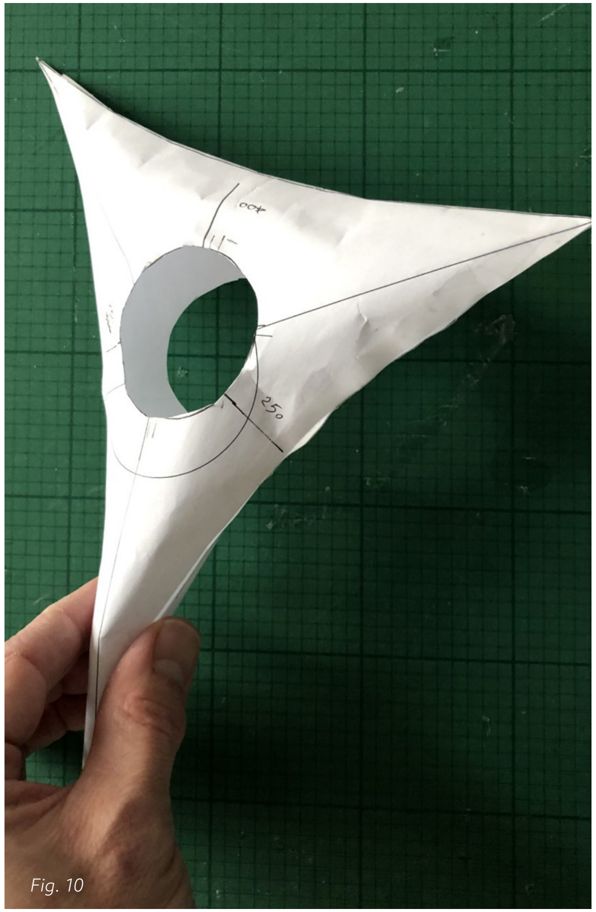
Fig. 10

Figs. 7-10 Development of the initial cutting pattern through paper maquettes. (SM)

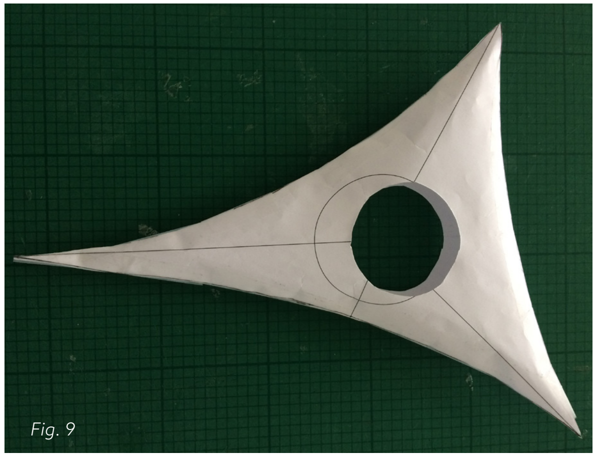
Fig. 9

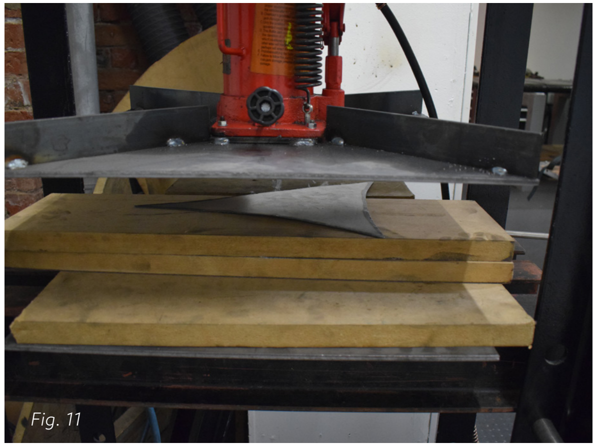

Fig. 11

Fig. 12

Fig. 11 (above) the flat form of the 1:8 scale mild steel maquette in the rig prior to hydroforming.

Fig. 12 (middle right) Steve Newby hydroforming the 1:8 scale mild steel maquette. The hand pump increases the water pressure inside the volume and the hand press controls the rate of expansion. (SM)

Figs. 13-15 (below, l-r) the oculus is cut out of the hydroformed 1:8 scale mild steel maquette. (SM)

Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17

Fig. 18

Fig. 20

Fig. 19

Fig. 21

Figs. 16-19 (clockwise)

- *the flat plates for the 1:2 scale macquette next to the 1:4 scale hydroformed maquette.*
- *the standing seams formed with a break press prior to welding.*
- *welding the edges.*
- *the fully welded 1:2 scale mild steel maquette prior to hydroforming.*

Fig. 20 (top right) the 1:2 scale macquette in the rig during hydroforming.

Fig. 21 (bottom right) the 1:2 scale mild steel maquette following hydroforming.

Fig. 22

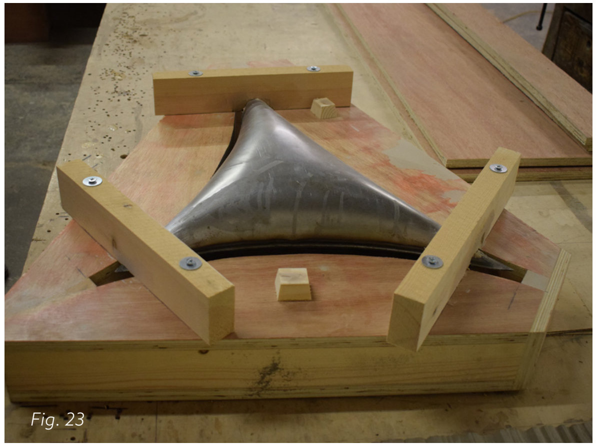

Fig. 23

Fig. 24

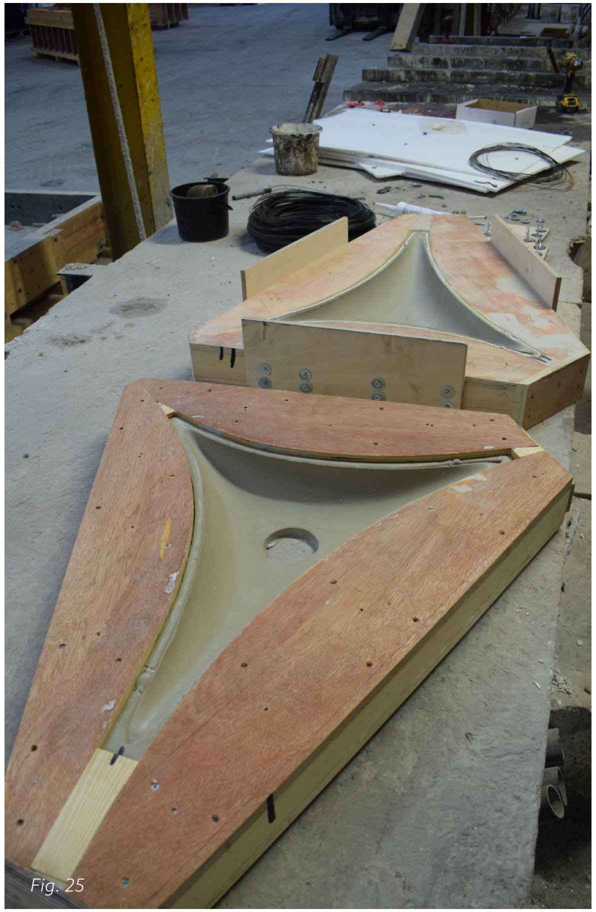

Fig. 25

Figs. 22-25 (above l-r)

- *mixing the liquid epoxy which forms the mould.*
- *the mild steel positive in the wooden mould former.*
- *pouring the liquid epoxy into the mould former.*
- *the final two part mould.*

Fig. 26 (lower middle) fixing the top and bottom parts of the mould together.

Fig. 27 (lower right) pouring the concrete mix into the mould on a vibrating platform. The platform agitates the liquid concrete into the full extents of the mould and any air bubbles created in the process of placing the concrete are vibrated out of the mix.

Fig. 26

Fig. 27

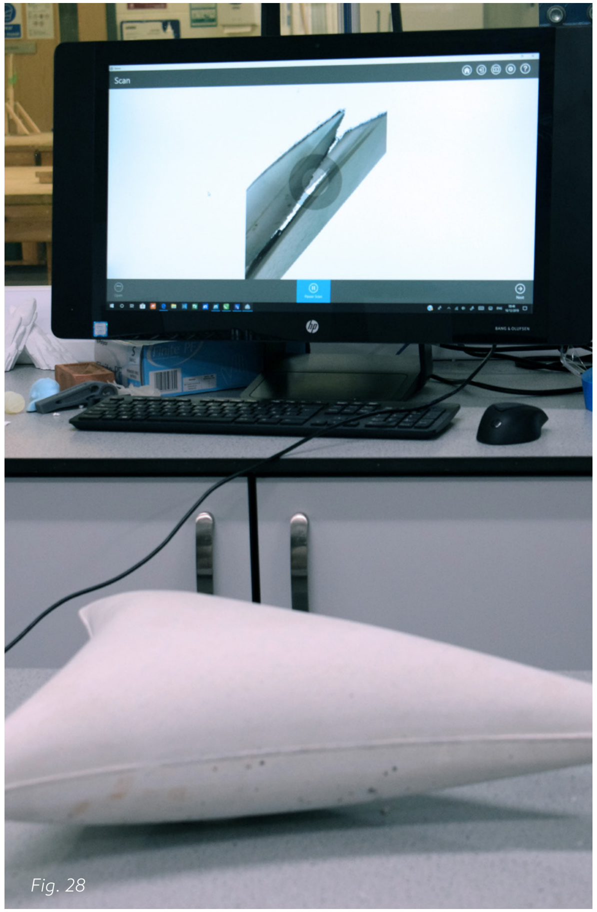

Fig. 28

Fig. 29

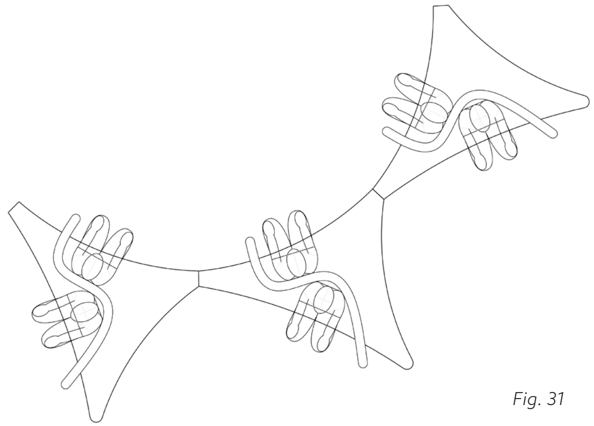

Fig. 31

Figs. 28-29 (above l-r)

3D scanning the concrete cast cloud to calculate the volume. (SM)

Fig. 30 (lower middle) the horizontal joint in the moulds (coinciding with the edge weld on the steel positive/ maquette, will be left unpolished as a 'tell' of the construction process. The epoxy mould is so accurate, surface scratches on the steel original are visible on the surface of the concrete casting. These striations will be removed from the final version with a light, acid wash. (SM)

Fig. 31 (top right) sketch plan showing multiple concrete seats combined and with 'kissing seat' backrails. (SM)

Fig. 32 (lower right) testing the proportions of the concrete seats. Following this, it was agreed the full-sized seats would be 75% (rather than 50%) of the size of the final steel 'Tethered Cloud'. (SM)

Fig. 30

Fig. 32

Rigour (continues)

Fig. 33 (top) the 1:2 scale mild steel maquette undergoing the second inflation to 'test to destruction'. (SM)

Fig. 34 (bottom) the welding at the convergence of the three standing seams (the point of maximum deformation) fails. (SM)

Fig. 33

Fig. 34

Unlike the edge seam, which resists vertical pressure by being compressed horizontally (i.e. it deforms in only two dimensions), the standing seams will be on the curved faces and are therefore required to distort three-dimensionally (vertically and horizontally).

10 mm perpendicular/ 'standing' seams[1] were introduced and tested at the at 1:2 scale prototype. When the volume is inflated the seams curved outwards. It was observed the 'standing' seams:

- maintained a true line, and did not introduce a wave, or 'wobble', along their length.
- remained narrow and 'tightly' formed nearer to the arises but did begin to 'open up' and take on an inverted 'V' shape towards centre/ point of maximum deformation. (In fact, it was at this point of maximum deformation, where the three seams converge, that the weld ultimately failed under pressure testing.) As the area where the seams visibly had begun to spread will be removed from the final sculpture to form an oculus, we determined that the extent to which this had occurred was still acceptable at the overall depth for the designed volume.
- introduced tensions in the surface which we had not anticipated that constrain the expansion of the volume. This had two effects:
    1. the shortest side/ edge of the volume was visibly distorted perpendicular to the horizontal/ edge seam, which it had not in the later 1:8 scale, and 1:4 scale prototypes. We decided therefore to modify the cutting template for the 1:1 to decrease further the radius of this arc.
    2. the curved panels slightly 'pillowed' parallel to the standing seams, creating a quilt effect rather than the smooth, continuous curve to the skin for which we hoped[2].

Messer and Newby decided to undertake a second inflation to 'test to destruction' this prototype (fig. 33). This increased the overall depth of the volume from 200 mm to 260 mm before the weld failed at the convergence of the three seams (fig. 34). ◘

1 The standing seams on the full-sized "Tethered Cloud" will also be 10 mm, so any spreading of the joint will be less apparent than on the 1:2 scale prototype.

2 to be reviewed again with the 1:1 scale maquette.

Significance

Kielder Art + Architecture

The visual art programme at Kielder was initiated by the Kielder Partnership, forerunner organisation to the current Trust, in 1995. Initially it commissioned sculptures and environmental art projects, including Chris Drury's "Wave Chamber" (1996), and James Turrell's "Kielder Skyscape" (2000). Following Isabel Vasseur's "Seeking Shelter" 1998 Report, the programme expanded to include experimental architecture commissions.

The first such architectural commission, Softroom's "Belvedere" (1999) was the winner of the RIBA Stephen Lawrence Prize 2000 (for the best building with a construction budget of less than £1m). Subsequent, award-winning architectural projects at Kielder include, Nick Coombe and Shona Kitchen's maze "Minotaur" (2003), winner of a Civic Trust and an RIBA Regional (NE) Award in 2004; Charles Barclay Architect's "Kielder Observatory" (2008), winner of a Civic Trust and an RIBA Regional (NE) Award in 2009; and sixteen*(makers) shelter "55/02" (2009), winner of an RIBA Regional (NE) Award in 2010.

Kielder Water & Forest Park received approximately 410,000 visitors in 2016[1], generating £24.4m for the local economy. "Tethered Cloud" [will be] installed on the Lakeside Way, the pedestrian path, cycleway, and bridle path that circumnavigates the reservoir, and adjacent to Waterside Park, the main site of holiday accommodation and visitor facilities and will therefore have the highest possible footfall. ◘

1 source: www.chroniclelive.co.uk/news/history/northumberlands-kielder-water-35-facts-13097792, accessed: 07 December 2018

Fig. 35

Research Question 2:

How can a site-specific artwork be reconceptualised when it is placed in another context?

Research Context

The competition brief for a 'waymarker' detailed a specific site – at a junction of a forest road and a new cycle path, which make up part of the Lakeside Way that circumnavigates the whole reservoir – and specific function(s) – to replace a multitude of aged signage and to provide a resting place for walkers and cyclists. The 'waymarker' structure would contribute to the KA+A programme and therefore had to be a distinctive landmark in its own right (figs. 35 - 37). It also had to have a lifespan of 10 years with minimal maintenance required and to withstand the extreme winter weather experienced by the Kielder Water & Forest Park. ◘

Fig 35. (previous page) Stage 2 Competition perspective: view looking north towards the Tethered Cloud on the original competition site. (MG)

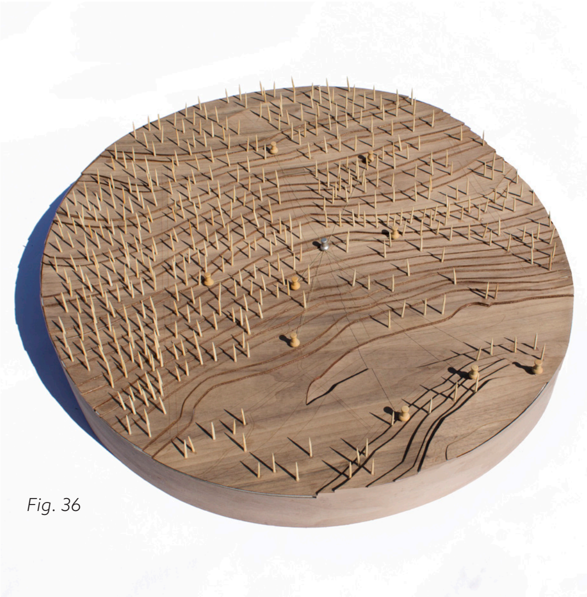

Fig. 36

Fig 36. (left) Stage 2 Competition site model, showing the lines of sight towards Tethered Cloud from the wider area. (TG)

Fig. 37

Fig. 37 (right) Stage 2 Competition perspective: view north east on the approach from the lower cycle track. (MG)

Fig. 38

Fig. 39

Design Process

Following the two-stage competition selection process, the client wished to proceed with the design of the "Tethered Cloud" but on a new site, with different spatial characteristics, and without the functional requirement of 'waymarking'.

This led both the designers and client representatives to reflect on what was significant to the design process (and the essence of this design) versus what is signified by the final artefact and necessary to the aesthetic experience. That is to what degree can tangible artefacts embody information and communicate that knowledge to third parties?

Although the artefact remains the same – the form of the "Tethered Cloud" was 'frozen' following the two-stage competition, and due to the empirical-iterative making process required for refining the cutting pattern as it is scaled-up – and its relationships: to the site (to which it is no longer designed to 'fit' - see fig. 6), and to the viewer/ audience (who, in this instance, are now invited to look at it, rather than orientating themselves around it, or looking out from it to another destination). Both relationships are fundamentally altered by transposing the artefact to a new site.

Retrospectively therefore, Messer had to construct a new context (metaphorically and physically) around the 'orphaned'/decontextualised "Tethered Cloud" to re-establish its significance and site-specificity. (The process of decontextualisation-recontextualisation is illustrated in figs. 38 & 39, and on pages 21 and 22).

Fig. 38 (top) sketch of the Tethered Cloud emphasising the aspect of a 'lookout' on a site overlooking Kielder Waterside. (SM)

Fig. 39 (bottom) sketch of the Tethered Cloud emphasising the aspect of 'gathering' near the final site. (SM)

Design Process (continues)

In the 2020-21 Masters of Architecture design studio led by Sebastian Messer at Northumbria University ("Material Poetics"), this condition is described with reference to Angus MacPhail and Alfred Hitchcock's concept of the 'MacGuffin'. In script-writing a 'MacGuffin' describes a plot device which motivates the protagonists' actions but is of only incidental interest to the audience. In architectural/ sculptural terms, the 'MacGuffin' refers to an object which fundamentally is unaltered but the context in which it is located changes (physically, economically, socially, etc.), and therefore the meanings which can be 'read' from the artefact are also changed by the audiences' contextual perceptions of it.

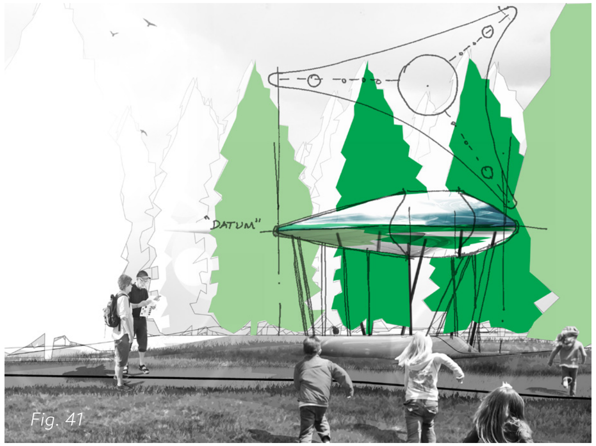

Fig. 41

Fig 41 Competition Stage 1 sketch proposal (SM + MG)


Fig. 40

Fig. 40 the "Temple of the Sun" is in fact a complex of singular spaces, each dedicated to a specific element – wind, sun, earth – linked vertically by a watercourse, as a manifestation of the transubstantiation of the water as lifeblood of the living rock, giving life to the mountaintop city. (SM)

Design Process: Narrative

It is a banal observation that the Kielder landscape is permeated by water, but the design team were interested in the tensions between the man-made environment – designed to commodify the water – and how that water constantly threatens to undermine and recuperate the functional landscape. The reservoir, built to service anticipated needs of heavy industry which had largely disappeared by the time the reservoir was completed, creates a horizontal plane and a view of the sky dome, the extents of which are unusual in the region, enabling the weather to be 'watched' in real time and panoramically. Messer et al's intuitive response to the KA+A's brief therefore, was to (re)make that horizontal datum (fig. 41) to draw attention to this expanse. The contrast between the brightness of the reflected sky and the darkness of the spruce forest on the surrounding hillside providing the 'landmark' effect from a distance. (figs. 35-36) The sculpture also illustrates the ambiguity between the man-made, the 'artificial' object, and the 'natural' (but equally man-made) landscape, by perceiving the latter through the former as a 'viewing machine'.

Design Process: Precedents

The initial sketches circulated quickly between the design team began to focus on water as a symbolic agent of transformation and referencing the "Temple of the Sun" (fig. 40) at the Inca city of Machu Picchu (in present day Peru).

In parallel with the narrative idea of water as transforming the viewers' *experience* of the sculpture, Messer et al. also began collaborating with the artist-maker Steve Newby, of fullblOwn Ltd., to develop the hydroforming process physically *to shape* the sculpture using the power of water.

Messer et al. interpreted the brief for a 'waymarker' – an object whose function is displaced, related to somewhere which it is not, and 'occupied' only as a consequence of travelling to some other destination – as an opportunity to bring some of the existing art and architecture projects into a dialogue with each other.

Therefore the "Tethered Cloud" alludes visually to the 'negative space' under Charles Barclay Architect's "Observatory" (fig. 42), which traces the silhouette of the distant hills with a timber sky; to the 'funhouse-mirror' façade of Softroom's "Belvedere" (fig. 43); and to the oculus in James Turrell's "Kielder Skyspace" at Cat Cairn, which 'solidifies' a disc of sky through its oculus within a man-made cave.

The design of the "Tethered Cloud "was a metaphorical response to the wider context; alluded to precedents conceptually (the Temple of the Sun) and materially (Belvedere, Skyspace); formally it was developed with the geometry of the (original, competition) site in conjunction with the empirical, iterative making process as the 'flat to form' geometry was refined.

Fig 42. Charles Barclay Architects (2008) Kielder Observatory

image: http://cbarchitects.co.uk/wp-content/uploads/2013/07/KIELDEROBSERV_IMAGE_01.jpg

Fig. 43 Softroom (1999) Belvedere

image: https://www.softroom.com/projects/kielder-belvedere

Fig. 42

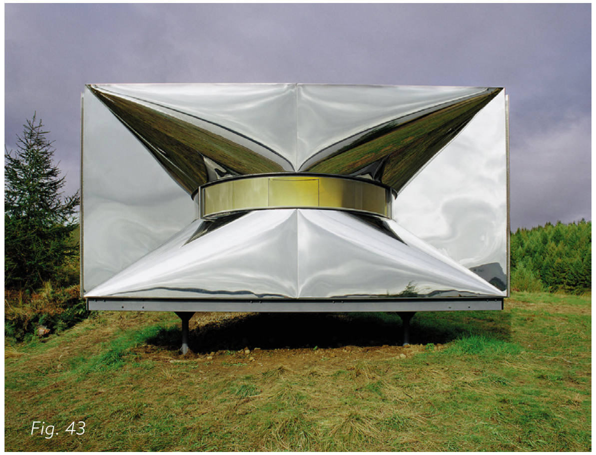

Fig. 43

Design Process (continues)

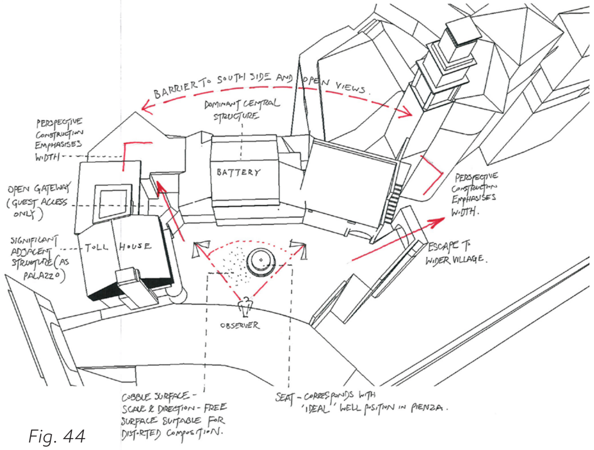

Fig. 44

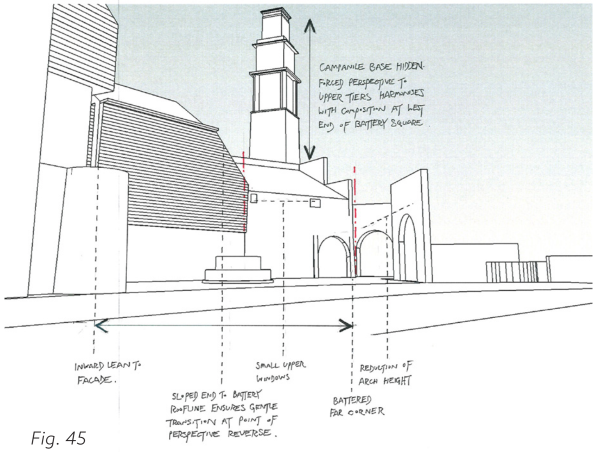

Fig. 45

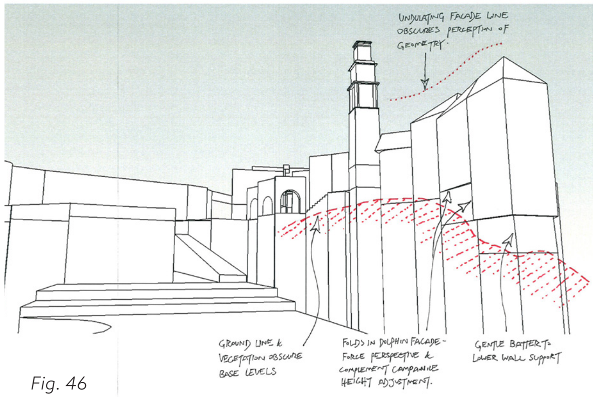

Fig. 46

Although it is not necessary to know about the conceptual process by which the artefact was designed in order to experience it, those considerations (described on pages 19 and 20) could be accessed by the visitor or an art critic and may enhance the aesthetic appreciation of the sculpture. There are two further aspects of the design which are important for the visitors' engagement and comprehension of the artefact:

1. Messer et al. wanted the fabrication process(es) to be 'read-able' directly from the sculpture. This is an important consideration for understanding the artefact(s) at different scales/ proximities (figs. 30 & 33).

2. The original requirement for the 'waymarker' was also to provide a resting place. This aspect of the brief was strengthened, so the "Tethered Cloud" was recontextualised as a focus for 'gathering' (see figs. 39 & 48-50). That is, the visitor is led by the landscaping towards an encounter with the sculpture, instead of it being a lookout at the landscape.

The new landscaping is designed to conceal where the "Tethered Cloud" meets the ground (figs. 47 & 51) - similar to Battery Square obscuring the base of the Campanile at Portmeirion[1] in order to accentuate the bell-tower's height (figs. 44-46). The 'stockade' thus makes the scale of and/or distance to the 'Tethered Cloud' ambiguous until you enter the gathering space. ◘

Fig. 47 (right) sketch of the proposed Gathering Space. Approaching the 'Tethered Cloud' the scale is deliberately ambiguous. (SM)

Figs. 44-46 (left) analysis of the Campanile composition at Portmeirion (Francis Ellis)

Figs. 48-50 (overleaf, left) three phases of developmental models showing the evolution of the landscaping proposal for the gathering space around the 'Tethered Cloud' sculpture. (SM)

Fig. 51 (overleaf, right) Planning Application visualisation of the final design for the gathering space. (TG)

Fig. 47

1 A similar effect occurs with the Cleveland Street elevation of the General Post Office Tower (now British Telecom Tower) in London, which Messer recalled observing whilst he studied at UCL.

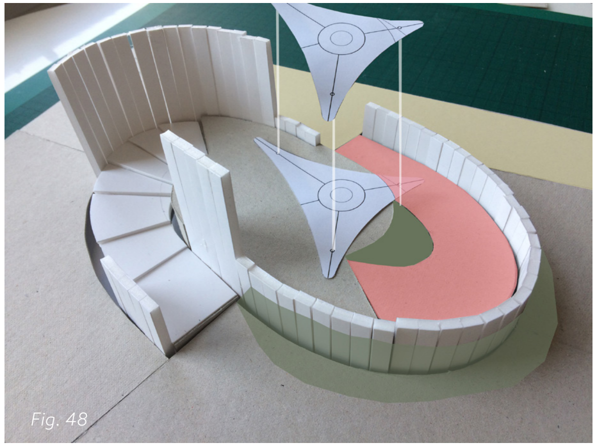

Fig. 48

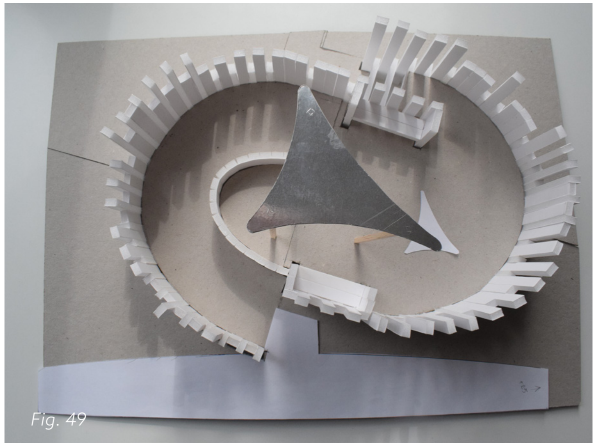

Fig. 49

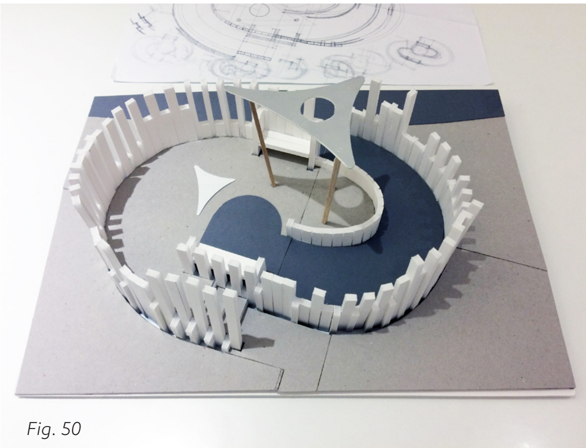

Fig. 50

Fig. 51

Conclusions

Research Question 1: *can mould-less hydroforming be up-scaled to manufacture structural components?*

The empirical-iterative design process demonstrates the mould-less hydroforming technique can be scaled-up to an 'architectural scale' in order to form lightweight structural components. An application of such components is demonstrated by the "Tethered Cloud" sculpture. The research and design development has shown the scale of such components need not be limited by sheet metal sizes, only by the size of the fabricator's rig for controlling the pressure during the hydroforming process.

The hydroforming process also offers the posibility to create durable, 'organically'-shaped, positive formers efficiently for casting processes.

Research Question 2: *how can a site-specific artwork be reconceptualised when it is placed in another context?*

An artefact can communicate knowledge which is inherent (*embodied*) in the object through 'tells' which exhibit (*exemplify*) the making process... when the designers and makers decide this is a desirable attribute for the artefact.

It is not necessary for the viewer/ audience to be aware of the metaphors/ narratives, the precedents, and the context/ site influencing the designer, but a viewer's awareness of these can add to the aesthetic appreciation (and the artefact's *expression*) and apprehension. As at the "Temple of the Sun", where the Inca's world-view (perception of the mountain as 'alive') is embodied in both its construction and the watercourse ('life-blood') running through each of the spaces, a deeper understanding of the designer's motives can 'unlock' further levels of comprehension.

When an artefact is decontextualised (for example, displayed in a museum) then the original spatial and/or functional relations and meanings of the artefact are reduced or lost, even though the object itself is unaltered. However, as discussed in the application of the concept of a 'MacGuffin' to an artefact, the object is ***re***contextualised in its *new* surroundings. As demonstrated in the second part of this portfolio, an artefact can also be recontextualised consciously and given different emphases through a critical reappraisal of the multitude influences on the design and 'tuning' the context.

In this instance (the design considerations for "Tethered Cloud") the movement vectors around the original competition site are entirely irrelevant in the new location, although the "Tethered Cloud" still has a 'memory' of that footprint. The empirical-iterative process of refining the 'flat to form' geometry becomes more significant. The connection between form and function ('waymarker') is therefore reduced while the connection between form and making process is emphasised. The original, primary function of the 'waymarker' is supressed entirely by the new siting. Secondary functions in the competition brief: as a 'look out', is transferred to the immediate, designed enclosure; while the function of a resting place is accentuated as a gathering space by the new context.

"Tethered Cloud" gains an 'agency' in this new context. The physical presence of the artefact creates a changed context that catalyses a different approach to the wider landscape, allowing a more natural and diverse flora to replace the mown grass which currently covers the site. ◘

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