Author: Robert Sheil of sixteen*(makers)
Research Output 2: *Kielder Residency*

Co-Authors: Phil Ayres, Nick Callicott, Chris Leung

Output Type: Design

Design and Production of Artefact: *Kielder Residency*

Media: Aluminium sheet, thermo activated sensor array and pistons, gas return springs, microprocessor, dedicated software

Dimensions: Variable

Locations: Kielder Park, Northumbria, UK

Curator: Peter Sharp, Kielder Partnership's Art and Architecture Programme

Dates: 2005 – 2007

Funding: Kielder Partnership's Art and Architecture Programme

300 Word Summary

Questions/Aims/Objectives

The research focuses on how understandings of growth and adaptation may drive the design, manufacture and performance of built environments, involving the interdependent design practices of representation and making.

Contexts

The research occupies the increasingly connected worlds of digital and analogue design. The majority of related research in 'evolutionary' design processes (notably Fraser and Bentley) has concentrated on the role of computational representation; the Kielder Residency positions realization as equivalent to representation.

Methods/Description

Variably dimensioned work comprises aluminium sheet, thermo-activated sensor array and pistons, gas return springs, and microprocessor with dedicated software. Manifest as an assembly of sensory probes, micro-environmental data from selected plots was gathered and recorded over time while being simultaneously responsive to data fluctuation through passively activated mechanisms. As a method of validating the 'real' against the 'ideal', the actual behaviour of the assembly was captured and mapped upon the computational model programmed to simulate behaviour by inputting data numerically. Rigorous methodologies (Phil Ayres, 'Getting Specific', in *Design Through Making*, Robert Sheil (ed.), special issue of *Architectural Design* v. 75, n. 4) catalogue a circular process in assessing the design and performance of responsive artefacts while advancing the notion that adaptable architecture may become synthetic with its environment and energy-efficient.

Dissemination/Esteem

Funding: Art and Architecture Partnership at Kielder (commissioners of works by artist James Turrell and architects Softroom).

Solo exhibitions: The Building Centre, London, 2006.

Reviews: W Jones, in *Blueprint*, 248 (2006).

Publications: By sixteen* (makers): one joint referreed paper by Sheil and Leung, 'Kielder Probes', in *Smart Architecture Conference Proceedings* (ACADIA), Savannah College of Art and Design, 2005; two additional refereed papers by Ayres.

Talks: six international and four national.

Authorship

As part of the design/making practice sixteen* (makers), Ayres, Callicott, Leung, Sheil all contribute equally to the research.

Image 1

General Description

In October 2003, sixteen*(makers) were awarded an architecture residency by The Art and Architecture Partnership at Kielder (AAPK) of Northumbria, UK. This organization is well known for commissioning works such as the 'Belvedere' by Softroom and the 'Skyspace' by James Turrell. Coordinated by Peter Sharp, AAPK consists of a number of large public bodies, including The Forestry Commission, Northumbrian Water and Tyndale District Council. Together they manage a land area of 62,000 ha centred on the UK's largest reservoir and surrounded on all sides by one of Europe's largest managed forests. (image 1)

In their appointment, AAPK were explicit that no architectural outcome was expected, but that a role for architecture in Kielder should be explored. Subsequently, the research began by exploring how an architectural design process could be challenged and informed by the site itself. Hence, our work focused on how understandings of growth and adaptation may drive the design, manufacture and performance of built environments. In this regard, the artefacts designed in the course of the project adopt passive energy and may be adapted to any location within temperate climates. The body of work as a whole involves the interdependent practices of design through representation and design through making, and occupies the increasingly connected worlds of digital and analogue design.

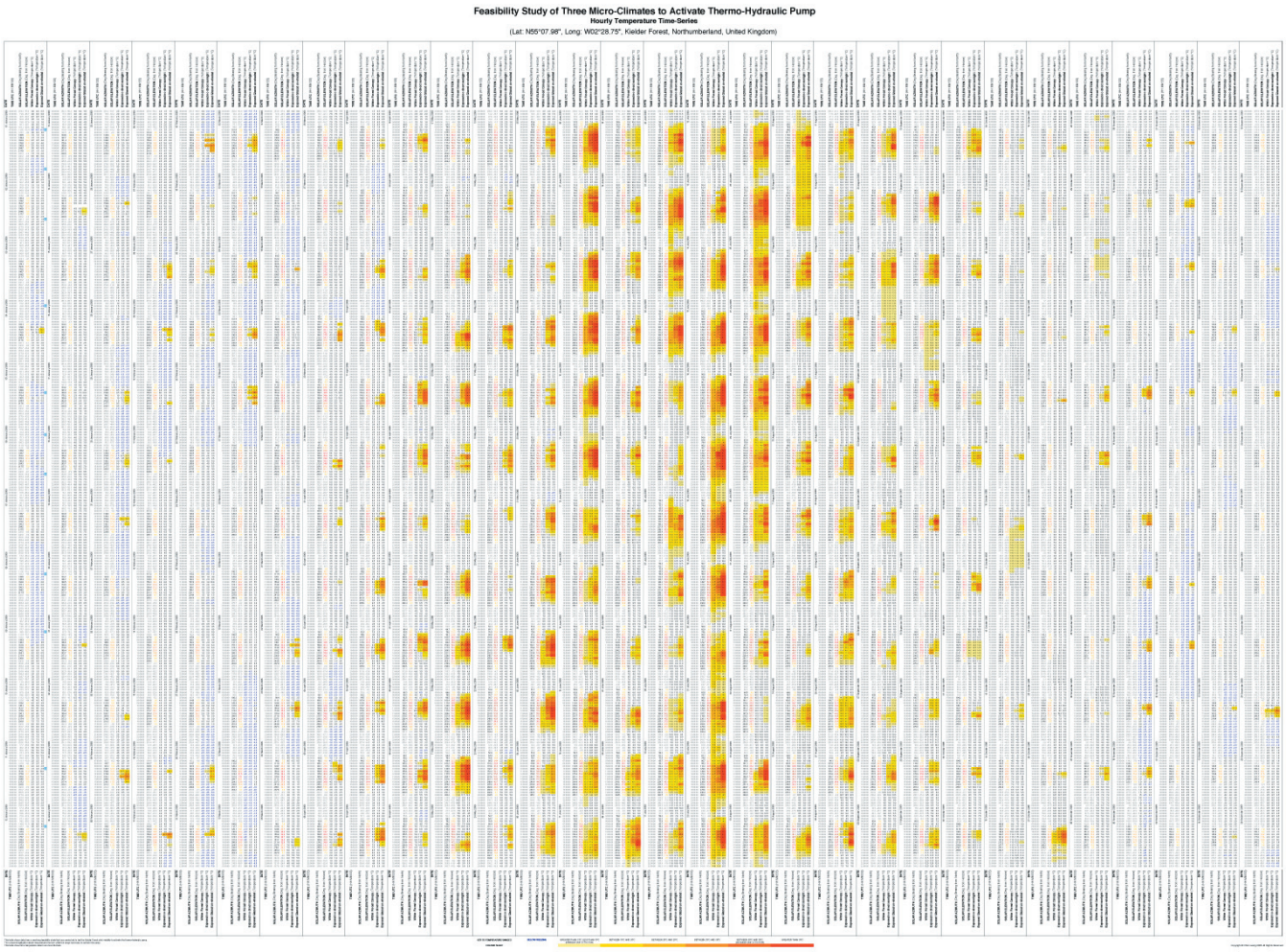

Feasibility Study of Three Micro-Climates to Activate Thermo-Hydraulic Pump
Hourly Temperature Time-Series
(Lat: N55°07.98', Long: W02°28.75', Kielder Forest, Northumberland, United Kingdom)

Image 2

Research Questions/ Aims/ Objectives

The focus of the research is twofold:

(1) To explore difference in micro-environments across the territory of Kielder in order to inform strategies for future architectural interventions. (image 2)

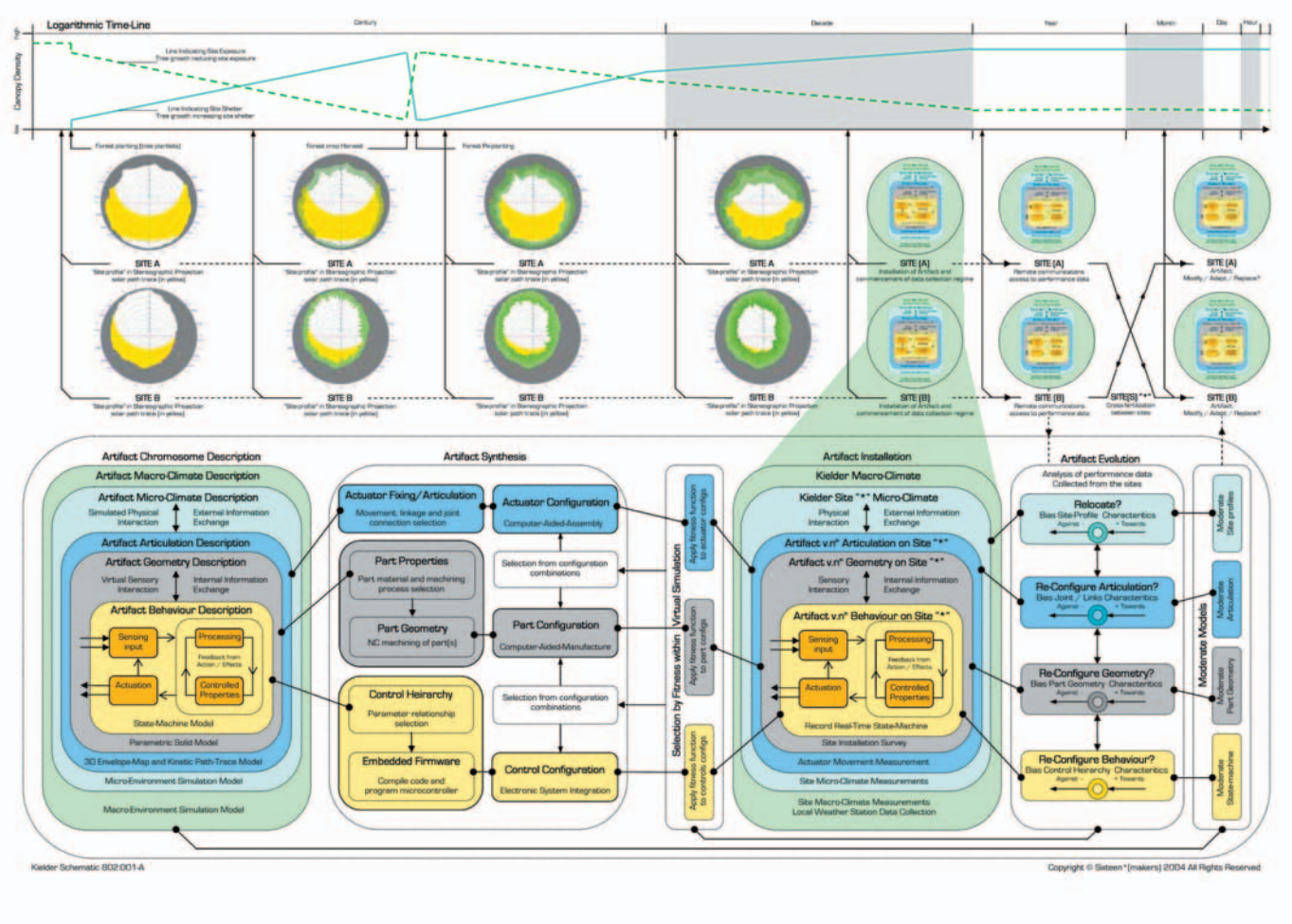

Logarithmic Time-Line
Century
Decade
Year
Month
Day
Hour
Canopy Density
Line Indicating Site Exposure
Tree growth reducing site exposure
Line Indicating Site Shelter
Tree growth increasing site shelter
Forest planting (tree plantlets)
Forest crop Harvest
Forest Replanting
SITE A
SITE B
SITE [A]
SITE [B]
Artifact Chromosome Description
Artifact Macro-Climate Description
Artifact Micro-Climate Description
Simulated Physical Interaction
External Information Exchange
Artifact Articulation Description
Artifact Geometry Description
Virtual Sensory Interaction
Internal Information Exchange
Artifact Behaviour Description
Sensing input
Processing
Feedback from Action / Effects
Actuation
Controlled Properties
State-Machine Model
Parametric Solid Model
3D Envelope-Map and Kinetic Path-Trace Model
MicroEnvironment Simulation Model
Macro-Environment Simulation Model
Artifact Synthesis
Actuator Fixing / Articulation
Movement, linkage and joint connection selection
Actuator Configuration
Computer-Aided-Assembly
Part Properties
Part material and machining process selection
Part Geometry
NC machining of part(s)
Part Configuration
Computer-Aided-Manufacture
Control Heirarchy
Parameter relationship selection
Embedded Firmware
Compile code and program microcontroller
Control Configuration
Electronic System Integration
Selection from configuration combinations
Selection from configuration combinations
Selection by Fitness within Virtual Simulation
Apply fitness function to actuator configs
Apply fitness function to part configs
Apply fitness function to controls configs
Artifact Installation
Kielder Macro-Climate
Kielder Site "*" Micro-Climate
Physical Interaction
External Information Exchange
Artifact v.n° Articulation on Site "*"
Artifact v.n° Geometry on Site "*"
Sensory Interaction
Internal Information Exchange
Artifact v.n° Behaviour on Site "*"
Sensing input
Processing
Feedback from Action / Effects
Actuation
Controlled Properties
Record Real-Time State-Machine
Site Installation Survey
Actuator Movement Measurement
Site Micro-Climate Measurements
Site Macro-Climate Measurements
Local Weather Station Data Collection
Artifact Evolution
Analysis of performance data Collected from the sites
Relocate?
Bias Site-Profile Characteristics
Against
Towards
Re-Configure Articulation?
Bias Joint / Links Characteristics
Re-Configure Geometry?
Bias Part Geometry Characteristics
Re-Configure Behaviour?
Bias Control Heirarchy Characteristics
Moderate Models
Moderate Site profiles
Moderate Articulation
Moderate Part Geometry
Moderate State-machine
Kielder Schematic 802:001-A
Copyright © Sixteen*(makers) 2004 All Rights Reserved

Image 3

(2) To develop a method of designing architecture within a context that is defined by a continual state of change. (image 3)

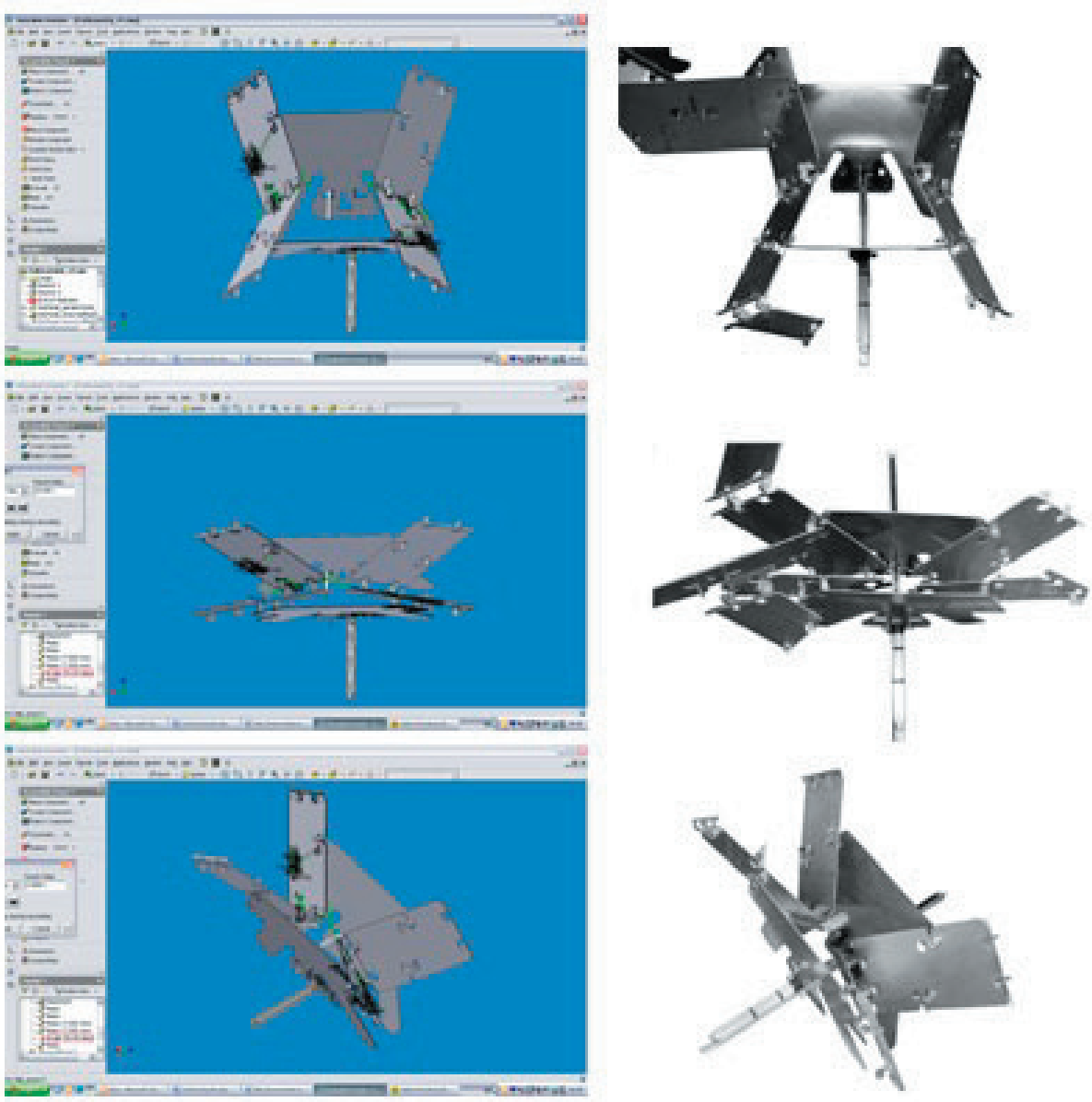


Image 4

Design by Survey

With regard to these aims and objectives, bespoke surveying 'probes' were designed to act as dual monitors and responsive artefacts. (images 4–7) The probes were installed on an approved test site chosen for its remoteness, and for its variety. It was adjacent to a dense territory of trees, an area recently harvested and an area planted with saplings. (images 8–11) The probes were designed to measure difference over time rather than the static characteristics of any given instance. Powered by solar energy, the probes gathered and recorded 'micro environmental data' over time. The probes were simultaneously and physically responsive to these changes, opening out when warm and sunny, closing down when cold and dark. (images 12–15) Thus not only did the probes record environmental change, but they demonstrated how these changes might induce a responsive behaviour specific to a single location. This aspect of the work generated three critical issues for design in relation to surveying methods:

(1) How surveys become active tools in making design decisions

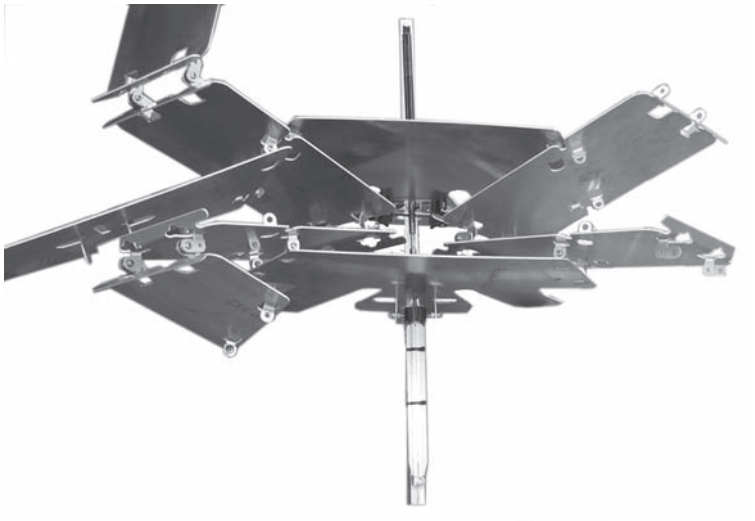
Surveys that capture information over time present the differing rather than the static conditions of any given instance. In this regard, responsive architecture may be designed to accommodate change with greater specificity.

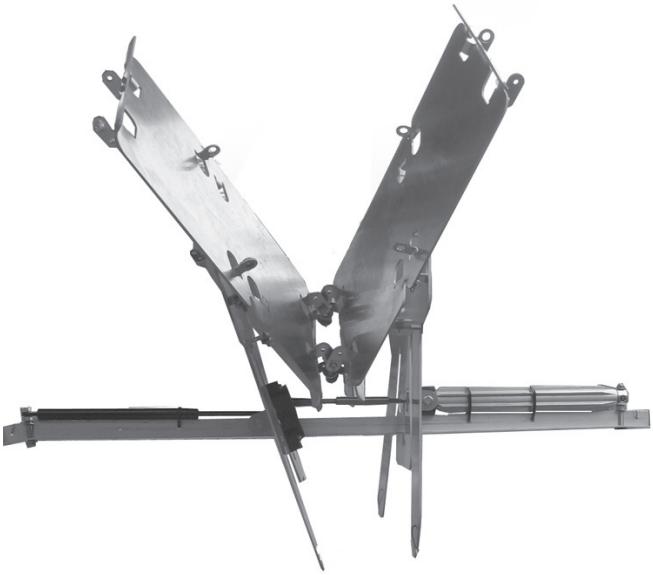
(2) How micro-environmental conditions can inform site selection

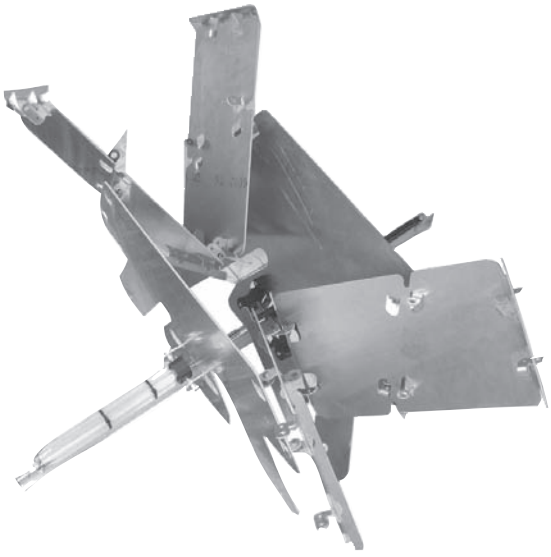
Different sites will induce different responsive behaviours. For example, a site in constant shade will not present the same micro-environmental variability as one that dips in and out of shade. Thus micro-environmental data gathered from a time-based survey across a variety of potential locations will provide the designer with the information to preview their potential to activate a responsive construct.

(3) How by mapping seasonal scope and climate variability, passively activated responsive architecture may achieve synthesis with user needs

The peaks and troughs of visitor numbers in Kielder, as a recreational site, correspond with variation in weather and broad seasonal change. An architecture that is constructed to passively respond to environmental change, opening out when the weather is fine, closing down when the weather is poor, may thus achieve a synthesis with patterns of visitor frequency.



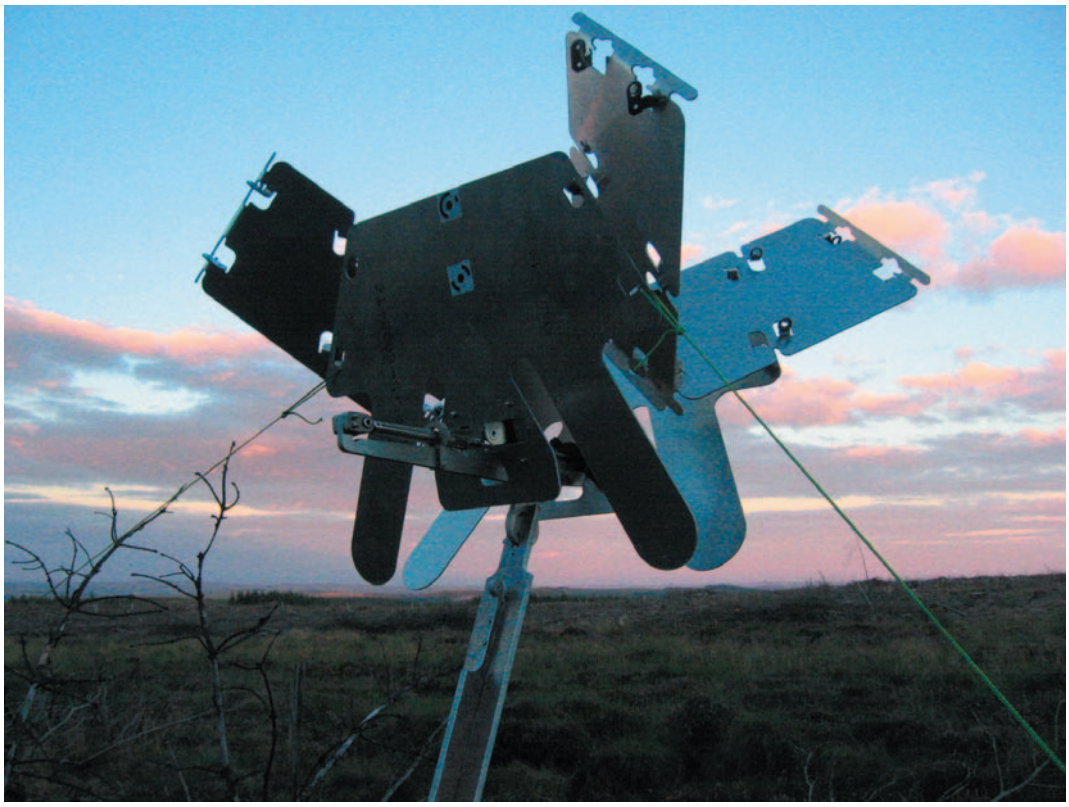




Images 5–7

Image 8

Image 9



Images 10–11

Image 12

Image 13

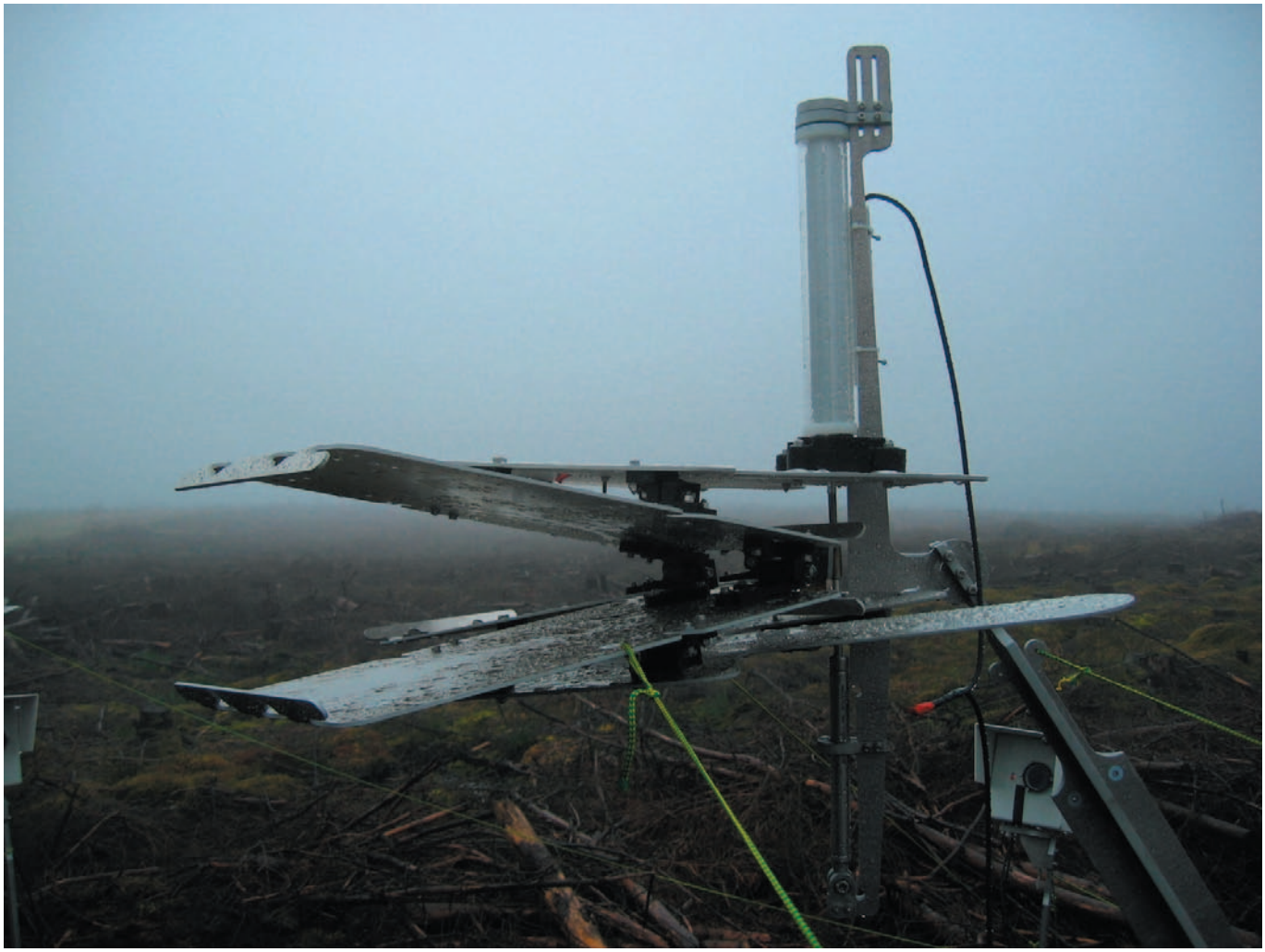


Image 14

Image 15

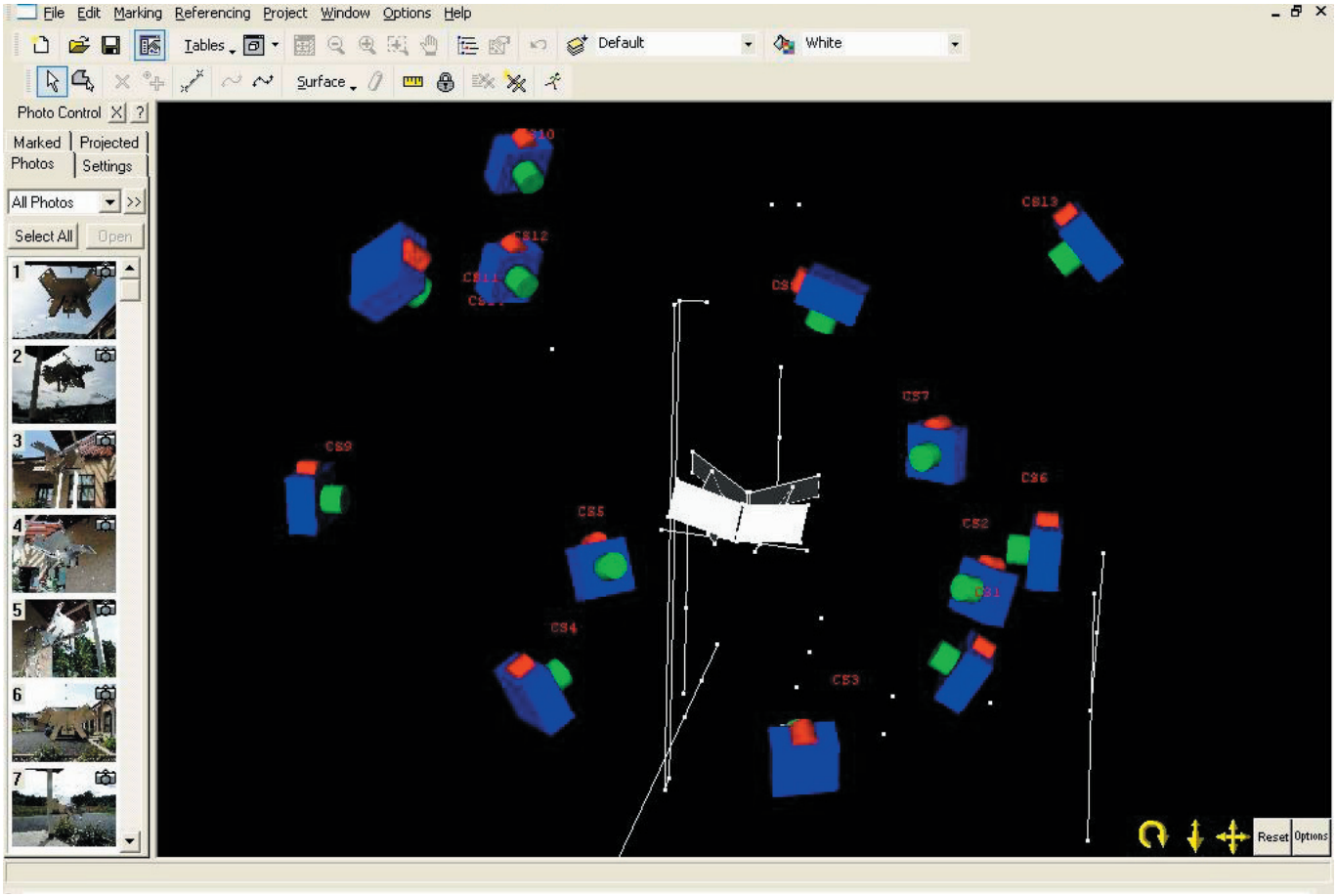

File Edit Marking Referencing Project Window Options Help
Tables
Default
White
Surface
Photo Control
Marked
Projected
Photos
Settings
All Photos
Select All
Open
CS13
CS12
CS11
CS9
CS7
CS6
CS5
CS2
CS1
CS4
CS3
Reset
Options

Image 16

With respect to the second focal interest, new surveying methods that would enable the designer to recognize and work with change were developed. Using the same probes, 'feedback' mapping the difference between the ideal (digital model) and the real (manufactured artefact) was generated using time lapse image capture, photogrammetery, and a transgression of digital and analogue design media.

Like many architectural constructs the probes were initially designed by drawing, in this case as a 3D CAD model. As a property of the software in which it was designed, this 'ideal' model was capable of being dynamically animated to behave in response to data input. Before they were manufactured, the 'ideal' models were activated by an input of environmental data gathered on site. Thus before manufacture, a preview of how they might behave was ascertained. As a digital preview, this performance was a simulation, in other words an 'idealized' response that relied on the capability of the controlling software to interpret 'real' data. This is a familiar scenario in architectural design, whereby 'reality' is only experienced in the real world and design for manufacture is a projection of idealized expectations based on the best explicit and tacit knowledge available.

The assembly of probes at Kielder was installed with a further purpose. They were designed as props in the first phase of a process of evolutionary design. Once assembled and released on site, their dynamic behaviour, activated by the micro-environment, was captured by an array of high-resolution digital cameras programmed to record at regular intervals. The captured visual data was later developed to generate three-dimensional outline models via digital photogrammetery software. (images 16–20) The resulting 3D outline models were superimposed upon the time lapse footage of the probes, generating a digital analogue composite. (images 21–29)

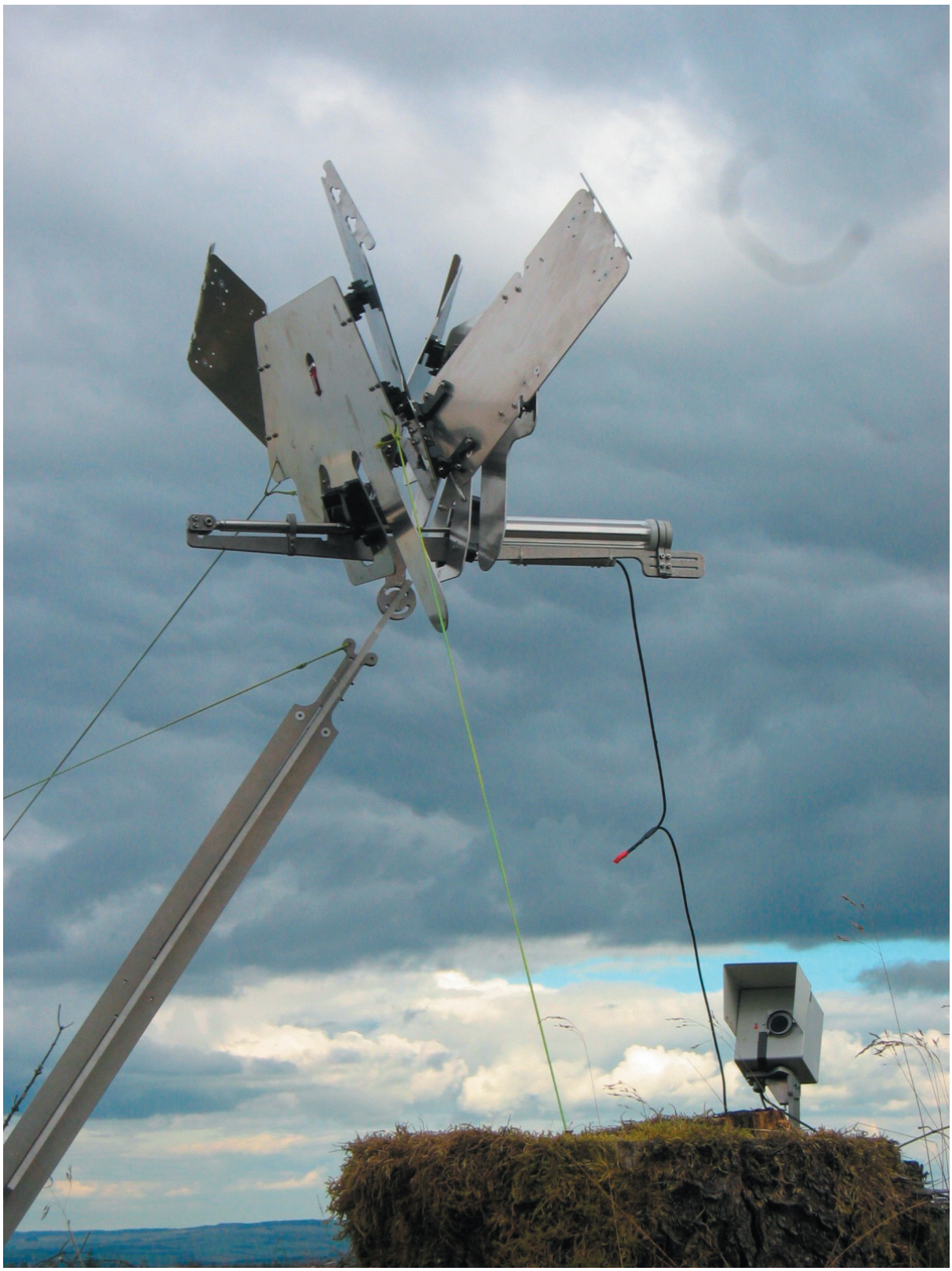


Image 17

Image 18

Image 19

Image 20


Solar Gain
Air Temp
Pump Temp
27 12:22PM


Pump Temperature
Solar Radiation
Solar Altitude (Degrees)
North
27 4:26PM


Pump Temperature
Solar Radiation
Solar Altitude (Degrees)
North
27 3:37PM

Images 21–23

The digital analogue composite could be compared compared with the 'ideal' model as it was loaded with the same data that has been used to drive the 'real' probes in the period in which they were captured. This established a method whereby deviations between 'ideal' and 'real' design models were observed and could inform strategies to modify the design for a second generation of artefacts.

This marks a significant shift in design for manufacture in responsive architecture that seeks to be site-specific. A new methodology has been developed that ties together 'ideal' intent with 'real' behaviour. It incorporates feedback that maps difference between ideal and real behaviour and thus offers the designer the opportunity to modify subsequent iterations based on that difference. Designed in this way, passively activated architecture may, as a consequence, evolve in accordance with its immediate context.

The majority of related research in 'evolutionary' design processes (notably Fraser and Bentley) has concentrated on the role of computational representation. The Kielder Residency places equivalent status upon realization and for this reason can be understood as a novel investigation within this field.


Pump Temperature °C
Solar Radiation kWm²
Solar Altitude (Degrees)
North
27 2:56PM
Pump ΔL (mm)


Pump Temperature °C
Solar Radiation kWm²
Solar Altitude (Degrees)
North
27 1:22PM
Pump ΔL (mm)


Pump Temperature °C
Solar Radiation kWm²
Solar Altitude (Degrees)
North
27 12:37PM
Pump ΔL (mm)

Images 24–26


Pump Temperature °C
Solar Radiation kW/m²
Solar Altitude (Degrees)
North
27 12:11PM
Pump ΔL (mm)


Pump Temperature °C
Solar Radiation kW/m²
Solar Altitude (Degrees)
North
27 11:41AM
Pump ΔL (mm)


Pump Temperature °C
Solar Radiation kW/m²
Solar Altitude (Degrees)
North
27 11:32AM
Pump ΔL (mm)

Images 27–29

Dissemination/ Esteem

Exhibitions

Robert Sheil, Phil Ayres and Chris Leung, 'Assembling Adaptations', The Building Centre, London, (December 2006).
Media: Aluminium sheet, thermo activated sensor array and pistons, gas return springs, microprocessor, dedicated software, DVD, Flat artwork.
Sponsors: Kielder Art and Architecture Partnership, Building Centre Trust, Access Engineering, CADventure, OMNI printing, YRM, iButton, Photarc Surveys, Microchip.

Invited talks

Arizona State University, Chelsea College of Art, Delft University of Technology, Royal Academy Copenhagen, Savannah College of Art and Design, University College Dublin, University of Manitoba, University of Waterloo.

Appendix 1: Related Articles by Robert Sheil and other members of sixteen*(makers)

(1.1) R. Sheil, and C. Leung, 'Kielder Probes – bespoke tools for an indeterminate design process', O. Ataman (ed.), *Smart Architecture – ACADIA* (Association for Computer Aided Design in Architecture) *2005*, (Savannah: Savannah College of Art and Design, GA, USA, 2005), pp. 254–259.

Conference Proceedings
(1.2) R. Sheil, 'Time to be Real', A. Dutoit, J. Odgers and A. Sharr (eds), *Quality*, Welsh School of Architecture, Cardiff, July 2007, p. 72.

(1.3) P. Ayres, 'Complexity from the Ordinary', *The Complexity of the Ordinary*, School of Architecture, Royal Danish Academy of Fine Arts, Copenhagen, 2006. http://www.scarch.dk/uk/index.html

(1.4) P. Ayres, 'Digital Representations/Analogue Realisations', P. Beesley, S. Hirosue, J. Ruxton, M. Trankle, and C. Turner (eds), *Responsive Architectures – Subtle Technologies '06*, (Waterloo, CA: Riverside Architectural Press, 2006), pp. 48–49.

(1.5) P. Ayres, 'Constructing the Specific', K. Oosterhuis and L. Feireiss (eds), *Game Set and Match II*, (Rotterdam: Episode Publishers, 2006) pp. 314–321.

(1.6) P. Ayres, 'Getting Specific', *Design Through Making*, special issue of *Architectural Design*, Robert Sheil (ed.), n. 176 (July/August 2005), pp. 58–65.

(1.7) P. Ayres, 'Making a Difference', O. Ataman (ed.), *Smart Architecture – ACADIA* (Association for Computer Aided Design in Architecture) *2005*, (Savannah: Savannah College of Art and Design, GA, USA, 2005).

Appendix 2: Critics' Reviews

(2.1) W. Jones, 'sixteen*(makers)', *Blueprint* (November 2006), 248, pp. 86–90.