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GETTING SPECIFIC

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Expressions of the generic

In 1998, 1000 hybrid walnut tree plantlets of the 'Paradox' variety were exhibited in San Francisco. They had been grown from the same genetic material, cloned to make 1000 equivalent instances.
It was already evident at this early stage of growth that environmental influence was the key driver of specific formal expression, rather than genetic determinism. Local variations were exhibiting themselves through different leaf numbers, inter-nodal lengths and branching patterns. The clones have since been planted in the San Francisco Bay area, being sited in diverse micro-climatic and social environments, acting as material witnesses to the influence of their specific locations.
Natalie Jeremijenko's 'OneTrees' project is a powerful demonstration of how the same genetic starting point will result in unique and specific expressions determined through each instance's particular engagement with an environment.

The emergence of the specific from the generic over time is a compelling process to consider. Could we imagine a piece of artifice that might develop local specificity in a similar manner? Could notions of 'growth' and 'adaptation' extend beyond metaphor and actually become processes embedded in, and actually driving the design, manufacture and life cycle of fragments, or larger parts, of the built environment?
This article will examine these questions by presenting a collection of ideas, drawn from previous work by sixteen*(makers), to inform a methodology that will be investigated and tested as part of a two year residency programme in the Kielder forest, Northumberland.

A methodology

An abstract generic model digitally encoding a collection of architectural attributes defines our 'genetic material' – an architectural 'seed'. This can be planted into a computer and replicated to provide a population of possible outcomes. Over time (measured in gigahertz and generations) individuals of that population are grown, driven by environmental data and their own imperative.
After a period of time suitable individuals are selected for synthesis. The means of synthesis is computer-numerically controlled (CNC) machinery. The designer need not interfere as the specific individuals have grown from the generic with all the necessary descriptions to be manufactured. The constructs are then sited and sensors placed, the data from which provide a record of actual performance in relation to environmental conditions. This data set drives further generations in a process of reiteration.
Two parallel worlds are being described here. They are connected to each other to form a circular system with both positive and negative feedback loops. One connection acts as a data *input* 'bridge' from the world of the analogue and into the world of the digital, and the other connection acts as a data *output* 'bridge' direct to CNC facilities and back into the world of the analogue.
This cycle need not be broken, resulting in an architecture that is in continual transformation – the design designing itself.

With the route to manufacturing now directly within the grasp of the designer through the advent of computer-aided design and computer-aided manufacturing technologies (CAD/CAM) the opportunity exists to re-cast the design process in relation to the making of physical output. The use of computer-aided manufacturing is generally predicated upon the definition of a digital design model. In the majority of cases the digital representation is defined through the use of proprietary CAD packages that encode processes of geometry

creation and geometry removal through the application of 'tools' on the model. The CAD operator draws from a palate including 'lofting', 'extruding', 'sweeping', 'drafting', ' boolean subtraction', ' boolean addition', ' boolean intersection', amongst many others, to encode specific design intent.
The methodology outlined above offers an alternative approach to the generation and iteration of design model data. Explorations into this territory cross boundaries of design, computer science, mathematics, engineering, and belong to an emerging paradigm – computer-generated design (CGD).

Siting the seeds

Moving though the Kielder landscape, histories of use, redundancy, re-use, appropriation and exploitation reveal themselves through marks and conditions to a backdrop of fairly typical temperate climatic conditions for the northern UK. The landscape possesses witnesses to most processes you can inflict upon a ground condition: turned, planted, eaten, harvested, parcelled, cut, excavated, relocated, detonated, burned, flooded, laid upon.
Some marks are left to entropic forces, being consumed by the persistence of gorse, grasses and goats, until they are virtually homogenised with their surroundings. These are the gashes of 19th and early 20th century open-pit mining and quarrying.
Some conditions are layered in the severest of ways, the edges where they meet becoming thresholds between polarised conditions: dry/wet, hard/soft, enclosure/exposure, proximity/distance.
Amongst the most enduring are those that exist through representations of the landscape, and in the minds of those familiar with it. 'Wind Hill', 'Devil's Lapful', 'Creamy Rigg', 'Hunger Edge' and 'Jock's Pike' – the names of places carefully preserved through numerous surveys and surviving most transformations of the landscape.
Some of the latest marks belie a complex set of interdependencies between use of landscape, landownership, social responsibility, business, tourism, economics, and cultural awareness. These include 'Minotaur' the contemporary maze by Nick Coombe and Shona Kitchen, the 'Kielder Belvedere' by Softroom, and a 'Skyspace' by James Turrell.
A glance across Explorer™ OL42 ordnance survey map (Kielder Water and Forest, scale 1:25,000) presents three dominant conditions; reservoir, forest, moor. Of these the forest covers the greatest area. It is one of Europe's largest man-made forests with 150 million trees standing within its boundary. The dominant species is the Sitka spruce. Lying well outside its native range of west coast North America, it accounts for approximately 75% of the planting with Norway spruce, pine (lodgepole, Scots) and broadleaf appearing in diminishing proportion. This canopy acts as habitat to a wide variety of inhabitants including the rare goshawk, crossbills, eider ducks, otters and the red squirrel exiled to a few pockets of the British mainland by the grey.
But this is a working landscape operating to a strict temporal model – the 50 year cycle. This temporal measure defines a complete period of growth, harvesting and preparation for re-growth. The myth of the bucolic landscape is quickly dispelled upon seeing the mappings, predictions, calculations, simulations, strategies and computational models used by those involved in the management of the land to relate the forest as resource to demand over time. From the introduction of non-indigenous species to the determining of harvesting parcel boundaries in irregular geometries so as to appear more 'natural' in perspective to the observer, this landscape is contrived from a mix of hard economics and notions of the romantic.
It is a complex piece of biomass accounting. Current demand requires the production of 1,300 tonnes of timber daily. This is used for paper production and feeding the construction industry with timber. Yearly, over 1,200 hectares are subject to harvesting and replanting programmes. It is a 62,000 hectare transient landscape.
For sixteen*(makers), this transience of conditions over varying time scales is one of the territory's most compelling attributes.

Drivers and registers

'Change' is the title to chapter 2 of W. Ross. Ashby's *Introduction to Cybernetics*. It begins by stating that 'The most fundamental concept in cybernetics is that of "difference", either that two things are recognisably different or that one thing has changed with time.'
'Change' or 'difference' is obviously key to processes that transform the generic into the specific and can be attributable to drivers and registers. But implied in the definition is the

observer who is able to do the recognising (drawing distinctions) of difference between entities, or with one entity over time.
The collective expression of attributes of an entity at a point in time, as observed by an observer, can be described as a 'state'. This is the register. We can subsequently describe the mechanisms by which an entity shifts from one state to another as behaviour.
If there are mechanisms of feedback such that the entity can 'sense' its own state then a regulation between 'internal state' and external influence can occur, assuming a palate of suitable behaviours. The entity now has the capacity to deal with change in an effort to maintain equilibrium between the two conditions. There are now 'internal' drivers possessed by the entity and 'external' drivers that act upon the entity, their relationship to each other being circular. The ability to generate new behaviours in the face of novel situations is known as adaptation. Adaptation also requires some form of memory through which a history of responses to stimuli can inform current and future behaviours.
The adaptive system intrigues us. Of those described it is the one that has the potential to surprise in its search for specificity. We have been exploring adaptive systems in an architectural context for some time – a few of these investigations are presented in the accompanying images. The Kielder residency offers us the opportunity to further this work in a landscape context.

The specific generic
We propose to begin the residency with a survey. It will be a time-based survey across a number of geographically dispersed sites with varying conditions. Orientation, elevation, current conditions and anticipated conditions will inform the selection of the candidate sites with a view that the initial starting conditions should be as diverse as possible. Each site will be initially 'planted' with a small construct that has an interior. The enclosure defining the interior will be thermally driven such that increases in temperature into the actuation range will cause the enclosure to open to the ambient conditions, using technologies similar to those for driving passively actuated greenhouses. Our initial construct therefore already possesses mechanisms of feedback through which it tries to maintain equilibrium between internal and external conditions.
Digital temperature data loggers will be used to record external ambient temperature and the internal temperature of the enclosure. Other devices for gathering pyranometric data are also being considered. This data set will grow at a rate of 1 sample per sensor per hour, recording specific information about ambient conditions and the modulated condition of the interior from which inferences about the site and behaviour of the construct can be made. The collected data set from each site acts a 'fingerprint' for each location, and this will be used to drive our digitally encoded generic instances towards specificity, resulting in a more substantial 'expression' to replace the initial construct. The process of generating a specific response to each site requires an adequately defined environmental simulation to test evolved instances and determine their appropriateness. The evolving of instances requires the definition of the 'genetic material' together with the necessary mechanisms for breeding and acting upon expressions such as reproduction, crossover and mutation. Both of these processes require quantifiable and measurable attributes by which assessments of 'fitness' can be made. The design challenge is being able to adequately describe the criteria for assessment, and determining the nature of the 'genetic material'.
The 'genetic material' encodes parameters for the formal and behavioural attributes of a construct. In genetic terms, the chromosome defines the complete encoding. Within the chromosome, individual genes map to individual parameters of attributes and the value of the attribute – its expression – is described by the 'allele'. Every member of the population has to be tested at each generation. The fittest pair are selected and become the parents of the next generation through a process akin to reproduction in which the chromosomes are recombined to create new 'offspring'. The process balances the inevitable drive towards optimisation through selection of the fittest, by generating a population that competes amongst itself and with its environment to maintain diversity. Once sufficiently optimised, the selected representation can then be manufactured and sited, the representation cloned to re-populate the search space, and the simulation re-driven. Environmental data from the ambient conditions together with the modulated conditions (those created by the construct) provide the data set for re-driving the simulation, and through this feedback a performance assessment can be determined. This assessment is not limited to the construct but to the entire set of

definitions comprising the simulation. It is difficult to argue against empirical data, and so any disparity between it and the simulation will tend towards re-defining the model.
Each site will be considered as its own problem space. However, we are assuming that there will be common characteristics between sites and over time certain solutions developed for one site might be useful as a reference to another. This requires a degree of collective knowledge sharing and might lead to the cross-fertilization of 'genetic material' between sites.

Over time, trends will start to appear in the data set of each site – diurnal and nocturnal fluctuations, seasonal variations and yearly rhythms. We also anticipate occasional sudden shifts in those trends. For example, a construct located on a south-facing incline under mature canopy is likely to be subject to very little solar gain during the day and exposure at night. Once harvested (a process that is guaranteed for almost all sites at some point in the 50 year cycle) this new condition of exposure will alter the thermal characteristics of the site and subsequently the passive behaviour of the current construct.
As new conditions begin to reveal themselves through changes in the trends of the data sets, we anticipate adaptive responses from our models. With this iterative adaptive cycle implicitly retaining an embedded history and supporting progressive development, the adaptations will be directly related to the existing structure allowing the addition, replacement or removal of components thus altering its formal characteristics and behavioural potentials.

There remain a number of conceptual and practical issues to be addressed regarding the implementation of such a process. Two immediate issues are:

1. The encoding of interaction rules between developed geometries and the tools and processes used to synthesise them.
2. The interfacing or coding of a simulation that understands basic concepts such as 'gravity', 'load distribution' and 'solar geometry' with our 'breeding' environment to allow the direct testing of instances.

The synthesis of this working brief will result in an architecture that is driven both by its immediate context and its own requirements.
It will be an architecture that has the potential to continually reinvent itself formally and behaviourally in relation to particular context and to its own history.
It will certainly be described as responsive. Some observers might even attribute it with intent.
It will simultaneously exist locally and remotely – geographically and in substance.
It will be an architecture that continually transforms in an effort to become specific to purpose and specific to location.
We hope it will be both strange and magical.