Experiencing the Big Idea

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ABSTRACT

Shrewsbury Museum Service invited Dew Harrison to create a work relating to Charles Darwin for the bicentenary of his birth in the UK town. Her research is practise-led and uses computer technology to interlink series of related thoughts and ideas, in multimedia form. Texts, images, animations and sounds are networked into one overarching 'concept'. The complete concept is then exhibited as a looped projected film or interactive screen work offering a contemporary understanding of a complex issue. She had previously worked with the ideas encapsulated within the work of Marcel Duchamp, in particular his *Large Glass*, which she transposed together with his boxes of notes and associated previous work, into one hypermedia system. Duchamp being the instigator of current Conceptual practice, his thinking began the shift of value within art from aesthetic to idea. This new challenge was to explicate the ideas of Darwin by synthesising them into one concept which could be grasped through audience interaction. Harrison is interested in relational works that invite an audience to participate together in revealing an understanding of the 'concept' on display. Earlier works used mouse and keypad to access a work, now the interfaces can involve sensors and physical movements for more playful and instinctive engagement. To develop the new project, Harrison worked in collaboration with two programmers and an animator to explore the 'big idea ' of evolution and elicit an understanding of Darwinian adaptation through interactive installation.

For the new installation entitled *Shift-Life* they have produced an alternate, or fantasy, biological life as a project which delivers an implicit understanding of Darwinian evolution and examples the rapid life changes necessary for survival in accelerated alternating climatic conditions. *Shift-Life* is an installation which focuses on 'hands-on' possibilities for witnessing an evolutionary process in alternate life forms as they struggle to adapt to a volatile environment. In response to Darwin's idea, the aim of this work was to create an 'alternate' biological life as a set of artificial or virtual organisms that possess similar biological processes to their 'real' counterparts, such as growth, reproduction, and adaptation. The virtual life forms exist in a nutritional (trophic) relationship of prey/predator, and include both rooted (sessile) and free ranging (vagile) organisms. Animal-intelligence was programmed into the virtual organisms to allow them survival strategies. The project also involved the construction of an enhanced mixed reality-based virtual environment to support the organisms. The climate of the virtual environment was directly influenced by the data gathered by wireless sensors (phidgets) in the real world landscape (sand box), plus implements (lights, shakers, pourers…) that altered the parameters (temperature, humidity, acidity, stability…) and so allowed visitors to change the condition of the virtual landscape.

The installation comprised of a large 'sand-pit' box representing the virtual world terrain, this encouraged interactivity for visitors who could physically manipulate a set of implements to radically alter the living conditions of the fantasy creatures in their virtual ecosystem, projected into the installation space. By pouring liquids, switching on lights, moving objects etc., in the sand box, visitors could see immediate responses to their actions played out in the animated ecosystem as the life forms adapted to survive. Interacting with the real world landscape and

observing the instant affect a visitor's actions had on the animated ecosystem projected into the installation space, proffered an understanding of how causing changes in environmental conditions, forces evolutionary developments on the life-forms in them.

2009 is the 200th anniversary of the birth of Charles Darwin in Shrewsbury and the 150th anniversary of the publication of *On the Origin of Species*. As part of the national celebrations underway, *Shift-Life* was exhibited at *Shift-Time – a festival of ideas* in Shrewsbury, summer 2009. It was still in its prototype stage and, following this beta-testing, it will be modified and enriched with extra behaviours and more sensitive environmental changes as we develop the project to more closely demonstrate Darwinian ideas for further exhibition.

Keywords

Associative media, Duchamp, Darwin, interactivity, virtual bio-life forms, sensor networks

1. INTRODUCTION

As lead artist for this project, Harrison was aware that the creation of the *Shift-Life* installation called for a cross-disciplinary Art-Sci collaboration, and might be beneficial to other researchers where each team member could extend their specific interests to wider understandings beyond their particular fields. The *Shift-Life* team of programmers and animator were drawn from the CADRE research centre at the University of Wolverhampton to serve their own independent research interests through contributing to this project. Under Harrison's direction, CADRE enables researchers to work together to explore the potential of pervasive and ubiquitous computing for a participatory art practice, which engages digital data with physical objects, sites and people in a natural and intuitive way. For many projects they use data gathered from wireless sensor networks to enable interactive

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AR/VR (augmented and virtual reality) visualisations and other creative multimedia responses. This team consists of an artificial life programmer, a sensor developer and a 2D animator but relies heavily on the 'animal intelligences' programmed in to display accelerated Darwinian principles – the survival of the fittest, this work will continue to greater complexity through phase 2 of the project. This next, more complex stage will bring in extra parameters, advanced behaviours and changing forms to create sophisticated organisms, with a view to making a work that will bridge the virtual with the real through varied forms of intuitive audience participation, and achieve full public exhibition in 2010.

The paper begins with a short overview of Harrison's work, as she is the lead artist who has generated the creation of the current project on Darwin from her research concerns. Section 3 describes the creation of the virtual world, it presents the challenges of the animator searching for the appropriate aesthetic when working to the parameters set by the bio-life programmer. The work of the bio-life programmer explains the coding of behaviours and rules motivating the creatures in relation to their virtual habitat. Section 4 continues with an explanation of the physical interaction incorporated into the installation by the sensor developer, as a way of directly impacting onto the virtual world. There then follows a review of observations and reflections which will inform the development of the project towards phase 2.

2. PREFACE TO SHIFT–LIFE

Within her research Harrison aims to further ideas from the field of computer-mediated art and consciousness studies. This has developed into a merging of art and AI, the unlikely partnership determined by Lev Manovich as 'Duchamp-Land and Turing-Land' and which he declared would never work [7].There are other art historians and theorists (Gere, Paul, Popper, Ascott, Shanken for example) who are more optimistic about new forms of synthesised practice, and her work sits somewhere inbetween the two positions. Her particular form of practice-led research stems from the understanding that the original vision of the computer, as supplied by Vannevar Bush, was to augment human intellect [1]. When aligned with the thinking processes behind Turing's Universal Machine [14], she can then interrogate the inter-connected ideas which constitute contemporary conceptual-based art practice. Projects develop from her findings where separate components are thematically unified through semantically associative media providing new holistic understandings of complex issues. In this case, Darwin's 'big idea'. As technologies have developed, the interactive element of her work has moved on from screen and mouse to the more intuitive approach of sensor enabled physical activity and projection, and from hypermedia software to AI programming.

In keeping with a conceptual practice she continues to question and analyse the idea of art. Her work concerns the use of computer technology to augment our thinking and elucidate deeper understandings of issues and positions. Initially this was kept confined within the art field, and specifically to the work of Marcel Duchamp, but has now expanded this to approach the highly creative 'big idea' of evolution through adaptation in order to respond to Shrewsbury Museum Service's request. In moving from Duchamp to Darwin the approach has remained the same in that viewer engagement is paramount and the work is interactive where the participating visitor's actions and choices contribute to the delivery of the piece's content. Although there is a facade of entertainment, in that the artwork is quite playful and engaging, the intent remains of harnessing new technologies as creative systems to present and elucidate more complex ideas about art and life.

2.1 Duchamp

Harrison's earlier works have informed the 'Shift-Life' installation, she began by exploring the work and ideas of Duchamp as the godfather of Conceptual Art. This was approached through the new digital technologies considered as best suited to the investigation, specifically hypermedia. Harrison proceeded to transpose his definitive piece, *La Mariée mise à nu par ses célibataires, meme,* across the internet with 25 collaborators through 25 websites, a site for each element of his *Large Glass*. She then inter-related these and more Duchampian texts, sounds and images, together with his 'green' and 'white' (*l'infinitif*) boxes of notes into discreet offline interactive systems. Hypermedia software was used as it could support the linking together of multimedia items by semantic association rather than by indexing or alphabetic ordering. This form of thought inter-connection is paralleled in Conceptual Art where ideas are semantically linked by the artist into a concept, often presented as a visual statement, or object, to the viewer. However, hypermedia technology required mouse and keypad access which brought an unintended game-like element to the works. Duchampian archaeologies then continued with a series of digital interactive movies projected onto a canvas bridging new media and traditional practice through digital video. The intent was to capture the relationships between Duchampian objects and statements in a more fluid way, and in so doing give an holistic view of his oeuvre.

The moving image projections further displayed the relationships between the thoughts and ideas of Duchamp in a more natural and intuitive way than 'point and click' or 'roll-over' interaction. It is these works which have led to the hands-on installation, 'Shift-Life' in that they employed AI programming to animate them. The moving images incorporated the 'swarming' and 'clustering' of the content of his boxes of notes with seminal images from his body of work. By applying AI 'behaviours' to these Duchampian objects they moved towards or away from each other according to their semantic relationships when in close proximity. An over-simplified example is: the word 'rain' may move away from 'stone', until the word 'hail' appears and oscillates between 'stone' and 'rain'. As the multimedia items required for these experiments had been re-cycled from the earlier hypermedia projects, they were really *ready-mades* newly re-connected into a more organic and dynamic display of the relationships between them. The new 'flocked' Duchampian objects more clearly show the 'families' of images, texts etc., and the oscillations that occur between them due to the pull of their similar semantic positions. Interactivity is incorporated to enable viewers to move the items around and drop-in others, in order to find out how they re-position within the Duchampian mindset.

The next set of 'flocked' objects is to evolve to text only items, with the intent of clustering words and sentences into positions around an argument to further make sense of Duchampian non sense. Text and language are the tools of a post-Duchampian conceptual practice. The text strings will evolve to be statements and words illuminating a set of positions around a current art debate where words can be added by the viewer to sway the

argument, keeping it alive and dynamic. The argument pattern should evolve from the individual behaviours of the objects.

2.2 Darwin

Ideas taken from Harrison's recent work on Duchamp have directly influenced the approach to the exploration of Darwin's 'big idea', in that instead of Duchampian objects, AI behaviours were attached to a virtual world of animated objects featured as creatures and plants. These 'families' were grouped by their form and colour, and it is the changes in these identifiers that are of interest when observed by viewers who can cause physical upheavals in their world, to which the artificial families of life-forms then have to respond. The first phase of the *Shift-Life* project entailed a fantasy biological life-form, 'bugs-in'a-box', existing in conditions analogous to Darwinian evolution. Interfering with the stability of their ecosystem was done through real world actions directly affecting the virtual one.

3. EXPERIENCING THE VIRTUAL WORLD

In attempting to both respond to the idea of a young Darwin and to elucidate his thinking in an holistic hands-on way, the bug-like creatures in the box are reminiscent of his/any childhood and so take the form of jelly sweets and allsorts. Darwin was born and spent his childhood in Shrewsbury, where he began his observation of natural life-forms and started his vast collection of beetles. This boyish interest would last all his life and led to his great insights later on as an adult. The virtual world of 'bugs-in-a-box' was first shown as part of the national activities underway for the Darwin bicentenary year, 2009.

3.1 Animating creature phenotypes

With the young Darwin in mind, the *Shift-Life* animator, Sam Moore, developed the 'bugs-in-a-box' as 'sweet' creatures with a view to making them as approachable as possible to an audience diverse in gaming/AI experience. The images moved away from a computer-games visual aesthetic of hyper-reality and towards a deliberately non-digital, non-microbe aesthetic. This positioned her work in the realms of the overtly rather than covertly 'made' and referenced a clear fantasy world instead of attempting photo realism. The creatures were based on pick and mix sweets; the carnivore was a liquorice all-sort, the herbivore was a jelly sweet and the foliage (for shade, sustenance etc.) was based around a selection of penny sweets. (See Figure 1.) The creatures were limited to two dimensions, (See Figure 2.) as they were to be observed from above, and in collaboration with the bio-life programmer a set of characteristics, limitations and behavioural patterns were decided upon and integrated into the design. For example, the herbivores were much larger than their predators and had better eyesight. The carnivores though, despite being small and short sighted, had a fast scuttling gait compared to the lumbering movement of their prey so the relationship between them was not as uneven as it may have first appeared. Moore found that animating to the agreed behavioural perimeters was interesting and frustrating in equal measure; some behaviours (such as procreation/multiplication of the creatures and fighting/ cannibalism between carnivores) were able to be animated, but were not included into the software programme as the final animation was too complex to be smoothly integrated. Moore and Ch'ng hope to resolve these issues in the next stage of the project.

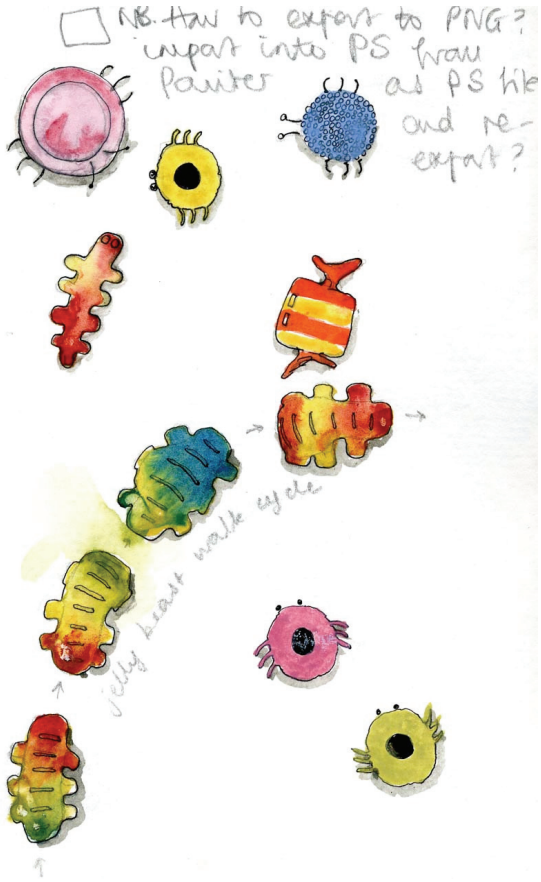

Figure 1. Preliminary sketch of sweet creatures

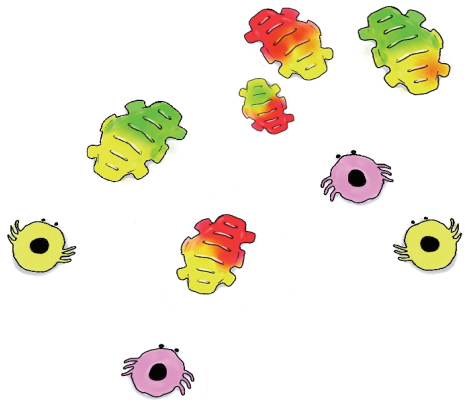

Figure 2. Carnivores and Herbivores

3.2 Artificial Life and Creature Behaviour

Eugene Ch'ng's recent programming work on enhanced Virtual Environments (eVE) and in particular climate-change and biodiversity research for terrestrial and marine environments identified him as the prime candidate for contributing animal behaviour and adaptability to the *Shift-Life* work. In this section Ch'ng describes the simple rules that constitute the aggregate behaviour of the *Shift-Life* creatures. He also describes the virtual habitat that they live in.

Artificial life (alife) [6] is a relatively new science that attempts to model biological life. It is an experimental science for the study of synthetic systems that exhibit behaviours characteristic of natural living systems. The synthetic system, created with data structures and algorithms, dwells within voltage and silicon and may exhibit a life-cycle parallel to its carbon-based counterpart: growth, reproduction, competition, and adaptation. The fundamental theory of emergence and self-organisation in alife is analogous to Complex Adaptive Systems (CAS) [15, 9] and can be classified within the same field. Emergence [5, 4] is a phenomenon intrinsic to natural and social systems [2, 8]. John Holland, the father of Genetic Algorithms gave a description of emergence: "The hallmark of emergence is this sense of much coming from little… where the behaviour of the whole is much more complex than the behaviour of the parts." A more elaborate sentence states that "Emergence is the production of global patterns of behaviour by agents in a complex system interacting according to their own local rules of behaviour, without intending the global patterns of behaviour that come about." In emergence, global patterns cannot be predicted from the local rules of behaviour that produce them. To put it another way, "global patterns cannot be reduced to individual behaviour." [13]. Self-organisation [10, 11] "is a process in which pattern at the global level of a system emerges solely from numerous interactions among the lower-level components of the system. Moreover, the rules specifying interactions among the system's components are executed using only local information, without reference to the global pattern [2]. These two concepts are closely related and modelling biological systems requires their understanding. Since global patterns (the whole) are not modelled but 'emerge' from the interaction of the individual units (the parts), knowledge of the bottom-up, decentralised approach is crucial [12].

3.2.1 General Creature Behaviour

The system is constructed with a trophic network of predator-prey and vegetation. The organisms are short-lived (60 seconds minimum and 150 seconds maximum). The general behaviour of each organism is its survivability and the reproduction of progenies. The survival of the entire ecosystem depends on the balance of the organisms that inhabit the landscape. If the predator out-grows the prey, an imbalance occurs and the system perishes. If the prey out-grows the edible plants, the food is scarce and the system is at a dilemma. If the canopies (large trees) over-reproduce, the predator has little space left to hunt. If the red poison plants outgrow the vegetation, more herbivores eat them and become toxic; consequently their newly acquired toxicity kills the carnivores. (See Figure 3.) When the environment particularly suits them, a plant species will thrive (poison plants love high pH levels). The difficulty of such an alife development is the maintenance of equilibrium. The 'fun' part is when users interact with the system by increasing any of the environmental factors via our sensor network: temperature, sunlight, humidity, pH level. They can do this by using watering cans, hammers, and lamps.

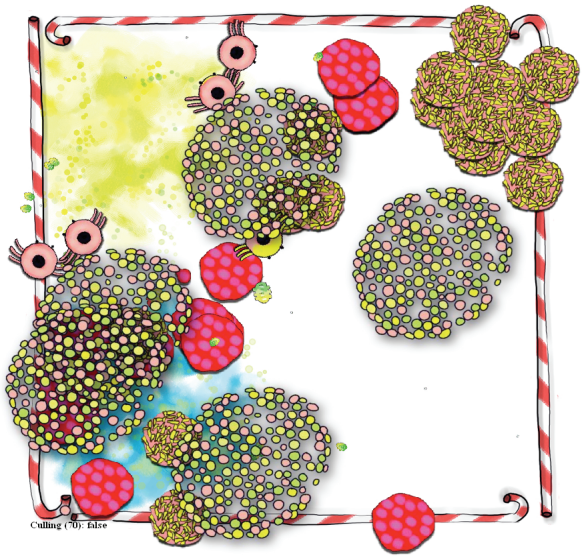

Figure 3. The Shift-Life virtual environment

3.2.2 Simple Rules in Artificial Agents

We approached the development task with an agent-based modelling technique. That is, we modelled each individual unit of biological life as an autonomous agent. Simple rules (computer algorithms) were built into each entity. The ecosystem has two vagile organisms (carnivore and herbivore) and three sessile organisms (poison plant, vegetable, and tree). The rules for each organism are specified below.

```
Carnivore
  Sense the environmental (Temperature,
Sunlight, Humidity, earthquake)
  Grow (aging) and die of senescence
  Roam when not hungry
  Avoid tree canopies
  Look for herbivore when hungry
  Hunt when herbivore in sight
  Rest when tired
  Hide when in danger (earthquakes)
  Reproduce when sexual maturity is reached
  Die when the fitness is depleted

Herbivore
  Sense the environmental (Temperature,
Sunlight, Humidity, earthquake)
  Grow (aging) and die of senescence
  Roam when not hungry
  Look for edible plants when hungry
  Move to eat plant when in sight
  Change colour when toxic plant eaten
  Rest when tired
  Flee when in danger (being hunted)
  Reproduce when sexual maturity is reached
  Die when the fitness is depleted
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```
Vegetation (in general)
  Sense the environment (Temperature,
Sunlight, Soil, Humidity, pH level, Space)
  Grow (aging) and die of senescence
  Compete with nearby plants for space
  Reproduce when sexual maturity is reached
  Die when the fitness is depleted
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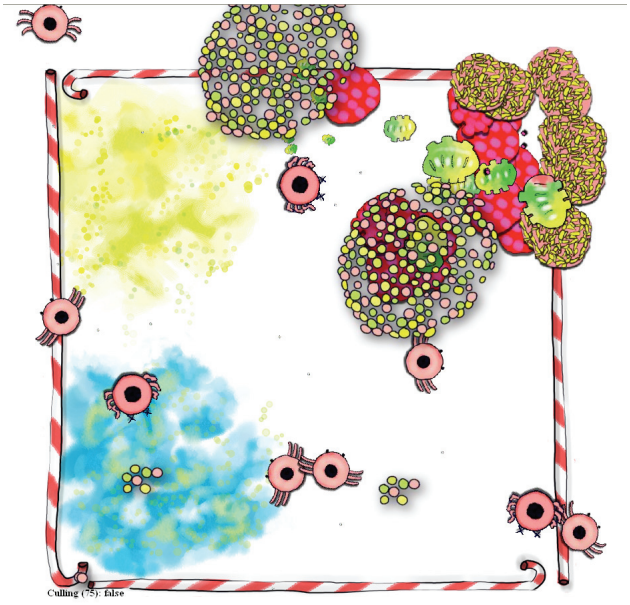

Figure 4. Shift-Life adapting to imbalance in its ecosystem

3.2.3 Genetic Traits

The genetic traits of the creatures determine their survivability in the highly competitive ecosystem. The tables below describe the genotype for each organism.

Table 1. Carnivore Genotype

Alleles	Lower	Ideal	Upper
Sunlight	0.2	0.6	0.8
Temperature	-4.0	25.0	35.0
Humidity	0.3	0.5	0.8
Maximum Age		60 seconds	
Eyesight		100 pixels	
Field of View		180°	
Reproduction		1 child policy	
Age of Maturity		30 seconds	
Speed		3 pixels	

Table 2. Herbivore Genotype

Alleles	Lower	Ideal	Upper
Sunlight	0.1	0.6	0.8
Temperature	-4.0	25.0	35.0
Humidity	0.3	0.5	0.8
Maximum Age		100 seconds	
Eyesight		250 pixels	
Field of View		180°	
Reproduction		5 child policy	
Age of Maturity		60 seconds	
Speed		2 pixels	

Table 3. Poison Plant Genotype

Alleles	Lower	Ideal	Upper
Sunlight	0.1	0.4	0.7
Temperature	16.0	33.0	27.0
Humidity	0.3	0.5	0.7
Soil	0.0	0.5	0.8
pH	6	10	14
Space	0.0	0.6	1.0
Maximum Age		50 seconds	
Reproduction		3 child policy	
Age of Maturity		10 seconds	

Table 4. Edible Plant Genotype

Alleles	Lower	Ideal	Upper
Sunlight	0.1	0.5	0.8
Temperature	18.0	26.0	38.0
Humidity	0.3	0.5	0.7
Soil	0.0	0.5	0.8
pH	5	8	11
Space	0.0	0.6	1.0
Maximum Age		70 seconds	
Reproduction		5 child policy	
Age of Maturity		10 seconds	

Table 5. Canopy Tree Genotype

Alleles	Lower	Ideal	Upper
Sunlight	0.1	0.8	1.0
Temperature	15.0	30.0	45.0
Humidity	0.3	0.5	0.7
Soil	0.0	0.4	0.6
pH	1	7	12
Space	0.0	0.28	0.5
Maximum Age		150 seconds	
Reproduction		5 child policy	
Age of Maturity		25 seconds	

3.2.4 Creature Adaptability and Environment Factors

The fitness of each organism is measured by Ch'ng's Adaptability Measure [3]. The creatures are affected by three environmental factors: temperature, sunlight and humidity and the plants are affected by six factors: temperature, sunlight, soil, humidity, pH level, and space. The temperature, sunlight, humidity and pH level are streamed from electronic sensors installed at strategic locations in the virtual bug box. Soil conditions are unchanged and are based on height fields (certain regions are more habitable). The availability of space for the plants depends on the number of plants growing within that space.

4. EXPERIENCING THE REAL WORLD ACTIVATORS

In order to interact with the virtual 'sweet' bugs they are projected down into a real box arrayed with sensors. This takes the form of a wooden 1.2 meter sq box filled with polystyrene beads held under a muslin sheet and surrounded by a set of manipulative tools which, when activated, can affect in real-time the projected virtual world of creatures causing them to adapt to survive in their rapidly changing ecosystem. The tools are for hammering earthquakes into existence, watering to alter the humidity and pH count of the planet environment and altering light sources to affect temperature and depth of shade.

4.1 Enabling User Interaction

Sarah Mount is an expert in pervasive computing and wireless sensor networks, her work formed the basis of the tangible interface of the installation which she details below:

Since the early 1990s pervasive (or ubiquitous) computing has been seen as the next paradigm shift in practical computing. In what is now seen as seminal work in the area, Weiser [16] described this emerging paradigm as "... the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user". This seamless integration of computers and the physical world and the removal of any sort of "user interface" has long been the goal of researchers and indeed produced many successful

Figure 5. The Shift-Life installation, phase 1.

prototypical applications, but few which are immediately available to the general public.

The "bug box" described in this paper is one such pervasive computing application which has moved beyond the research laboratory and into the public domain. The interface itself consists of the following apparatus:

- An Oak USB attached 3-axis accelerometer hidden underneath an icon attached to the side of the bug box and a toy hammer with which to actuate the sensor. The output of the sensor was normalised and an exponential weighted moving average applied to smooth the response from the transducer;
- An Oak USB luminosity sensor, actuated by an angle-poise lamp;
- An Oak USB relative humidity sensor, protected by a Gortex membrane, actuated by pouring water into the bug box, and
- An Phidgets USB pH sensor, actuated by pouring vinegar and bicarbonate solutions into the box.

The sensor network was centralised and reported back in a best-effort fashion. A number of optimisations were made to enable the application to appear to be responding immediately. In particular, unnecessary reports were suppressed, and each datum only reported back to the ecosystem if it differed from the previous reading by a threshold.

5. OBSERVATIONS — TOWARDS PHASE 2

In order to meet the commission and elicit an understanding of Darwinian adaptation through interactive installation an intuitive interface was required with the potential for tangible physical activity. The wooden virtual bug box was large enough to allow for small groups of people, families, and individuals to interact with it and with each other, it was accessible to both children and adults. The box was equipped with sensors to respond to the visitors actions and relate their physical activities directly to the virtual ecosystem projected into it. As they poured water, for instance, the humidity would alter and some plants may die back, this would mean less food for the herbivore green jelly sweet bugs, and consequently less bugs to eat for the pink carnivores. Switching the lamp on would dry out the atmosphere and enable

plants to grow again, however too much 'sun' might be detrimental to the point of wiping out the carnivores entirely! They could, in fact, become extinct due to their reproduction method of cloning, unlike the egg laying herbivores. When this occurred, we had to re-start the programme to reassure the smaller children that they weren't responsible for a complete genocide. Pouring vinegar from a watering can would 'feed' the red bushes, toxic to all the creatures, but this could be remedied by pouring baking soda liquid and restoring the plant balance, the herbivores' food. Hammering on the box sent the carnivores into panic mode and they would run for cover under the trees.

We ran the installation for two days at the Shrewsbury event and our observations and interviews showed that all our visitors, young and old actively contributed as participators by physically moving the box objects to change the parameters that affected the projected virtual world. Perhaps more importantly, they also often remained for some time in a state of reflection to passively observe the other's actions and watch the life-form changes taking place. The jelly bug world was set at a self-sustainable and stable level without the intervention from human meddling and as such was visually mesmerising, it was essentially a sugar-coated version of 'nature red in tooth and claw'. There was room for contemplation where the virtual world could be understood as an analogy for human activity and it's effect on global climate change within our own real world. This became evident through the participants' conversations. The tangible 'hands on' interface proved to be instinctive, attractive and informative on many levels, delivering a good example of an Arts-Sci collaboration, but in this first stage, there were many questions about the behaviours and environmental conditions which we hope to render unnecessary for the next exhibiting of the work. The constant flow of visitors activating the sensors by hammering, pouring liquids etc., indicated that for a longer showing with more participants, we will need more robust methods of protecting the sensors, a set of spares and a more efficient way of dealing with the excess liquids collected underneath the display. Phase 2 of the project should result in a smoother sophisticated interactive piece as a platform for deeper thought and questioning arising from subliminal understandings. The team intends to programme/animate the creatures not only to rapidly evolve and change physically in accordance with their volatile world, but to evolve unpredictable social patterns from their individually programmed behaviours.

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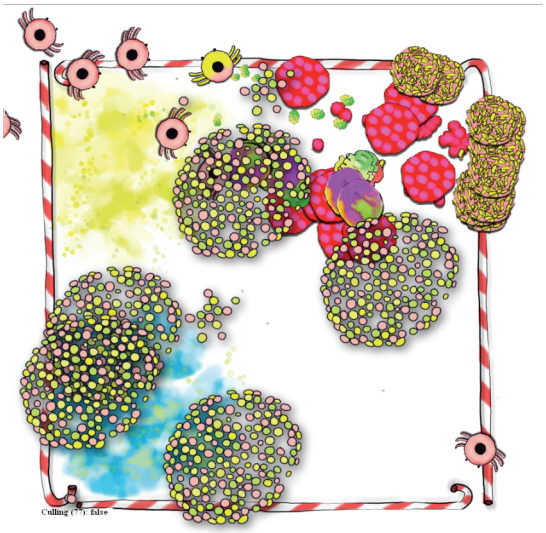

Figure 6. Life and death in Shift-Life continues.

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