lifeSigns: Eco-System of Signs & Symbols

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ABSTRACT

The nature of the computers as a machine for processing symbolic logic is widely recognised. However, they also have the potential to 'generate meaning' through these same processes, particularly in the domain of constructed, artificial worlds that exist in terms of their own logic and codes. An interdisciplinary model for meaning generation is articulated via the intersection of artificial life and generative systems, computational semiotics, and digital games. This model may be described as a 'generative meaning system'.

A digital media art installation entitled *lifeSigns*, an eco-system of signs and symbols, is presented as a prototypical generative meaning system. This work is a multiplayer digital game set in a world of iconic lifeforms, called 'lifeSigns', that make up an abstract world of form, colour and movement.

Keywords

artificial life, generative systems, digital media language, electronic media art, digital games, iconography, interactive sound design, media creatures, generative meaning system

1. INTRODUCTION

The idea of computer as a processor and manipulator of symbols and logic is widely understood. Aspects of electronic spaces, such as their fluid, mutable nature and immediacy become familiar as they become part of everyday experience. However, these artificial worlds offer other possibilities outside the simulation of the material world. They are systems that possess their own logic and potential forms of expression. Push one or two parameters past the 'normal' limits and you are into the realm of transmutational space where anything can be parameterised, algorithmically generated, or made interactive. There is not one global code or language that defines all electronic spaces - each space is potentially a unique instance of a particular logic or language.

This paper intends to explore an interdisciplinary approach to the construction of artificial worlds that have the potential to generate meaning. In artificial worlds where signs and symbols have agency - could they adapt their form or behaviour so as to change their meaning? Existing theories and systems will be explored to examine the potential of electronic space as a site for the evolution of audiovisual languages. It explores the flux of meaning and constant reconfiguration of language brought about by new technologies of communication. If electronic signs, such as icons, have agency within the digital realm in which they reside, then how does this change our understanding of information, data, language and communication? What happens when the formation of meaning is augmented by computational processes?

These ideas are demonstrated in a recent artwork entitled *lifeSigns: an eco-system of signs and symbols.* In this work, a system for generating, playing and interpreting digital media languages is the basis of an artificial world. Further to this, my interest in these themes has evolved from the development of digital media artworks that explore new communication systems in the digital realm. Through the experience and creation of digital media, I have been interested in what can be described as a 'language of computers' that articulates the unique characteristics and properties of digital media.

2. PAGE SIZE

In order to facilitate the idea of the evolution of language in digital space, the right processes, interactive mechanisms and representations need to be developed. The goal is to realize a space that is capable of change and evolution, user feedback and interpretation, and that can be expressed in terms of codes and structures of communication. Language may then 'emerge' through ongoing interaction and user participation in that space.

2.1 Interdisciplinary model

The conditions required in an environment suited to the evolution of digital media languages need to draw upon the formal languages and models of evolution in artificial life research, the analysis of digital media language from computational semiotics, and the capacity of feedback and gameplay in digital games.

2.1.1 Artificial Life and Generative Systems

Artificial life, a discipline of computer science, encodes life processes into algorithms and data structures that can be implemented in computer software. A genotype defines entities within the system may be mutated or combined with that of other entities in a process similar to biological reproduction, the genetic algorithm. Typically a fitness function will test entities in terms of criteria that may be defined in terms of the system, or entities will adapt their behaviour through learning and adaptation.

Generative systems build structures from simple base elements combined using rules and grammars. Many iterations of these processes result in complex forms that can create novel results not readily apparent when looking at the source material. These systems may be integrated into artificial life models and may also be tested in terms of fitness, combined using genetic algorithms and so on. These systems have been used by artists and designers to evolve worlds and develop new aesthetics.

2.1.2 Computational Semiotics

In order to make use of these systems, the subject of the artificial life simulation needs to be defined in terms of

First published at COSIGN 2004
14 – 16 September 2004, University of Split (Croatia)

elements and relationships that may be manipulated by the system. Computational semiotics provides methods for relating the 'computer and sign system' that may guide the formal definition of semiotic systems in terms of an alife algorithm. The unique characteristics and opportunities of computer mediated communication are articulated and decoded through the adaptation of semiotic theories to the computational medium. These findings may be used to translate communication processes into formal languages that may be defined in the symbolic code of the computer program.

2.1.3 Digital Games

Digital games combine key properties of digital media, such as interaction, simulation and symbol processing, in a single coherent form. In particular realtime 3D simulation of space offers the ideal medium for the experience of artificial worlds. Many different kinds of worlds can be simulated with a high

degree of 'realism' in terms of the players experience and perception. Gameplay offers a structured code of interaction while also allowing exploration and play within the rules of a world. The immediacy of feedback combined with the realism of the simulation result in a high level of engagement that places the player directly within the action of the symbolic game world.

2.2 Generative Meaning Systems

An interdisciplinary model for meaning generation is articulated via the intersection of artificial life and generative systems, computational semiotics, and digital games. The life processes encoded into artificial life software may be connected to systems and codes of signification in digital media to develop models for the evolution of digital media languages. The forms evolved by the system may be represented in realtime 3D simulation – through form, structure, colour, sound, motion, surface and behaviour. The game environment makes the system tangible and provides a medium for feedback. This model may be described as a 'generative meaning system'.

These systems should have the following key characteristics:

1. clearly defined base media elements described in terms of current knowledge on signification and meaning within digital media;
2. rules or grammars for the combination of elements to create larger entities;
3. evolutionary or generative aspects such as the use of iterative processes, genetic algorithms, fitness function;
4. a method or function for the interpretation of meaning of the entities evolved by the system;
5. rules of play that relate to interpretation functions and communication;
6. a representation that encapsulates these characteristics in a coherent, persistent world and enables the interaction of an audience.

Generative meaning systems highlight the potential of digital worlds to manifest new configurations of media and meaning. They demonstrate the intersection of life processes with the evolution of communication forms in terms of what could be described as 'emergent language'. Digital media languages may be evolved and bred rather than designed. Furthermore, these languages may adapt to different semiotic landscapes or evolve through their interpretation and usage. Generative meaning systems are representative of the 'nature of digital media' by demonstrating properties of mutability, interactivity and symbol processing.

2.3 Previous work

This project builds on previous works that have explored dynamic relationships between meaning, artificial life, interaction and electronic space.

2.3.1 Iconica

Iconica [3] is an artificial world made of language, populated by lifeforms made of media. An artificial life model drives the evolution of the world, augmented by human interaction. The endemic language of this world is a system of icons that may be combined using rules to create an endless number of possible meanings. However, the forms within this world are derived from combining elements within a database of pre-existing forms. *lifeSigns* aims to extend this process of meaning generation by using a grammar to create multiple possible iconographic languages.

2.3.2 Semiomorph

Semiomorph [2] is a digital game that explores "semiotic morphism", a "systematic translation between sign systems". [1] The term captures the shape-shifting plasticity of relationships between sound, image, text, and users in virtual worlds; the interactions through which meaning is made, transformed and remade dynamically and synaesthetically in real time. In this work, the gameplay is centred around a typical digital game structure with levels, score, enemies and so on. *lifeSigns* aim to allow 'free play' with the world by removing these constraints - enabling exploration and experimentation within the world.

3. lifeSigns: Eco-System of Signs & Symbols

lifesigns explores the idea of language as emergent phenomena. It intends to establish a digital semiotics that includes dynamic form, evolving structure and synaesthetic representation in its definition. An underlying "abstract machine" defines rules for generating the glyphs in the language, and these rules extend to define their behaviour in a virtual world.

A number of theories on the language of digital media have emerged recently. *lifesigns* investigates five properties of digital media described by the Manovich [6] theory on digital media language.[1] The numerical representation characteristic of digital media is the basis of all processes and interactions within the *lifesigns* system. The living signs, or 'lifeSigns', generated by the system are built from simple atoms, and this modular approach is applied at all levels in the system. The work evolves through multiple iterations autonomously, utilising the capacity of digital media to encode process. Icon's that evolve from these processes display a high degree of variability in their representation, resulting in an emergent language rather than a language that is designed or constructed. lifeSigns are represented as image, sound and motion through the transmutation of the digital code from which they originated. The user may play selected icons and

[1] Lev Manovich proposes five properties in *The Language of New Media*: (I) numerical representation, (ii) modularity, (iii) automation, (iv) variability, and (iv) transcoding.

this causes signals to be transmitted through their geometric structure. These signals create movement and sound in the generated icons that illustrate the internal processes within the system.

3.1 Overview

lifeSigns is a world that generates iconographic languages. It explores the idea of 'emergent language' through computational processes, where both human and digital agents contribute to the formation of meaning.

It explores he interdisciplinary model for meaning generation articulated earlier via the intersection of artificial life and generative systems, computational semiotics, and digital games. The processes encoded into artificial life software may be connected to systems and codes of signification enabling the evolution of digital media languages. The living signs ('lifeSigns') evolved by the system are represented through form, structure, colour, sound, motion, surface and behaviour. The game environment makes the system tangible and provides a medium for feedback.

Navigation and play in the *lifeSigns* world using conventions of digital games and electronic musical performance. Playing each lifeSign reveals its unique form and behavior through synaesthetic animation of image and sound. The languages generated by the work are interpreted by the audience through a cumulative process of assigning meanings during play in the world.

The work explores themes of language and meaning, synaesthesia, process, representation and reality, and the nature of digital media. The system and processes of the *lifeSigns* world will be explored within the context of these themes.

3.2 Installation

The lifeSigns world is an interactive installation that combines two separate views of the space. A large projection shows a map of this world, accompanied by a generative soundscape. Four workstations placed around the edges of the map enable navigation and play of the world. The space appears to be infinite as the player may continuously navigate and search in any direction – there is no up or down. Although it is a three-dimensional representation there is no horizon line or indication of linear perspective, but instead multiple layers of abstract form, colour and movement. When lifeSigns are played they perform animation and music, and their energy is increased thus making them more likely to persist in the world. When multiple users are playing a number of lifeSigns simultaneously, the result is a symphony of artificial image and sound.

The gallery space is extended by the connected web site, which documents all of the icons generated in the world. Visitors to the site can assign meanings to each lifeSign that are transmitted back to the installation.

3.3 Interaction

Interaction with lifeSigns can be summarised into three levels of experience:

1. Ambience: experience the installation space, multi-layered sound, activity in map view
2. Navigation: using one of the workstations to move through the world, observe icon behaviour and form
3. Play: Select and play icons causing them to perform animation and music, give them energy. Multiple players may perform together.

3.4 World

Within the installation space, the *lifeSigns* world is represented in a top-down 'map' that shows all the current lifeSigns, meanings for sequences of connected lifeSigns, and behavioural interaction. This view is shown in Figure 1. In addition to function as a dynamic display of information pertaining to the current state of the artificial world, this map visualizes the idea of a world made of signs and symbols. It can be seen as a kind of iconic cosmos displaying the evolutionary process of the world's audiovisual language.

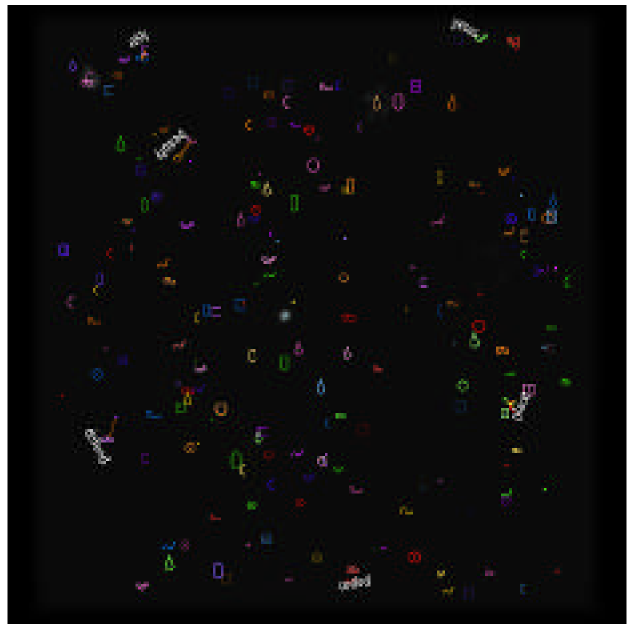

Figure 1. map of lifeSigns world

The world itself is populated by hundreds of lifeSigns that move and interact autonomously. It is a persistent world – data is saved regularly – so that during a period of gallery installation the world population is the result of many generations of lifeSigns. As depicted in Figure 2, the space is simply a large, square volume filled with lifeSigns. As the player freely navigates this space, the experience may be described as immersion in a three-dimensional volume of abstract form and colour. It is a 'persistent world' – the data is automatically saved on a regular basis allowing the same lifeSigns world to run over many generations during its installation in a gallery space.

4. STRUCTURE

Each lifeSign generated by the world is unique. Its form and structure is generated by rules that are stored within a 'dna' string that defines many of its attributes and properties.

Structural patterns are discernable in existing families of signs and symbols. Studies of these patterns have resulted in their use as an indexing tool to search large collections of symbols using features of their form and structure to identify them. The Dictionary of Symbols [5] uses this kind of system to allow the meaning of symbols to be defined simply by deconstructing their form and structure. The system used in this dictionary classifies symbols in terms of soft and hard lines, symmetry and other formal properties

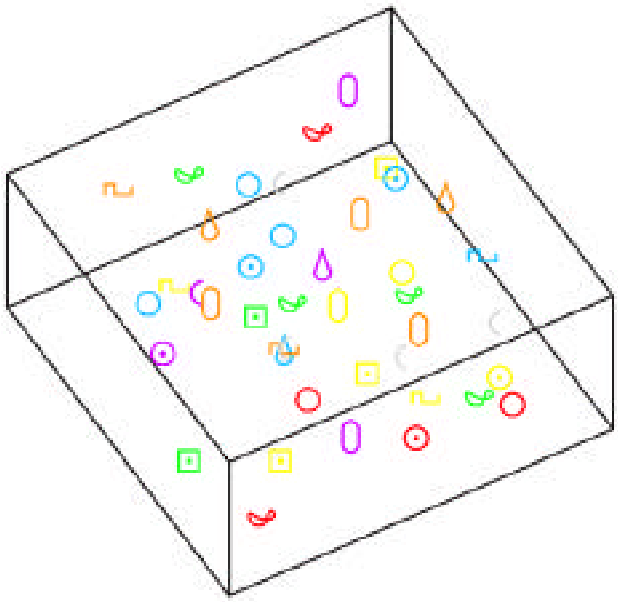

Figure 2. 'volume' of lifeSigns

This system was adapted into the rules used for generating the form of lifeSigns. An atom is the most fundamental component of the system. It exhibits visual and sound effects. Atoms are used to form more complex structures, called lifeSigns. Within this system each lifeSign is built from the atoms in a hierarchical fashion, beginning with a central core shape. An atom is defined as the basic unit within this structure –in Figure 4 a central core shape (the large circle) has six atoms (the smaller circles) connected to it.

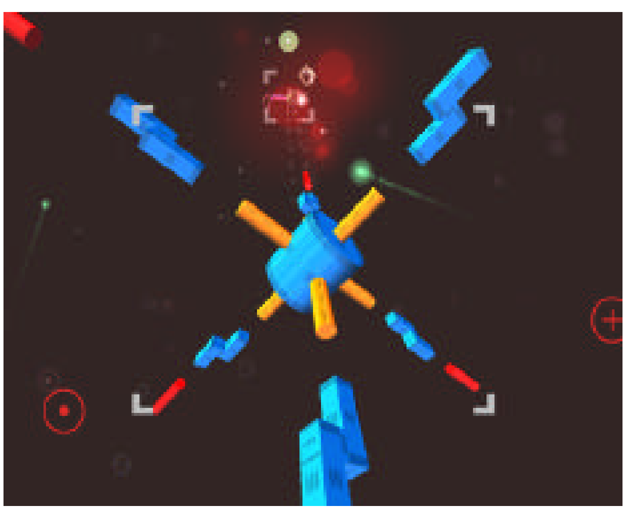

Figure 3. an image of a lifeSign

4.1 Structural Constraints

The structural constraints are defined in terms of a further developed set of criteria for the structural features of signs and symbols. As the lifeSigns exist in three-dimensional space, many of these rules needed to address the new possibilities of that space such as multiple axes of symmetry. Further rules for colour were also added that apply constraints to the palette of each lifeSign.

Fifteen structural constraints are defined in the system that are defined in detail in terms of the software operation, and some constraints interact with one another to create combinations of rules. However, in general terms, there are five main groups of these constraints:

1. *Symmetry:* this occurs in X, Y & Z axes
2. *Construction:* whether or not atoms intersect one another, if they ascend or descend in size through levels of the hierarchy and whether atoms form clusters or long chains of structure.
3. *Geometric primitives:* structural constraints govern the selection of geometric primitives (as described below).
4. *Colour:* different colour palettes may be generated including monochrome, uniform colour, any colour.
5. *Core shapes:* different core shapes may be used, including solids, freeform lines, points, open and closed lines.

These structural constraints comprise the basic, fundamental defining rules of the lifeSigns structure. Other levels of the system build and interact with these principles.

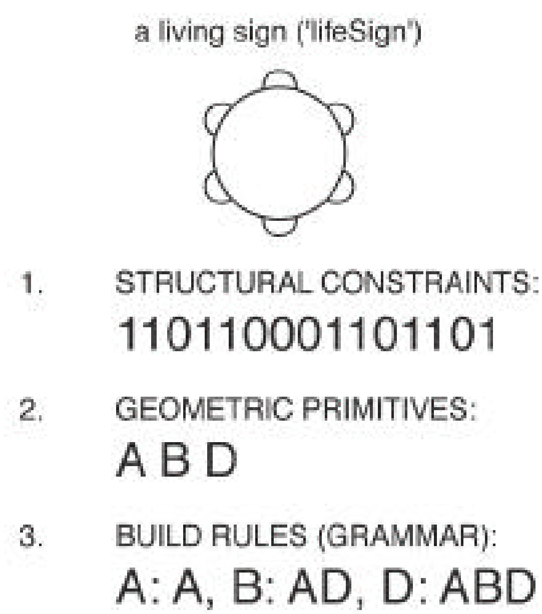

Figure 4. Structural rules for lifeSigns

4.2 Geometric Primitives

Governed by the structural constraints, selections from a set of geometric primitives and cores shapes are made for each lifeSign. This selection defines the basic set of building blocks usable in construction. Forms in the shape library consist of spheres and ellipsoids, cubes and oblongs, cones, cylinders, elbows and corners, torus shapes, squares, and some freeform curves. These are classified into 'soft' and 'hard' forms and different combinations of structural constraints will allow either or both of these to be used within a lifeSign.

It was important to limit the possibilities to those that make sense within the intended aesthetic and communication strategies of the work. In this case, the shape library is made from 'natural' forms of electronic space – the kinds of forms typically generated in 3D modeling software that are useful for constructing computer icons. Alternative shape libraries could also be used. One possibility that was considered during development was the use of gestalt symbols such as a star, a heart, a lightning bolt, and so on in order to create hybrid meanings of a different sort.

4.3 Build Rules

A simple grammar is defined that adds further constraints to the building process. For each shape selected from the library, a rule for what other shapes may be connected to it is defined. Probabilities for the each connecting shape are also generated. In the example depicted in Figure 4 a lifeSign with shapes A, B & D is defined. A build rule is then defined for each of these shapes. In the example, an A shape may only be followed by another A shape, a B shape by either a B or a D, and a D shape may have any of A, B or D connected to it. These rules generate patterns in the levels of structure within a lifeSign. Some patterns of structure generated by the sample rules would include:

AAAAA

BAAAA

BDBDBAAA

DDBDBDD

DAAA

DBDAAA

and so on…

All of this information is stored in the dna string so that it recorded as a characteristic of that lifeSign and passed onto children in further generations of the system.

4.4 Outcome of the system

Codes and relationships defined using the analytical tools of computational semiotics may be translated into genotypes, fitness functions, rules and grammars of artificial life / generative systems. These systems may then in turn generate more complex semiotic entities that would benefit from analysis using computations semiotics. Models of communication in digital games may be connected to the data generated by artificial life / generative systems to make this data perceptible and facilitate user interaction.

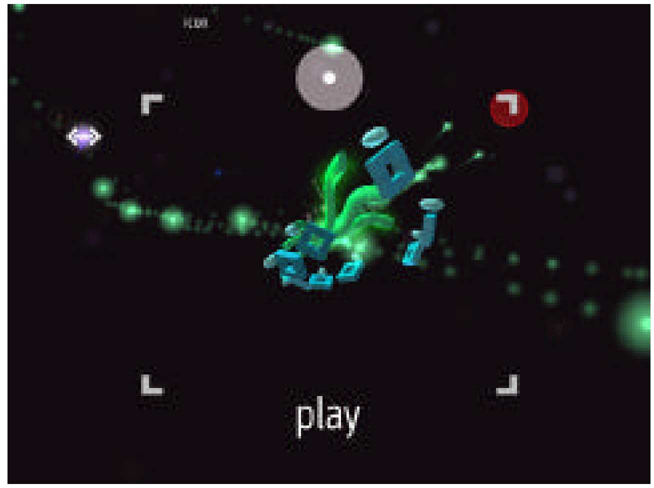

Figure 5. lifeSign in play

5. IMAGE & SOUND

Once each lifeSign is constructed from geometric primitives, additional parameters are defined that relate to its visual appearance, animation and sound. As the lifeSigns exist in a three-dimensional space represented by computer generated images, their visual representation relates to aspects of the 3D engine used to render the world. Translations of geometry, particle effects, texture mapping and 3D shader effects were among the parameters explored in the visualization. The sound or voice of the lifeSigns is generated using musical instruments defined by MIDI controlled synthesizer patches. Parameters of the synthesizer used to create the instruments such as its envelope, filters, pitch and amplitude effects form the parameters of sonic representation.

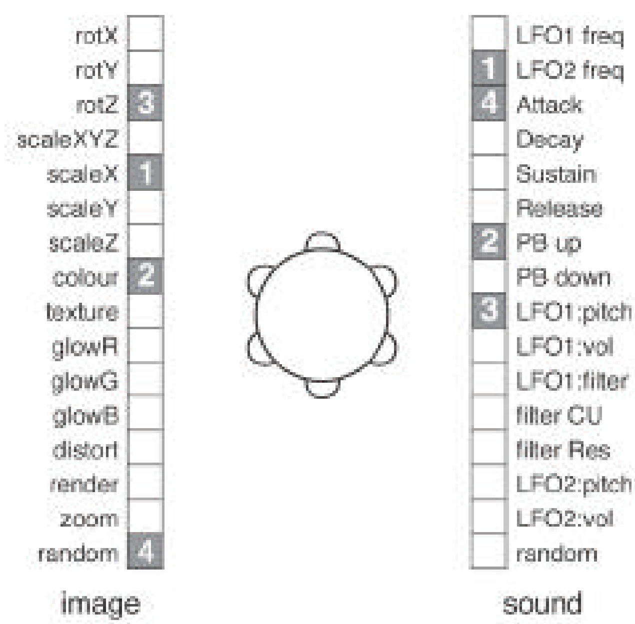

Figure 6. image and sound parameters (with selection)

5.1 Image & Sound Parameters

In this work, the Criterion Renderware 3D graphics engine was used to display the simulation. There are three basic types of image parameters in the system – those that alter the form of the geometry, such as scale, rotation and distortion; others that alter the surface of the forms, including colour, texture and rendering mode; and finally those that project glowing particles from the surface of the forms. An additional 'random' parameter selects a different parameter at random every time the lifeSign is played. During play, different parameters may be combined so that compounded effects may be generated such as scaling a form in the X-axis while changing its colour to blue and rotate in the Y-axis while glowing red.

The sound of each lifeSign is generated by the synthesizer on the Creative Audigy sound card and played back through stereo speakers. The sound parameters may be grouped into four groups – those that change the amplitude of the sound, including LFOs (Low Frequency Oscillators); others that alter the pitch; including pitch bend and more LFOs; parameters that change the frequency of the LFOs themselves; and filter effects. The sound parameters also have the 'random' parameter. Both the image and sound parameters may be performed in realtime and are vary in degree from zero to full effect using a 'continuous control' mode of operation. This allows the players input to be directly mapped to these parameters so that a 3D form may squash and stretch in response to the amount of input received, while simultaneously altering the pitch of a sound in response to the same input.

5.2 Synaesthetic Parameter Selection

Four image parameters and four sound parameters are randomly selected upon the generation of each lifeSign. A sample selection is indicated in Figure 6. These selections are sequentially grouped into image and sound parameter pairs. In Figure 6, for example, the image parameter 'scaleX' is connected to 'LFO2 Frequency' and 'colour' is connected to 'PitchBend Up'. When a player performs the system these parameters are played together as a single image/sound event.

This system allows many different combinations of the parameters to be explored through multiple iterations of the lifeSign generation process. Every lifeSign is unique in its form and structure, and also in how that structure is animated and transmutated into sound through performance of its image and sound parameters. As a result, many different synaesthetic relationships are explored by this system. Changes in the scale of 3D form may be connected to shifts in pitch, the frequency of an oscillator or the amount of attack on an envelope.

All of the selected parameters and groupings are encoded into the dna string of the lifeSign so that they are passed on from one generation to the next. In this way, successful combinations of image and sound persist in the simulation enabling the discovery of new expressive potential within the aspects of digital media used by the system.

5.3 Colour and Timbre

The results of the lifeSign generation process are used to determine other properties of each lifeSign. Their colour and texture is related to a set of defined behaviours in the artificial life model. These are defined in detail in section 6 – the visual effect is simply that each atom in the lifeSign structure may have a different colour. The lifeSigns overall colour scheme is governed by the relevant structural constraints. As a result, the behavioural mix of each lifeSign may be read through its colour and texture. A colour scheme that is predominately red, for example, would indicate a high proportion of the attack behaviour. Mostly green would indicate a more friendly lifeSign. Each behaviour is also represented by an animated texture.

Characteristics of the structure and colour of each lifeSign are used to select from a palette of instruments representing a range of timbres mapped across a simple two-dimensional grid. One axis of the grid varies from 'pure' sounds such as simple electronic tones through to noisy sounds that have complex harmonics and spectral dynamics. The other axis is used to classify sounds from those that are artificial, obviously computer generated or 'electronic', through to natural sounds, including samples of acoustic instruments and human voice. These two aspects of the sound timbre – pure / noise and artificial / natural are mapped to structural complexity and colour respectively. A lifeSign with a simple structure will have a sound on the pure end of the scale, another with a more complex colour scheme will be noisy. Likewise, a lifeSign with a simple colour scheme will have an artificial sound, while one with a more complex colour scheme will sound more natural.

5.4 Sequencing of Image & Sound

When these structures are played, inputs are passed from one atom to another in a hierarchechal fashion. As each atom is 'played' by receiving a signal, it displays a visual effect and plays a note via its instrument. This process is called the propagation of the signal.

There are different styles of propagation that change the way a lifeSign is played, mainly through the initial distribution of inputs to the atoms. These styles are called language, ambient and beatbox. Language mode sends all input to the first atom in the structure, allowing it to propagate down the hierarchy. Only one signal is allowed at a time, resulting in monophonic sound and immediate feedback. It is intended that this mode approximate speech, allowing the lifeSign to 'talk' using its voice and actions. Ambient mode allows multiple signals to propagate up and down the hierarchy, resulting in overlapping patterns of image and sound. Finally, beatbox mode maps inputs directly to separate and specific atoms with no propagation. This results in discrete image / sound events directly in response to play.

5.5 Outcome of the System

A complex system of interconnected parameters that relate to the audiovisual representation of lifeSigns allows the exploration of many permutations of the subset of digital media language expressed through the image and sound parameters defined within the 3D graphics engine and sound synthesizer. Furthermore, these permutations are encoded into the dna string of each lifeSign so that successful combinations of these parameters are inherited by offspring and passed on through generations within the simulation.

6. ARTIFICIAL LIFE

A simple artificial life model governs the overall population and evolution of the lifeSigns world. The lifeSigns have attributes such as energy and meaning that affect their actions in the world. Their primary function is to survive and attract the attention of players who increase their energy by 'performing' them.

6.1 Properties

Each lifeSign has a number of properties that relate to the artificial life model. These properties define each lifeSign as an organism or entity in terms of an eco-system of signs and symbols. As a result, they relate to both life processes, such as survival and reproduction, and to semiotic processes, such as signification and the transmission of signals.

Properties defined in the system include:

Energy: each lifeSign starts with a small reserve of energy. This energy is used when it moves about or performs behaviours. Simply being in the world causes this energy to slowly regenerate, so that there is a simple state of equilibrium. However, an excess of energy is required in order for the lifeSign to reproduce. If a lifeSign uses too much energy or loses it by being attacked it will 'die' and be removed from the world.

Meaning: all lifeSigns have a list of 'meaning vectors' (see also section 6.4) from which their overall meaning is determined by finding the highest value in the list. The amount of this value changes interaction within the system as one lifeSign may have the meaning 'happy' with a value of 100, while another may also mean 'happy' but only with a value of 10. In terms of the lifeSigns world, therefore there are 'degrees of meaning'. There may be many different lifeSigns competing for the same meaning.

Compatability: compatability between lifeSigns is calculated using a comparison of their meanings. Friendly and aggressive behaviours may modify this compatability.

Behaviours: Interaction between lifeSigns occurs through behaviours defined in the system. Each atom in the lifeSigns structure is assigned a behaviour, resulting in different combinations that define its overall strategy. One lifeSign may have a combination of 'leech – befriend – attack' while another may use 'mutate – command – join'. The effect of each of these is described in more detail below.

These properties are manipulated by interaction between lifeSigns and through the actions of players within the installation. The primary methods for these interactions are the behaviours, reproduction process, meaning vectors, formation of sequences and play.

6.2 Behaviours

Each lifeSign has a unique combination of behaviours (see Figure 7) that it may use to interact with others in the world. During interaction, different behaviour will be selected depending on the compatability if meaning between two lifeSigns – if their meanings have relevance to one another they will select friendly, helpful behaviour, if they are not compatible then they will select aggressive, destructive behaviour. An inbetweem state may also be achieved where the two lifeSigns have a neutral relationship. Graphic symbols indicate these states on screen during interaction as depicted in Figure 9.

Figure 7. lifeSigns behaviours

These behaviours function as follows:

Attack: decrease the energy of target.

Reproduce: produced offspring with target using a genetic algorithm.

Leech: drain energy of target and transfer it to self

Befriend: express positive compatability to target

Message: state main meaning vector to target eg. 'I am truth'

Command: tell target to perform particular behaviour

Join: connect to target to expand or create a sequence

Mutate: randomly change one of the audiovisual parameters of target

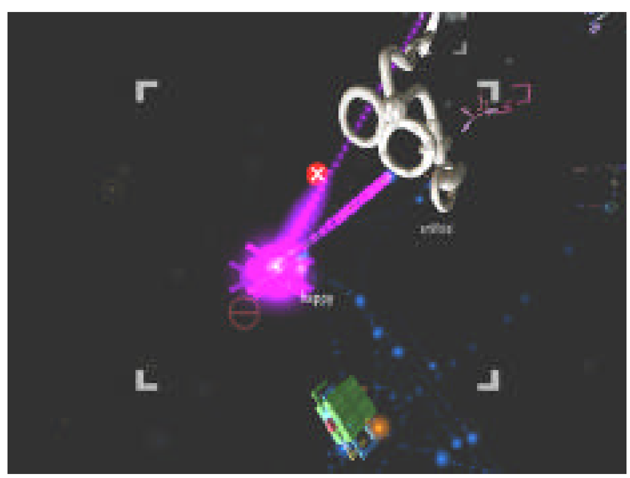

Figure 8. lifeSigns behavioural interaction

The interaction between lifeSigns occurs through the exchange of action signals – this process can be seen occurring in Figure 8. Each behaviour is weighted according to its 'strength' that is determined by how many times it is assigned within the overall 'strategy' of the lifeSign. Action signals are exchanged and may succeed or fail when they reach their target depending on these factors. The dynamics of interaction between the various 'strategies' create different situations between lifeSigns within the world.

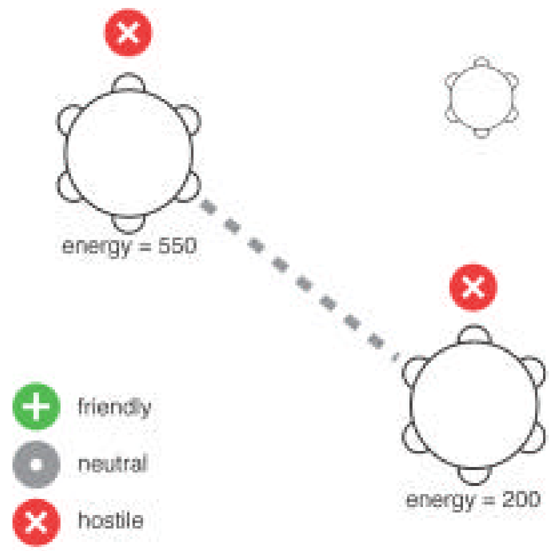

Figure 9. lifeSigns interaction model

6.3 Reproduction

The reproduction behaviour is a special case. If this behaviour is successful, two lifeSigns will produce offspring that combine features of their parents. As features such as structural constraints, build rules, image and sound parameters, behaviour and meaning of each lifeSign are stored in a dna string this can be achieved using a genetic algorithm. The dna string of each parent is used to create a new string combined at a random point of crossover, so that each new lifeSign is a unique blend of its parents.

When the simulation is started, a random batch of lifeSigns is generated. Over time, several generations of this initial population will be created through the reproduction process. Those lifeSigns that are best adapted to their world will survive and reproduce. In this case the parameters for survival include their 'strategy' (a successful mix of behaviours), significance in terms of the meaning system within the world, and being attractive to the players (see also 6.5 Play).

6.4 Meaning Vectors

Each lifeSign has a list of 'meaning vectors' that defines its meaning in the world. This is a list of sixty-four words that describe actions, attributes and structures that are possible in the space. Associations between all of these meanings are expressed as percentage values in terms of the degree of compatibility between meanings. A small network of meanings is depicted in Figure 10 that shows the relative compatibility of a lifeSign with the meaning 'artificial' with other meanings from the list.

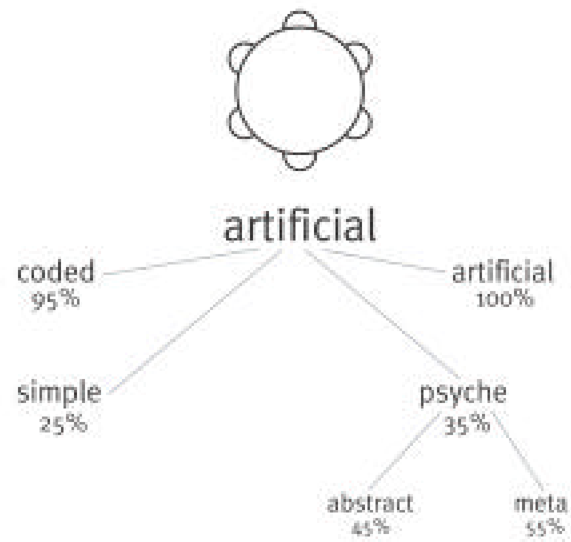

Figure 10. 'meaning vectors' and compatability

There are two main methods by which these lists may be modified. Firstly, the player may directly assign a meaning to a lifeSign in the world by selecting it from an onscreen list. This has an immediate effect, setting the players selection as the meaning with the highest value in the list. However, the process is also cumulative so that previously assigned meanings are also stored in the list, giving each lifeSign multiple 'degrees of meaning' in terms of the system. The second method is via an archive of lifeSigns stored on data-driven web site, separate to the installation space. On this web site, meanings may also be assigned but the process is more democratic in that each user may submit a meaning assignment for a lifeSign and the net result of all user submissions is tallied to arrive at the final list. This list is subsequently synchronized with the installation.

Furthermore, the *lifeSigns* web site supports the gallery installation of the work by archiving and documenting popular and successful signs and symbols that have been generated by the world. Users may search networks of meaning within a database and influence the meaning of icons by voting on their 'meaning vectors'. The web site is an ongoing 'research tool' for exploring the languages that emerge from the *lifeSigns* world.

6.5 Formation of sequences

The join behaviour allows the formation of sequences of compatible lifeSigns. This is indicated by dotted lines in the space showing the links in each sequence. Sequences perform the role of small 'communities' of similar lifeSigns that are able to share resources such as user play input. Being together also makes them more resistant to aggressive behaviour and increases the probability of friendly interactions between neighbouring lifeSigns.

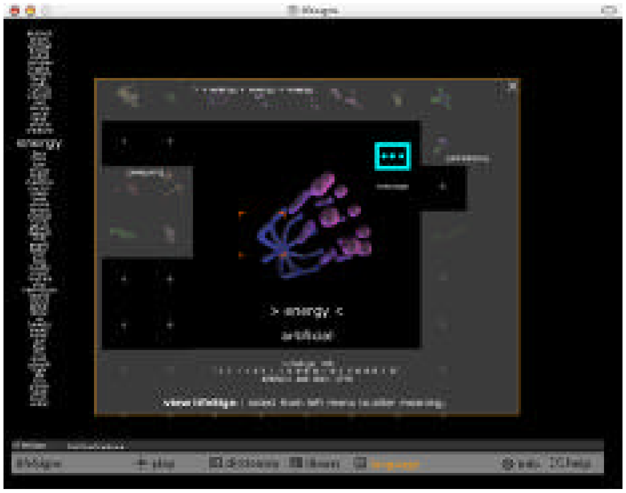

Figure 11. lifeSigns web site

The distribution and population of sequences in the world changes dynamically over time. Some links persist for long periods, other dissipate quickly either through the intervention of players or changes in the relationships between the lifeSigns. The clusters that form are visible on the map view as groupings of similar forms, labeled with the highest meaning in the sequence. In this way, sequences are a useful index to popular and successful meanings in the world – simply by viewing the map it is easy to see the current state of the simulation in terms of both population and distribution of meaning.

6.6 Play

As the players navigate the world, the lifeSigns that they select and play receive energy. More play results in more energy. This increases the likelihood of its persistence in the world and the production of offspring. The process of play itself is rewarding also for the player – this is described in terms of gameplay within section 7.

As a result, the survival of lifeSigns is dependent on this process of 'aesthetic selection'. Those that receive the most user input thrive and reproduce – their form and meaning spread throughout the world. Others that receive little or no user input eventually use up all of their energy and die, making space for the offspring of more successful lifeSigns.

6.7 Outcome of the system

New codes and communication forms may potentially be evolved using genetic algorithms and iterative processes. This provides a methodology for searching the solution space of a given set of semiotic relationships translated into an alife model. Signs and symbols may have agency within a simulation, such as a digital game, to evolve and adapt to suit the conditions of a particular environment. They may modify themselves in reaction to data collected in relation to factors such as their interpreted meaning, popularity or patterns of use.

7. PLAYING THE WORLD

The interface and play of the lifeSigns world are essential in the experience of the world. It is a world that needs to be played and explored in order to perform its function as a generator of iconographic languages.

7.1 Interface/sign system

The interface pictured below is used to play the work. It combines a trackball, used to navigate the world / select icons, and four 'touchpads', used to play the lifeSigns as audiovisual instruments.

Figure 12. lifeSigns interface

To navigate the world, the player may orientate their view using the trackball. The left button causes forward movement through the world. With a lifeSign in view, clicking the right button allows you to 'acquire' that icon. The HUD changes to show you have a lifeSign acquired.

In this mode the controls change. Trackball movement causes rotation about the lifeSign, the left button zooms the viewpoint, and the right button 'deacquires' the lifeSign, returning you to the navigation mode described above.

When an icon is acquired it can be played through the interface, an AKAI MPD16, mapping four of the pressure pads to the four inputs of the icon. When an input is activated the image and sound parameters are performed, following the rules of propagation described earlier.

7.2 Signals

The inputs become signals that travel through the icon and result in further animation and sound. These signals leave the icon and can collide with other nearby icons causing them to play as well. Through this process the user can play the icons like an instrument.

The process of signal transmission is depicted in Figures 13 and 14. Once signals are propagated through a lifeSign, they are transmitted to the next adjacent lifeSign triggering a performance of its image and sound parameters. Multiple signals can be generated, dramatically increasing the image and sound activity in the world as the signals are transmitted across multiple lifeSigns. A hidden feature allows the player to also move and play a lifeSign at the same time, allowing it to move through space spreading signals. Within the installation, up to four players can perform at once allowing multiple performances to occur simultaneously.

Figure 13. lifeSigns at play

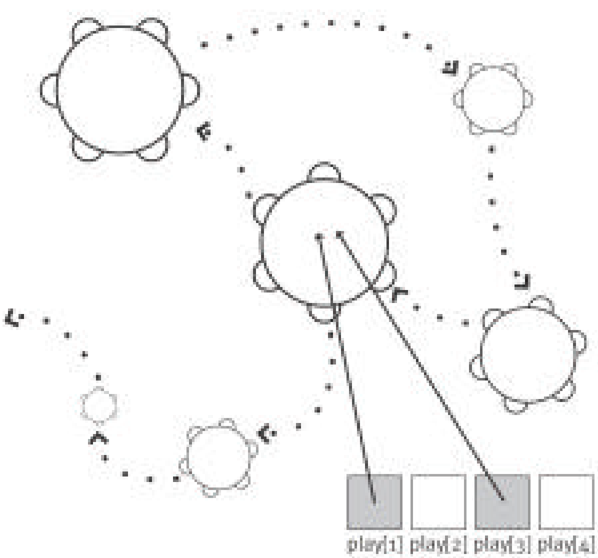

Figure 14. lifeSigns: signal transmission process

8. CONCLUDING REMARKS

8.1 lifeSigns as generative meaning system

lifeSigns allows engagement with the process of 'playing a world'. Interfacing the player as an active agent in the generative meaning system is achieved through the fluid, mutable representation of digital game worlds. The structure and relationships defined in a sign system are given a literal, tangible form in the simulation of the game world. As the simulation itself is essentially a network of signs, the world becomes both interface and representation of its underlying logic and evolutionary processes. So, in general terms the world as sign system is translated across three realms; its behaviour is defined in terms of artificial life / generative systems, its meaning defined in terms of computational semiotics, and its representation manifests in the form of digital games.

As the players may interpret the meaning of lifeSigns in the world, and the cumulative input of all players is collated to determine the final meaning of each lifeSign. This process, combined with the system for generating icons, demonstrates a protoyypical 'generative meaning system'. It combines the capacity of the computer to generate a multitude of novel forms using a generative system with the collection of data from human participants to interpret the meaning and significance of the forms generated.

9. ACKNOWLEDGEMENTS

lifeSigns was produced in association with the Film Victoria Digital Media Fund, the Australian Centre for the Moving Image (ACMI), Monash University and Renderware. Troy Innocent gratefully acknowledges the collaboration and contribution of Nicholas Sandow, Shee Zon Chen, Hou Leng Tan, software development/programming; Jeremy Yuille, interactive sound design; Steve Law, sound design; Steve Taylor and Harry Lee, database design/coding.

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