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Database Architecture: Arch-OS [Speaking in Tongues].

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ABSTRACT

This paper discusses the development of the Arch-OS Project (http://www.arch-os.com), an 'Operating System' for architecture - software for buildings. 'Arch-OS', commissioned in 2003 for the Peninsula Medical School is a transdiciplinary interactive architecture initiative that draws together a team of software engineers, architects, artists, robotics and AI researchers. The project has been developed around a number of research questions, the most, including:

The history of 'public' art for architecture is littered with decorative baubles festooning the facade. Is there potential in the visualisation of human-centric data framed through a responsive and intelligent environment provide a new and critical relevance at the interface between the 'architecture' and the 'art'?

When freed from the artifice of digital rendering techniques what are the true emergent behaviours of human interaction that define an architecture. Should the intent be to create an intelligent building or nurture intelligence within its inhabitants, and would this engender a reciprocal space of shared social responsibility?

INTRODUCTION

Arch-OS (http://www.arch-os.com) is an 'Operating System' for architecture - software for buildings. Arch-OS draws its inspiration from the affordances offered by the convergence of new technologies, debates around immateriality and virtuality, concepts of intelligence and interactivity (objects, environments, and systems) and the practice of interactive art and design. Arch-OS has been developed to manifest the social, technological and environmental life of a building and provide artists, engineers and scientists with a unique environment for developing transdisciplinary research and production. Arch-OS interacts with the inhabitants of buildings in order to provide dynamic temporal information on their activities and impact on the environment. In the process of realising these behaviors Arch-OS generates dynamic data models of the complex interactions within a building. Arch-OS has been integrated into the fabric of the University of Plymouth's Portland Square building, which houses the Head Quarters of i-DAT [the Institute of Digital Art and Technology: http://www.i-dat.org].

Figure 1: Arch-OS System.

Arch-OS

An 'Operating System' for architecture [software for buildings].

Arch-OS combines a rich mix of the physical and virtual into a new dynamic architecture. Arch-OS uses embedded technologies to capture audio-visual and raw digital data through a variety of sources which include: the 'Building Management System (BMS) (which has approximately 2000 sensors in the Portland Square development); digital networks; social interactions; ambient noise levels; environmental changes. This vibrant data is then manipulated and replayed through audio-visual projection systems and broadcast through streaming Internet and FM radio. By making the invisible and temporal aspects of a building tangible Arch-OS creates a rich and dynamic set of opportunities for research, educational and cultural activities, as well as providing a unique and innovative work environment. The Arch-OS takes the notion of 'smart'

architecture to a new level of sophistication. Arch-OS is its nervous system for 'intelligent' architectures, it interacts, responds and anticipates. The substrate for this Operating System is the data (collected, translated, stored, manipulated and manifest) that flows through Arch-OS. The amount of data flowing through the Arch-OS Core can be witnessed here: http://arch-os.scce.plymouth.ac.uk/real_index.html

A version of Arch-OS is currently being developed through an international public competition and commission, known as the 'i-500', and is incorporated into the fabric of the new Minerals and Chemistry Precinct buildings at Curtin University. A representative of the Arch-OS project works as a integral member of Woods Bagot Architects team. The i-500 is a responsive and intelligent installation that supports the development of research in nanochemistry, environmental science, biotechnology, and forensic science. The i-500 evolves through a dialogue with the research community and the translation of the dynamic data from physical and social interactions within the building.

Arch-OS Systems:

There are 3 system levels to Arch-OS:

[A] Interface: the construction of the internal media networks and data collection devices. The interface (between the physical and the virtual) consists of a dedicated network that transports data from a range of sensors (intelligent cameras that monitor the 'flocking' of people, microphones to monitor ambient sounds, BMS information, network traffic data, lift location and movement) to the 'Core'.

[B] Core: (*figure 1*) the processing and manipulation of the dynamic data generated by the 'interface'. The Core computer systems incorporate a range of interactive multimedia applications (video and audio processors, neural networks, generative media, dynamic visualisation and simulation software) that generate a dynamic 3D sonic model of the building and its activities. This model allows artists, scientists and engineers to manipulate and control the buildings media output which can be broadcast within and between each structure, and out over the internet. The core enables the sensing and monitoring of social, spatial and technological interactions such as:

- the movement of people and spaces occupancy can be translated into metaphorical representations such as flocks of birds, and many forms of natural phenomena: clouds, waves, buildings being constructed, viruses forming and collapsing.
- Temperature can be read and again translated into images and forms, and particularly into lighting systems that modify colour and ambience.
- Exploring 'Lift Zoning', we are able to develop interesting programming techniques that will make the lifts more intelligent, able to learn user habits and needs and provide a far more intelligent service to the standard dumb lift.

[C] Projects: the projects enabled by the Arch-OS system are the audio-visual manifestation of the dynamic data processed by the Core. The Projects component of Arch-OS are a curated ongoing programme of cultural events, musical performances, installations and exhibitions which take advantage of the unique digital opportunities presented by the building. The institute of Digital Art and Technology (i-DAT) is housed in the centre block of the Portland Square development and will develop, exploit and curate the Arch-OS Core systems to display and disseminate digital works produced by transdisciplinary practitioners.

Convergence:

It is the convergence of these systems that enable Arch-OS to generate powerful models that that reverse the traditional notion of the architectural model. As a system of convergent technologies Arch-OS realises Kwinter's aspirations for digital modelling tools for "...the consideration of dynamical phenomena or dynamical morphogenesis, toward geometries or patterns that are not static but appear only *over time*..." and "the study of phenomena no longer in analytic isolation but as embodied within a rich and unstable milieu of multiple communicating forces and influences..."
(Kwinter, S. 2001)

The Core system can be seen as an extension of the architectural model. It is a dynamically generated software model that cannot exist without the data feed that spawns it. It has a symbiotic relationship with the building that hosts it representing the combined activities of the code at work within the Arch-OS system Essentially an 'Operating System for Architecture' Arch-OS is able to unite and control existing software applications running within a building. It is easy to forget the level of code that exists within most buildings; code controls the lifts, heating, ventilation, alarms, security systems and door locks. Arch-OS provides a common interface that establishes a coherent language that makes all levels of a buildings software infrastructure accessible.

One output of this common language is the ability to map all the data sets within a building. A key aspect of this language is that it is translated into the domain of the buildings occupants through their interaction with the projects that it enables. In doing so the building has the ability to enter into a direct dialogue with its inhabitants. It senses their presence and makes its awareness known. It creates a critical relationship between the space, the architecture and the inhabitants. Through this relationship inhabitants

re-programme the building and the building re-programmes the behaviour of the occupants. This dynamic social interaction provides a backdrop to the following exploration of the space of a data architecture, but at all times the glue that binds the physical space of the building to the mental state of the inhabitants is code.

Components:

A selection of Arch-OS data components:

Core Model: The Core Model is available as a live 3D model of this code and can be downloaded as a screen saver or as an online 3D model. Every computer in a building has the option of using the Core Model screensaver (*figure 2*). This generates a dynamic recursive environment within the building. Sitting in the building the inhabitants can see a live, real-time 3D representation of the building, the space they occupy, on their screen. As a model its existence is dependant on the occupants of the building and the digital fall-out from their interactions with it. A multidimensional space that occupies no space at all.

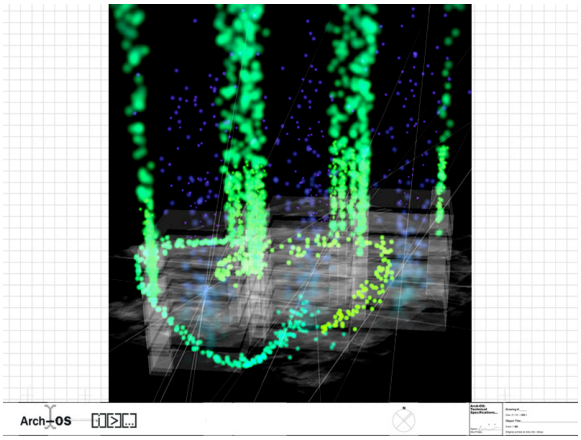

Figure 2: Core Model.

Vision Tool: The Arch-OS Vision Tool (*figure 3*) provides dynamic data on crowd motion in public spaces. The information is acquired by four CCD cameras overlooking the space in Portland Square and is made available to any computer in the Arch-OS system. The composite video signals of each camera are pre-amplified, before being sent to the Vision Tool. The Vision Tool acquires live images with a frame grabber card and processes them using a dedicated motion detection and tracking software (10 x 10 matrix). Motion information is stored every 40 ms as a data matrix using a double buffer scheme. The Vision Tool's web server allows it to access the most up-to-date data in the form of a binary stream produced by a server-side CGI program.

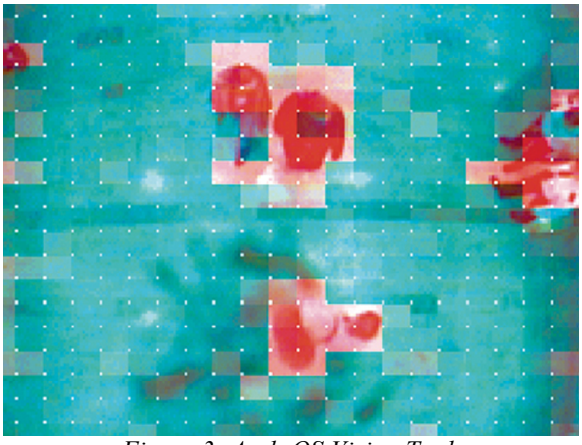

Figure 3: Arch-OS Vision Tool.

Slothbots: *Slothbots* (*figure 4*) are large autonomous robots that move incredibly/imperceptibly slowly. They reconfigure the physical architecture imperceptibly as a result of their interactions with people, over time. *Arch-OS:* Sloth-bots, build on robotic technology developed by Dr Guido Bugmann that was famously incorporated into Donald Rodney's *Psalms*. This work was exhibited in the South London Gallery as a part of Rodney's last exhibition, *Nine Nights in Eldorado*, in October 1997. In *Psalms* an autonomous wheelchair uses 8 sonar sensors, shaft-encoders, a video camera and a rate gyroscope to determine its position. A neural network using normalized radio band frequency (RBF) nodes encodes the sequence of 25 semi-circular sequences of positions forming the trajectory. The results may be viewed at the Web site:

http://www.tech.plym.ac.uk/soc/research/neural/research/wheelc.htm

The slothbot control system consists of a laptop PC 586 running a control program written in CORTEX-PRO, and linked to a Rug Warrior board built around the 68000 microcontroller. Slothbots use additional technology to link between the Arch-OS vision tool and the autonomous architectural forms. As the use of the space changes throughout the day, slothbots reposition themselves in anticipation of new interactions with the buildings occupants.

Figure 4: Slothbot.

GreenScreen: The large screen installed in atria A of the Portland Square complex is driven directly from the Arch-OS core. Visualisations of data generated by the building reveals the ecological footprint of the building and its inhabitants. The screen, measuring some ten meters high is constructed from low energy RGB LED's (ColourWeb) and allows a resolution of around 68x48 pixels. Figure 4 depicts an early manifestation of the screen and displays an interactive artificial intelligent entity called 'Noogy' (*figure 5*). Noogy's personality was wired directly into the Arch-OS core allowing him to experience 'emotions' such as: 'loneliness' when the vision system could not detect people, environmental temperature changes, Noogy's hair would move in the direction of the wind, and 'anger' in response to SMS messages that were deemed unsavory. The Green Screen is funded by the Centre for Sustainable Futures, one of the four CETL's (Centre for Excellence in Teaching and Learning) awarded to the University of Plymouth.

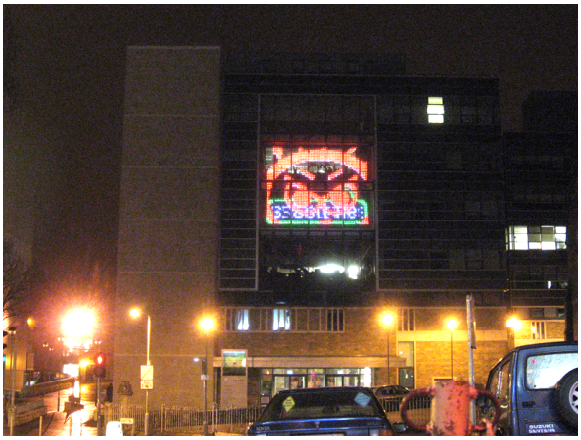

Figure 5: 'Noogy'.

Spatial/temporal Experience:
Data Architecture offers a spatial and temporal experience at a more human-centric scale. It is, after all, generated by the people that inhabit it. Arch-OS provides a new 'data model' for architecture and a new 'model' for social participation: a model that is simultaneously virtual and real, evolving through the collection of cultural crustacea, or transformed through a 'sea-change into something rich and strange'. The Arch-OS system enables dynamic real-time modelling of the processes within a building. These models enable a greater transparency and understanding of the complexity of modern buildings. Arch-OS models enable a building's occupants to reflect on the complexity of their own interactions as they move through time and space, both physically and through the extended social interactions enabled by communications technologies.

Through the acoustic and visual re-presentation of their social activity, combined with dynamic representations of data generated by the electro-mechanical and environmental activities of the building, occupants are able to better understand the complex relationships that exist between each other and their environment. In doing so the building has the ability to enter into a direct dialogue with its inhabitants. It senses their presence and makes its awareness known. It creates a critical data relationship (relational data) between the space, the architecture and the inhabitants. Through this relationship inhabitants re-programme the building and the building re-programmes the behaviour of the occupants. Arch-OS is a data model for all establishments whatsoever, in which, within a space not too large to be covered or commanded by a network, a number of persons are meant to be kept in a critical discourse.

BaseData:

The Arch-OS project is managed by the Institute of Digital Art and Technology and produced by members of i-DAT and CNAS research groups based in the University of Plymouth. Arch-OS is produced in collaboration with the Architects and Engineers: Feilden Clegg Bradley Architects, Buro Happold, Nightingale Associates, Hoare Lea, DrMM (Derijke Marsh Morgan), Signwave/CASM, Woods Bagot Architects.

Arch-OS: is a collective of individuals working from the School of Computing, Communications and Electronics at the University of Plymouth. The Arch-OS development team consists of: Birgitte Aga (Creative Producer), Martin Beck (Intelligent Systems/Genetic Data), G. Bugmann (Autonomous Robotics), Mike Phillips (Arch-OS Architect) Justin Roberts (Data Architect), Chris Saunders (Green Screen) and Chris Speed (Tele-Social navigation/Spaceman). Arch-OS is managed by i-DAT [http://www.i-dat.org].

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