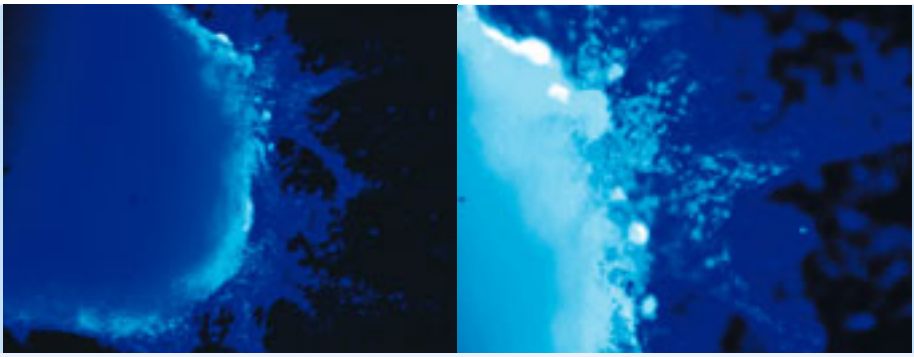
SymbioticA Research Group

Fish & Chips

The Current Status of the Research



Hieke Wiess

Outgrowth of cells from an isolated graft from the central nervous system of a gold fish

Fish & Chips is a bio-cybernetic research & development project exploring aspects of creativity and artistry in the age of biological technologies. *Fish & Chips* is assembled from fish neurons grown over silicon chips—"wetware," software and visual and audio art output devices – hardware. The current state of research – work in progress – into the development of a "semi-living artistic entity" will be presented.
This installation features the laboratory/studio set-up, prototypes and documentation of the project, and is an example of the research being conducted in SymbioticA—The Art & Science Collaborative Laboratory, Department of Anatomy & Human Biology, University of Western Australia.
Biology is evolving from a phase of discovery into a phase of creativity and utilization. The effects on society will be profound. Hands-on wet biological art is starting to be seen as a valid means of expressing cultural and artistic perceptions as well as exploring neglected areas in biological research. It explores the nature of contestable futures that may arise. The cybernetic notion of interfacing neurons with machines/robots is starting to become a reality[1].

The vision

The aim is to assemble a semi-living artistic entity from distributed colonies of isolated neurons grown over custom-made silicon chips fitted with an array of microelectrodes. Each colony of cells will communicate within itself via a real neural network that will be formed in the culture, while the colonies will interact with other colonies and receive input via a digital network (the internet). The neurons' action potentials will be induced by different stimulations generated by feedback loops such as "observing" the work of the robotic arms, or "listening" to the music. *Fish & Chips* will be "inspired" by various external inputs. A centralized server running pattern recognition and device controller software will process the resulting neural activity. The software will control the artistic output—audio-based art and artificial muscle-operated robotic drawing arms (with advances in tissue engineering we will try to control the movement of the arm using real as well as artificial muscles).
Fish & Chips is grown/constructed to evolve and create visual and audio artistic outcomes

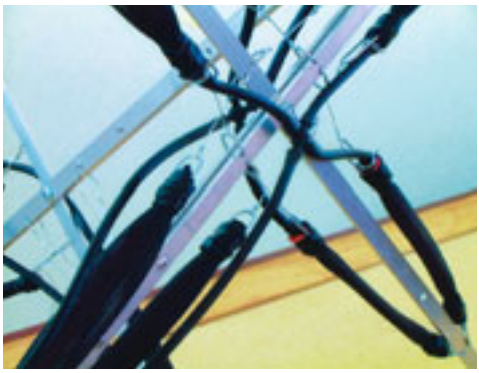
and through that, to explore the notions of creativity and the nature of art. This hybrid is set to perform an open task, reveal its inner working as drawings and manipulation of a sound piece.
The assimilation of wetware/software/hardware, fish-neurons/digital components/robotic arms sets a forum to symbolically deconstruct creativity into its basic elements while stimulating and manipulating it through the different stages in order to observe and explore what the "artist" will do and how "he/she" will react.
Notions of creativity and art have been explored extensively both from the point of view of the machine and the biological agent, for example "Aaron", an art-producing computer program created by Professor Harold Cohen[2]. A different example highlights the biological non-human entity as an artist. "Elephant Drawings" is a traveling exhibition of drawings made by elephants[3]. In these two examples the art establishment has accepted these drawings as works of art and exhibited them in the appropriate art institutions.
Fish & Chips takes the basic "thinking" components (isolated neurons) and attaches them to a mechanical body through the mediation of a digital processing engine to create an entity that will evolve, learn and become conditioned to express its growth experiences through art activity. The combined elements of unpredictability and temperament with the ability to learn and adapt, create an artistic entity that is both dependent on, and independent of, its creator and its creator's intentions.
The elements of audience interaction with *Fish & Chips* are of importance not only for stimulating *Fish & Chips* to further push its creativity, but also for exploring our abilities and intentions in dealing with a being that may be sentient, creative and unpredictable.

The current status of our research

In this installation we will present the current status of our research in SymbioticA. It will consist of 3 physical areas:

1. **The tissue culture laboratory:**
   We use methods developed in the science research labs at the University of Western Australia to investigate the ability of silicon chips with embedded electrodes and custom-designed morphologies to form a link between damaged nerve fibers and prostheses or muscle stimulators.
   We are now at the stage of developing methods for growing the neuron colonies in 3 dimensions in a bioreactor fitted with a multi-electrode array.

2. **Electro-physiology & data processing laboratory:**
   The neurons fire a signal (action potential) after reaching a threshold of input signals received from other connected neurons, or spontaneously. Some cells fire in "trains" or bursts, others singly, some like the ticking of a clock.
   For this installation we will set up a recording system to monitor and record these signals from a fish's tectum with part of the retina attached, which we do mainly to gain more knowledge in electro-physiology, tissue engineering and wetware/software/hardware interfaces[4]. The activity occurs when the fish's retina is stimulated with light. The recording system is fine-tuned to pick up the activity and pass it to the amplifying systems with as little extraneous noise as possible. The highly amplified signals are passed through an A/D converter to the software controlling the artificial muscle system. The spikes, time phases and other fundamental properties of the biological activity are extracted and used to control the various parameters affecting the pneumatic "muscles" of the device and the sound piece.



3. The Studio

The robotic drawing device receives the processed data from the computer software and translates it into drawings. The computer software will process the input data and control an array of valves in a binary way, signaling them to open or close. These valves allow compressed air to flow into the artificial muscles, which are pneumatic. As the muscles are inflated they contract with sufficient force to move a pen/pencil across the surface of a paper. The muscles are made of two major components – the internal air bladder which causes contractions in the second component, the outer casing.

The music-producing module will receive the processed data from the neurons. The input channel will be converted to the MIDI protocol in order to control and manipulate predefined rhythmical and timbral algorithms. The musical output of these algorithms will be sent to a MIDI synthesizer, which will generate the musical piece.
By creating a temporal "artist" that will perform art-producing activities, *Fish & Chips* explores questions concerning art and creativity. It sets out to explore these themes while referring to the ever-increasing pace of the evolution of biological technologies.
How are we going to interact with such cybernetic entities considering the fact that their emergent behavior may be creative and unpredictable? How will society treat notions of artistry and creativity produced by semi-living entities?

Endnotes

1. For example the cochlear, or inner ear implant, which takes an amplified signal from a microphone and converts it to a code that stimulates an array of electrodes implanted along the spiraling canal of the shell-like cochlea. The advances in the field of retinal prosthetics, such as the work by researchers like Wentai Liu at North Carolina State University are another example.
2. "Aaron": Art From the Machine, Mark K. Anderson, Wired news, May 12, 2001 (http://www.wired.com/news/print/0,1294,43685,00.html): In that article Stephen Blessing of Carnegie Learning is quoted saying: "I think Aaron at the very least is a very good model of how Harold Cohen (the creator of the software) creates art ... So, inasmuch as Harold Cohen is creative— and I think he is—then Aaron is creative as well."
3. The Asian Elephant Art & Conservation Project (http://www.elephantart.com/). One has to question the notion of the elephant as an artist. Is it more the case of humans projecting ideas of art and creativity into an indifferent elephant?
4. We use different parts of the central nervous system of a fish for culturing and recording.