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During the six years of our collaboration, we have worked at the borderline of art and biology and have used biological principles to create interactive artworks. [...]

In 1992 we developed the concept of natural interfaces and evolutionary image processes linked to interaction. We started working with evolutionary biology and became increasingly intrigued by how natural evolution and the processes of nature can function as tools of creation. [...]

Based on the insight that interaction per se and the interrelation between entities are the driving forces behind the structures of life, we investigated interaction and the creative process. Creation is no longer solely understood as an expression of the artist's inner creativity, but instead becomes an intrinsically dynamic process. Linking the interaction of human observers (visitors) directly to the dynamic and evolutionary image processes of an artwork allows us to create artworks that are under constant change and development.

We believe that interaction should not be linear but instead feel like a journey. The more one engages in interaction, the more one learns about it and the more one can explore it. We call this principle non-linear or multi-layered interaction: interaction should be easy to understand at the very beginning but also rich so that the visitor is able continuously to discover different levels of interactive experiences. [...]

One of our first interactive computer installations to use a natural interface, instead of then common devices such as joysticks, mouse, trackers or other technical interfaces, was *Interactive Plant Growing* (1993). In this piece, living plants function as the interface between the human visitor and the artwork. [...]

[W]e became increasingly inquisitive about the process of creation itself. Artificial Life (A-Life), a research field invented by scientist Christopher Langton at the Santa Fe Institute, proved capable of producing processes of nature within a machine (computer environment) and allowed computer programs to evolve over time. This enabled the development of processes and patterns that are no longer predictable or 'handmade'.

Fascinated by the idea of creation through evolution, not as a scientific simulation or mimicry of nature but as an investigation into the creative process itself, we studied the possibilities of applying A-Life principles to art projects.

Natural evolution has brought about a vast variety of forms and structures in nature, so it seemed reasonable to us that artificial evolution could function as a mechanism of the visual creation process. Also inspired by John Cage's use of chance procedures in his musical compositions, we began to introduce a combination of interaction and artificial evolution to our works.

In 1994 we started to collaborate with Tom Ray, A-Life scientist and creator of the 'Tierra' system. During this collaboration we developed the interactive computer installation *A-Volve*, which allowed visitors to create A-Life (in the form of artificial creatures) and to interact with it. Artificial creatures are basically computer-generated forms that display life-like behaviour and interact with each other as well as with their environment. *A-Volve* features A-Life principles in the birth, creation, reproduction and evolution of its artificial creatures.

In an interactive real-time environment, *A-Volve* visitors interact with virtual creatures in a water-filled glass pool. These virtual creatures are products of evolutionary rules and are influenced by human creation and interaction. Designing any kind of shape and profile with his/her finger on a touch-screen, the visitor creates virtual 3-D creatures that are 'alive' and swim in the real water of the pool. The movement and behaviour of the virtual creature are decided by its form – that is, how the viewer designs it via the touch-screen. [...]

Cross-over between the genetic strings of the parent creatures, as well as the mutation and selection of fitter creatures, provide a simulation of reproduction mechanisms found in nature. Newborn offspring also live in the pool, interacting with visitors and other creatures.

Laurent designed algorithms to ensure smooth and natural movements and 'animal-like' behaviour of the creatures. None of the creatures are pre-designed; they are all born exclusively in real time through the interaction of the visitors and the mating processes of the creatures themselves. [...]

Since the genetic code of the offspring is carried from generation to generation and the system emphasizes selection of fitter creatures, the code is able to evolve over time toward fitter creatures. Although evolution can take place by itself without outside influence, the system is designed in such a way that the visitor and his/her interaction and creation of forms will significantly influence the evolutionary process. The visitors act as a kind of external selection mechanism. [...]

All of *A-Volve*'s entities – the images, the forms and the graphical environment – change continuously, as does the audience itself, their imaginations, the ways they conceive and draw forms and how they interact with them. Human-creature interaction itself becomes a creative process. The social interaction between the viewers and the virtual world is essential to the creation of the work itself. We think of *A-Volve* as a complex system in which, as in quantum physics, the entities transform their states according to probability patterns. This system is like an interconnected, intrinsically dynamic web of movement, interaction and transformation of particles and entities. [...]

In 1996 we began to study the building blocks of visual creation and investigated how simple structures can result in complex-looking shapes and forms through genetic manipulations. We developed *GENMA* (Genetic Manipulator) – an interactive installation that allows visitors to create, manipulate and explore the genetic design of artificial creatures – for the Ars Electronica Centre (AEC) in Linz, Austria, as part of a permanent exhibition.

GENMA is a kind of dream machine enabling us to manipulate artificial nature on a micro scale: abstract, amoeboid, artificial 3-D forms and shapes. Principles of A-Life and genetic programming are implemented in this project, which allows visitors to manipulate the virtual genes of the creatures in real time. [...]

On a visual level, *GENMA* further explores the concept of 'natural' or 'open-ended' design – design that is not pre-fixed or controlled by the artists but that represents the degree of interest and interaction of each visitor. Each visitor creates the forms he/she wants to see, aided by artificial genetics, mutation and manipulation. One could even say that the audience become artists themselves, using the power and possibilities of the installation's tools.

In 1997 we extended the concept of *GENMA* a step further and implemented the principles of open-ended design in an installation called *Life Spacies* [...], an interaction and communication environment in which remotely located visitors via the Internet and onsite visitors at the installation in Tokyo can interact with each other through evolutionary forms and images.

Through the *Life Spacies* web page, people all over the world interact with the system as well. By simply typing and sending an e-mail message to the *Life Spacies* website one can create one's own artificial creature.

We developed a special text-to-form coding system that allows us to translate text into genetic code. In a way similar to what occurs in nature, letters, syntax and sequencing of the text are used to code certain parameters in a creature's design. Form, shape, colour, texture and the number of limbs are influenced by text parameters. As there is great variation in the texts sent by different people, the creatures themselves also vary greatly in their appearance, thus resulting in unique creatures for each participant.

As soon as the message is sent, the produced creature starts to live in the *Life Spacies* environment at the ICC museum, where on-site visitors can interact with it directly through touch. [...]

The artificial species can be created in one of two different ways:

Through incoming e-mail messages. A text-to-form editor creates the genetic code for each creature: one message equals one creature; complex text messages create complex creatures; and different levels of complexity within the text represent different species.

Through reproduction of the creatures themselves. Reproduction helps the creatures propagate their genotype in the system so they can form groups of different species.

Life Spacies is also based on the idea of evolutionary design – the result is not predetermined by the artist but depends solely on the interaction of the visitors and the evolutionary process. Only the messages e-mailed from people throughout the world and the reproduction and evolution of the creatures themselves determine how the creatures look and how they behave. One can therefore never really predict how the work will evolve and what kind of creatures will emerge. Its evolution depends on how many people send messages, how complex these messages are and how the creatures reproduce among themselves and through the selection of visitors at the museum.

Life Spacies is a system where interaction, interrelation and exchange happens on human-human, human-creature, creature-creature, and human-environment, creature-environment and real life–A-Life levels. [...]

The interaction rules are non-deterministic and multilayered; our aim was to create an open-ended system in which each entity – whether real life or A-Life, whether actually present (visitors at the ICC Museum) or virtually present (the users on the Internet or the creatures as code) – are equally important components of a complex, life-like system. [...]

Interactivity and A-Life teach us to rethink our definition of art, broadening our view by allowing us to integrate personality, variety, processes of nature and new perspectives on art and life. As the images in our installations are not static, pre-fixed or predictable, they become living processes themselves, representing the influences of the viewers' interactions and the internal principles of variation, mutation and evolution. The image processes are no longer reproducible but continuously changing and evolving. Such artwork can therefore be considered a living system itself, representing the relationship and interaction between life and A-Life.

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