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**“Biomimetics: Emulation and Propagation in Post-traditional Ecologies”**

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**Introduction**

The strategy of applied biomimetics has been heralded as design innovation inspired by nature. The inclusive process takes in phases of bioprospecting, biophilia, and emulated biosemiotics to arrive at an implementation of engineered design that ideally might carry implicit biological/environmental sensibilities.

Applied elements from this strategy can be found in cybernetics, therapeutics/medicine, structural engineering, militarized intelligence and now in the propagation of new media art practices. While the idealized practice emulates a platform of honoring/sustaining the original thru the preservation of context, the extended practice in post-traditional ecologies frequently crosses the lines of biopiracy and sustains a distancing spiral of simulacra thru a re-wiring of ecological consciousness.

This essay will examine the intent and impact of applied biomimetics across a spectrum of creative and technological-mediated processes through three comparative lenses: as the scientific characterization of natural biological systems; as historically-rooted sociocultural performances/practices and as

contemporary engineered-design and creative media-based expression. The objective of comparison through these three perspectives on the biomimetic approach to the appropriation and emulation of natural systems is to align the phenomena and practice within the contextual realms of traditional and post-traditional ecologies as a means of characterizing the distance between origin and derivative in this creative biocultural practice.

Biomimetic design practice is enabled and delineated by the collective lexical observations of biomaterials/composition, biological time, space, and the enchainment of interactive patterns of bio-, zoo- and ecosemiotics. In this transference between wild-type ecological contexts and anthropogenic constructs, the thread of intent, distance from origin and resulting impact of application vary according to underwriter, author and user/audience. The outlined comparisons will highlight these subjectivities in practice and realization while attempting to connect biomimetics as a practical cultural phenomena that emulates, appropriates and propagates across traditional and post-traditional ecological contexts.

### **Biological Context of Mimicry**

In delineating a space for this dialogue on biomimetics, multiple platforms warrant definition as ground for discussion including: mimesis as a phenomena of biosemiotics within a traditional biological or ecological context and biomimicry as an expressionistic/linguistic pattern with lengthy ethnoecological roots that have become intertwined across origins in animism and bioculturalism.

Mimicry as a biosemiotic phenomena was initially described as a classically characterized ecological phenomena in the 1862 field accounts of H.W. Bates.<sup>1</sup> Bates' Amazonian observations laid down the fundamental eco/zoosemiotic relationship of commensalism in *Lepidoptera*. The biological context of mimicry has since referred to imitations in nature as a survival rationale where the traits of one organism such as toxicity of a *Danaus* butterfly specie to predators gives survival coverage to a secondary specie that can adaptably emulate it's phenotypic patterns of expression. In this classic era of Western field biology, extended contributions by Fritz Müller, furthered this documentary platform regarding the mutualistic relationships bridged by mimicry within a biological context.<sup>1</sup>

Batesian and Müllerian mimicry overlap and differ in relation to the reinforcements of natural selection that flow in a biosemiotic stream among models, mimics and predators. Vane-Wright<sup>2</sup> defines this mimetic relationship as involving "an organism (the mimic) which stimulates signal properties of a second living organism (the model), which are perceived as signals of interest of a third living organism (the operator) such that the mimic gains in fitness as a result of the operator identifying it as an example of the model". Bates' and Müller's observations took into account visual pattern and associated phenotypic emulation as a cross over of bio/zoosemiotic relationship between the model and mimic with the operator's insertion of biophobia as reinforcement for natural

selection and the continuance of the mimic to model or original to derivative relationship.<sup>1</sup>

Mimicry in a biological context also has observation points within networks of social insects. The phenomena of chemical and tactile mimicry within ant colonies is practiced by a variety of opportunistic and symbiotic organisms that become colony guests as a means of benefiting from the activities, interactions and control that delineate the superorganismal construct of ant societies. The colony guests or myrmecophiles, include a diverse variety of flies, beetles, wasps, mites and other insect types that practice some form of mimicry for acceptance into the colony.

As Holldöbler and Wilson<sup>3</sup> discuss: “An ant colony possesses a complex system of communication that enables activities in food gathering, brood care, and other social activities, but makes possible instant recognition of nest mates and discrimination of foreigners. This identification and discrimination system functions like a social immune barrier: only colony members are allowed to enter the ant society, and alien individuals are harshly rejected. Nevertheless, by using various techniques, a considerable number of solitary arthropods have managed to penetrate ant nests. The fact that the ants treat many of these alien guests amicably suggests that the guests have broken the ants’ communication and recognition code. In other words, they have attained the ability to speak the ants’ language of mechanical and chemical cues”

Wasmannian mimicry<sup>3</sup> was originally postulated from observations of such acceptances of foreign insects into the marching columns of army ants.

Wasmann observed the mimicry to be on a tactile level; that is the acceptance into the colony was through light touch via the antennae of ant host workers onto the abdominal petiole of deceptive beetles. This tactile communication in combination with chemical mimicry are the key identifiable components of acceptance in this situation of social parasitism. Other cases of symbiotic acceptance of foreigners by social insects involve mimicry in locomotion patterns, behavioral imitation of solicitation signaling, and pheromone mimicry as additional zoosemiotic bridges between the transplanted foreigner and the collective superorganism.

In anthropomorphizing these observations one is tempted to rationalize the intuitive nature of mimicry as an enchained emergence from insect societies to the human superorganism. Here we have examples of the fundamental observations of the origins of mimicry as an emulated or reproduced thread between zoosemiotic systems in traditional ecologies. The imitation of visual pattern, movement, corporeal form and textures are all examples of phenotypic expression which are advantageously bartered for a leg up on survival and cross species societal acceptance. The questions of intent with respect to this inherent practice cannot be fully probed at this level of entomological observation but recognition of these phenomena of language cracking and manipulation as fundamental to the biological context of mimicry should be registered in the

emergence, persistence and scaling of this phenomena in higher organisms and their superorganismal constructs.

### **Biomimicry and Bioculturalism**

Pre-dating and running concurrent to the previously described scientific record, human ecosemiotic and ethnoecological relationships have been integrated into the lexicon of biocultural emulation and expression throughout the timeline of human history. As lay cultural phenomena, biomimetic integrations pre-date, have co-evolved and provided complementary ethnobiological witnessing to scientific dissections and characterizations. Cultural integration of bio/zoosemiotic reflective performance ritual spans the spectrum of ancient, indigenous, new age and contemporary cultures as emulation of our ethnoecological interactions. Embedded in these emulations is the biophilia hypothesis (the affinity and propagation of the human connection with other lifeforms) that are contiguous with vernacular explorations/exploitations of biologically derived materials, animal behavior, communication, interactions and habitat. Continually emerging from the biophilic response and aesthetic is the emulation of observations as language that continues to be propagated as material and non-material manifestations. The active evolution and lifecycle of these emulations ties expression to the context and sustenance of biocultural memory. The relevance and usage of this root of expression is supported by the interdependence of biological, cultural and linguistic diversity among

contemporary global indigenous peoples in Africa, Asia, the Americas and Oceania.<sup>4,5</sup> Global cross mapping of endemic languages and higher vertebrates highlighted the overlap between linguistic and biodiversity. A global comparison of endemic languages and flowering plant species exposes similar findings.<sup>6</sup> Here we have evidence that the tenets of biological sensibility are feeding the foundational elements of language and expression, with a cross threaded dependency for persistence.

In broadening the coverage of this work into contemporary Western societies we are now presented with the absorption of ethnoecological relationships into the linguistic ground of the societal frameworks which feed on creative mimicry, interpretation and expression. The spectrum of this framework includes engineered designs, scientific rationalizations and extends into the periphery of what can be described as experimental artistic constructs in pursuit of both practical and innovative manifestations of expression.

The recombination of scientific and vernacular observed biomimetics have previously resulted in aesthetic interventions and creative expression in material culture space. The Arts and Crafts Movement of the 19<sup>th</sup> Century and its emulation of ontological motifs in the offset of machine aesthetics is a grounding example of aesthetic intervention that historically permeated material culture with organic, biological and ecological sensibilities.

## **An Open Source | Bioindustrial Partition**

In the contemporary timeframe, a design practice with biomimesis at the emulated core has been firmly established as a process that observes/mimes/mines traditional ecological sources, emulates and technically transcribes, decodes and recodes biosemiotic relationships and re-mediate the reductionist resultant into a post-traditional ecological context. These creative/engineered applications cover a broad subjective spectrum in terms of intent, impact and ethics as they relate to origin and derivative. This creative practice as an idealized process can ethically emulate and honor the source of biomimicry and propagate a realization of environmental awareness while resulting in a material output as intellectual property, product, or rendering. The focus on biomimicry as an idealized practice of environmental consciousness described as “innovation inspired by nature” has been reflected on by Janine Benyus<sup>7</sup>, David Suzuki and is now one of the essential mantles of the Bioneers. Benyus’ Biomimicry Guild<sup>7, 8</sup> professes and propagates this process as an environmentally ethical approach to implementation and education of biomimetic design practices. Benyus has fostered a Biomimetics Institute, a business consulting service, a “Conservation for Innovation” program and an open source biomimicry database in collaboration with the Rocky Mountain Institute in following the green-mind set of “quieting human cleverness, listening to life’s genius, echoing what we learn, and giving thanks to nature”.<sup>7</sup> Essential to this version of biomimetic design practice is keeping the biological commons open as

a resource for the propagation of innovation, invention, expression and language and thereby the value of nature can be recognized and diversity preserved in a generative cycle of bioculturalism.

Parallel to this philosophy of an open biological commons is the longer standing practice of privatised reductionism which in the 1970s was deemed biotechnology. This design practice also intersects the collective record of ethnoecology but has parsed and processed the collective experiential lexicon through a sequence of bioprospecting, bioscreening, bioprocessing, biopatenting and in some cases biopiracy.<sup>9</sup> Biomimicry as design innovation inspired by nature is still at practice here, but the flow back to the commons is shunted and a privatised-form of innovation, expression and language is locked down within the bioindustrial context. A post-traditional ecology ensues but the semiotic connections are also gated by venture capital, intellectual property and investment rules. Without a flow back to the source, derivative expression and language become self-propagating in the vein of simulation spiraling into simulacra, in this case bioculturalism giving way to bioindustrialism.

Dissemination and assimilation of biological and environmental sensibilities ride on market lines. Despite the fact that this biomimetic design practice draws from the commons both ecologically and academically, the first person accounts of this context of ethnoecological rewiring is not openly accessible nor conversant for an exchange on the thread of intent nor the impact of this mode of biomimetic design practice on the distance from origin.

In speaking to this point of privatisation and the sequestering of biomimetic design practice, I give testimonial to my own past practice as an industrial microbiologist and environmental engineer in a bioindustrial context. The dissemination of results of this design practice as open source is strictly curtailed by the ownership of intellectual property rights that are signed over to the sponsor of your investigations.



**Figure 1.** *Biological Narrative 1 thru 5 (primata)*, 2004, Timothy Weaver

In comparing the propagation of language and expression in this privitised context to that of the biological commons, I also must contrast it against my current investigatory practice as a new media artist engaged in an aesthetically-driven form of biomimetic research and design. The biomimetic foundations in my recent work, *Biological Narrative 1 thru 5*, 2004, include the concepts of the re-narration of extinction, the emergence of life, biological time, the dilemma of sustenance and the internal drama of pain. The aesthetic mediation of these

works employs a poetic remix of video/audio sources filtered through computational routines of artificial life and predator-prey ecological models as captured and interactive digital cinema. The resulting work converges content into a biological narrative -- a storyweb which integrates an overlay of multimedia sources onto a bio/ecosemiotic backbone. The modularity of these media works are now resulting in new performative or live cinema works that are using biomimesis as an interpreter for real time media dialogues. My intent in this authoring is to enable an expectation of biological and environmental sensibilities within a media that is routinely discussed as post-human or post-biological. In producing this work I have been in pursuit of an understanding of the range of intent and inquiry exerted by new media artists who are hybridizing biomimesis into emerging media forms/expressions that can be recognized as biomimetic art.

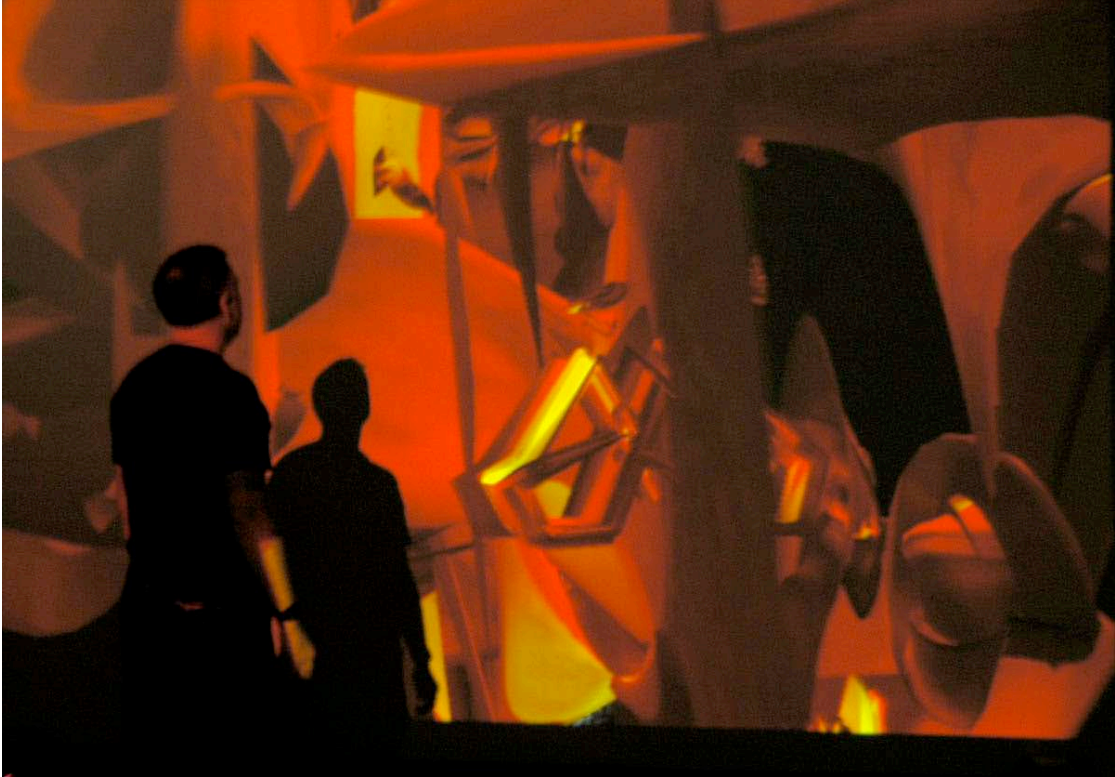
### **Biomimetic Art**

The propagation of new language, expression and dialogue related to biomimetic design practice has also been manifested in the tangential context of new media art. The manifestation of biomimesis in new media also draws upon the questions of intent with respect to distance from source, process, and bioethics. The extended dialogue also falls back on the implication brought up previously in this essay with respect to the interdependency of bioculturalism, biodiversity and linguistic diversity.

In the exploration of this dialogue, three practicing new media artists were interviewed for their first person response to the implicit issues that surface in this

genre of creative inquiry. The interviewed artists, David Stout, Gordana Novakovic and Steve DiPaola are all utilising biological modeling/biocomputing in their work for the production of interactive electronic media in an installation or digital cinema format. During the dialogue with these artists, reference was brought up with respect to audience response to the works in tension against real life, particularly in the case of synthetic ecologies being looked upon as simulacra and as a diversion from real time issues of environmental impact and habitat desecration.

In framing a dialogue, the artists were asked to provide 1) a descriptive platform/synopsis of a recent work that they have created in the domain of biomimetics and new media. The follow up question to this synopsis covered 2) the issues of investigatory intent, distance from origin and the potential resulting impact of the cited project with crossing the lines of what we might relate as biomimetic.



**Figure 2.** *100 Monkey Garden*, 2005, David Stout

David Stout is a new media artist, composer and Associate Professor of Moving Image Arts at the College of Santa Fe, Santa Fe, New Mexico. David's current work with artificial life based generative cinema is predicated on his long-standing interest in creation mythologies, immersive aesthetic experiences and audio-visual structures. David describes his evolving project *100 Monkey Garden*, 2005 relative to the domain of biomimetics; "My previous biomimetic explorations include the creation of contemporary dance dramas depicting fictional biota. These early works were closely aligned to the idea that humans are consummate *copycats* and that the richness of diverse multi-cultural artistic practice can be traced to our innate sense of biomimicry. These ideas closely mirror the theories underlying acoustic ecology, which posits that the evolving

history of a culture's musical aesthetic is closely aligned to the soundscape of any given cultural epoch.”

“The *100 Monkey Garden* is my first attempt to model a self-generating ecosystem based on algorithmic mutation and predator-prey relationships. The work is a significant step beyond the surface emulation of animal-like behaviors often associated with the earliest biomimetic artforms such as, indigenous music and dance rituals, in that it relies on a broad set of behaviors that guide the evolution of form within a complex system. In the development of this project I cannot overstate the importance of ‘noise’ as a *prima materia* in that it provides a wide range of quasi-random behavior within a broad field of frequencies that can be isolated, filtered, harnessed, sculpted and/or distilled to produce divergent sonic, visual, kinetic behaviors. This is an important distinction or addendum to the practice of Noise Art as a whole, which is typically associated with extreme experiences of audio frequency, amplitude and associated visual phenomenon.”

“The work is built on the premise that each aesthetic element will be responsive to every other element - sound will effect image, image will control sound, one organism will repel another while attracting yet another, new forms are born, older forms are eaten, the system remains in balance unless the predator-form fails to keep pace with the growing population. If the population grows beyond 100 entities there will be an increased likelihood of triggering latent morphogenic mutations and a growing possibility that the whole system could eventually come to a halt in either a cataclysmic computer crash or benign frozen

screen. The parallels to our own environmental condition are clearly drawn, while the idiosyncratic nature of the audio-visual forms expand the vocabulary of abstract image making and sound art independent of the biomimetic narrative.”

“In the design of the work, I have combined a number of isolated digital techniques into a comprehensive systemic vision that reveals increasing levels of connectivity. These techniques or components include, dynamic visualization of three dimensional forms, sound synthesis generated by formal motion, audio-visual recursion, simulation of attraction and repulsion between visual forms, independent spatial movement, recombinant procreation, predation, rules governing population dynamics, skin pattern, texture and recombinant genetic history, networked computer system allowing separate computers to drive differing synthetic entities, etc. The successful implementation of these components suggests the possibility of a series of dispersed installation sites networked as a complex system of independently evolving niche ecologies.”



**Figure 3.** *100 Monkey Garden*, 2005, David Stout

David addresses the investigatory intent of this project as it relates to the distance from its biological sources and origin, from the following perspective: “I work within the uneasy paradox of the exponential growth of computing power to simulate compelling mediated realities while environmental destruction results in the extinction of increasing numbers of the world’s species. On one hand, the artist and scientist can take the role of creative deity, whether playing out carefully constructed inquiries or wild postulations through digital genetic simulations that safely avoid the dark implications of wet-lab genetic engineering. On the other hand, the artist can imbue the fictional media eco-system with a socio-political perspective that questions or reinforces our environmental conscience. Considering the growing state of environmental crisis and the

potential calamities that could unfold due to genomic interventions, is the simulation of a complex web of connectivity really enough? This is not a simple one answer question bur rather a stimulating poke in the ribs to help us clarify the pragmatic resonance of our intentions. One thing is for certain, documentary film and coffee table photography which aestheticise environmental decay and species destruction can only go so far to stimulate positive action before freezing the event as just another fetishised aesthetic object. As artistic mediums, photographic essays and documentary films cannot approach the power of real-time dynamic media to directly engage the viewer-participant in a compelling sensation of interaction with a responsive interconnected world. The crux of this work is not to merely create a new narcotic in the form of an artificial paradise, but rather, to amplify the experience of interconnected participation in something larger than ourselves. This kind of simulation allows us to witness the consequences of our actions (or inactions) to affect unfolding events over many generations.”



**Figure 4.** *Fugue*, 2005, Gordana Novakovic

Gordana Novakovic is Artist-in-residence in the Department of Computer Science, University College London. Gordana describes the platform of her recent art/science collaborations in the investigatory realm of biomimetic art. "*Fugue*, 2005" is a scientifically informed interactive art project based on the functioning of the human immune system. It is inspired by the musical form of fugue, and operates within the framework of an artificial immune system algorithm, expressed through vision and sound. The emergent, evolving nature of the artificial immune system algorithm, the use of repetition in the form of a succession of variations of 'events', and the complex structural and functional interrelationships between the individual elements and processes are strongly

related to the musical form of counterpoint, which formed one of the inspirations for the artistic concept for *Fugue*. The sound is presented as a mental soundscape, a resonance of the function of the immune system in the body.”

“What marks *Fugue* is its approach to interactivity – as a way of engaging the participants, as a means of managing the relationships between the constituent elements of the software, visuals and the sound, and as the primary artistic methodology. The participant, immersed in the virtual world of inter-sensory experiences, engaged in a spontaneous non-verbal dialogue with the responsive intelligent medium, establishes a technology-mediated introspective relationship. Although it implements Dr. Peter Bentley’s computational model of the immune system, *Fugue* is not a computational anthropomorphic simulation. The focus is on the body of the participant and on the complex processes induced by the specific properties of an interactive immersive environment.”



**Figure 5.** *Fugue*, 2005, Gordana Novakovic

Gordana's perspective on the distance and context of this work in relation to its biological origin follows: "*Fugue* symbolises the inseparable interconnectedness between all particles and functions of a living body, which is shaped by its inner functions as much as by its interaction with the world. The technology-mediated environment of the contemporary metropolis manifests interdependence between the human and technology, leading to the experience of multiple realms such as reality/virtuality and presence/telepresence. Further complex changes have occurred in the perception of time/space, noise/silence, speed/duration and movement/stillness. In this context, *Fugue* deals with the emerging issue of the ecology of mixed realities. It aims to address a set of ethical and philosophical

concerns such as the interdependence of the human and technology, and the impact of specific technologies on the human body .”

“The fugal structure helps to achieve one of the major aims, by not only representing the processes involved, but at the same time painting a larger picture of the role of the immune system in the functioning of the human body and mind. This illustrates the immune system’s intimate interconnectedness with the total sum of particulars that constitute each human being, and creates a metaphor affirming holism as one of the fundamental principles of transdisciplinarity.”

“With regard to biomimesis, the focus is on understanding and applying the principles of biological processes rather than simply creating beautiful imagery, or re-representing scientific findings as visualizations or sonifications. In order to underpin the focus on processes, the conventional ‘real’ images of the lymphatic system have been reduced to symbols, and the roughness of the clay models of cells that were subsequently digitized has been deliberately kept present. The sound, composed by Rainer Linz, has been developed following an analogous methodology.”

“*Fugue* is designed to challenge the established approach to interactivity, and to explore what happens to the body, and consequently to consciousness, in an audio-visually rich, technologically dense interactive environment. We do not expect to arrive at a definite answer, but rather we expect to shed some light on the issues that we find important not only within the narrow scope of interactive

art, but more importantly in everyday life, where our environments, packed with technology, are being converted into interactive cities. We believe that to raise these questions from a non-scientific, but scientifically informed, viewpoint may make a significant contribution to the ecology of perception, emphasising the critical and political aspects of new media art.”



**Figure 6.** *Virtual Beluga Project*, 2005, Steve DiPaola

Steve DiPaola is a new media artist and scientist who directs the social based Interactive Visualization Lab as Associate Professor, at the School of Interactive

Art and Technology, Simon Fraser University in Vancouver, Canada. Steve has been conceptually, technically and aesthetically pivotal in biomimetic projects for the public interaction and interpretation with the beluga whale population in the Vancouver Aquarium. Steve describes the platform of his *Virtual Beluga Project*, 2005 as follows: “When Vancouver Aquarium visitors are asked what of all things they would you like to see for the live beluga whale exhibit, overridingly they response, that they would like to be able to 'swim with the whales'. When you see these magnificent multi-ton creatures from above the water or through the glass walls, as we humans want to be able to fly with birds, we just want to swim with these animals.”

“Our work focuses on the design of a real-time interactive simulation exhibit which uses adaptive technologies to better immerse the visitors in complicated concepts about the life of wild belugas. The beluga interactive uses extremely realistic 3D graphics and an action selection system that allows the virtual belugas, in a natural pod context, to learn and alter their behavior based on contextual visitor interaction. The interactive design was informed by: research data from the aquarium's live belugas, interviews with the marine mammal scientists and education staff as well as by it's proximity to and integration with the aquarium's live beluga exhibit. Ethogram information of live beluga behaviors was then incorporated into the evolving interactive simulation which uses 3D physically based systems for natural whale locomotion and water, artificial intelligence systems including modified neural networks and an action

selection mechanism to simulate real-time natural individual beluga and group behavior. The system allows visitors to engage in what-if scenarios of wild beluga behavior. By giving the simulated 3D whales complex, specific and interdependent behaviors, such as the mother-calf bond or male aggressiveness mixed with age based playfulness, the animals become individuals and their interactions become narratives. Add the visitor interaction and reflected conversation space as visitors interact with the belugas using a shared tangible interface and an additional level of narrative occurs. The domains of biomimetics and new media allow for the group behavior of visitors and whales to swim together for awhile.”

Steve addresses the investigatory intent of this project as it relates to the distance from its biological sources and origin, with the following detail: “In creating this project, many shared ethical, cultural and ontological issues have emerged that have lead to deep questions surrounding virtuality and nature. For instance, we have made a strong effort to ensure the interactive enhances and works with but never replaces the benefit of live belugas, but in doing so; ironically, the virtual belugas represent 'wild' nature while the real belugas can only represent captive nature. By pairing the virtual and the real in do lay persons appreciate the idea of nature more than nature itself? To illustrate this point, an example that happened among biology professionals is recounted as follows. We needed to educate a large group of aquarium trainers, educators and scientists on what was possible with the simulation software. As we discussed the

possibilities of the memory capabilities of the simulated brains of the virtual 3D whales allowing for new experiences to be learned and retained over the life of the exhibit, a whale trainer got excited that we could have visitors teach the whales typical training behaviors that they could retain for future visits. This brought a sharp and loud retort from one scientist who exclaimed, 'No, we won't treat these whales like trained monkeys too!' as she pounded her hand on the table. It became clear that even trained animal professionals would have trouble with virtual life. For while it is admirable to protect the virtual whales from human intervention and keep them naturalistically pure, saving the purity for the mirror of the whale rather than the real whales has several implications. It brings the point home even more when you realize that the aquariums real whales which live in captive quarters were the source of our data that created our pure and wild virtual whales. Should real animals be poked and prodded to get good sensor data to create perfectly wild virtual animals? While the Vancouver Aquarium takes very good care of the animals, this is not true of all zoos and aquaria. A near future scenario that is still wrought with ethical and culture issues but tries to deal with this issue of treating the real animals better than the virtual ones can be imagined. One could imagine, future zoos and aquaria that house only simulated animals with strong visitor interaction capabilities. These simulated animals would be derived from sensor data (real-time or stored) from live wild animals. The animals stay free and wild while human interactions with their virtual personas become more complex and experiential. Again there are serious

implications to such a scenario but one we have to face whether it is with interacting with 'wild animals' or having a distanced communication between our children and their grandparents in Florida who are holographically projected in real-time on the living room couch.”

The artist comments from above are a sampling of first person critical dialogue, perspective and intent relative to biomimetic design processes that have emerged as new media art. The described biomimetic art projects were built upon a biophilic foundation of ecological/ecosemiotic, immunological/biosemiotic and ethological/zoosemiotic observations and modeling for the development and realization of interactive, interpretive, and generative works through multimedia output. Underlying the technical mediation of these works is the voiced intent by each of the surveyed artists to deliver content, resonate with source and expand dialogue around issues that are at the core of our intellectual engagement with the contemporary issues of ecosystems, corporeality and cross species understanding. The applied processes of biomimetic design for these artists has a mission apart from those in the engineering design field but distinctly fall within a delineated domain which draws on natural sources as a platform for emulation.

In critically assessing these works in relation to their distance from origin to derivative, the perspective and immersive experience of audience must be acknowledged as well as the generative nature of the works. Each of these artists has expressed their intent of uncoupling the enchainment of simulation to

simulacra by adapting the narrative structure of their work to honor/sustain/inform the original thru the preservation of memory and context. The narrative structure of the works also allows for a presence of parallel or interdispersed access to reference to origins/source. In Novakovic's *Fugue*, 2005 the audience has their own bodies as a constant reference to the computational immunology of the work. In DiPaola's *Virtual Beluga Project*, 2005, an actual pod of beluga whales is comparatively available to the virtual work. The configuration of Stout's *100 Monkey Garden*, 2005, enables the audience to return to their real world environment for reference while maintaining the opportunity to revisit the ongoing evolutionary state of the work. The audience perspective on the distance from origin of these works is implicitly challenged by the constant output of dynamic multimedia patterns that are generated from the biological computational sources/models that comprise the mimetic core of each of these works. Because each of these works are generative and therefore open ended in nature, new ground with regard for the distance from origin comes to the fore as individualised/original content that audience/participants/users can immersively experience as an extended emulation of life systems. Although the potential for simulation and simulacra's diversion exists here, a continuum back to an affinity to biological source fills out the experiential spectrum from memory of origin and on to a horizon of novel pattern recognition.

## **Moving Toward a Critical Framework for Biomimetics**

In framing a dialogue around these works there is perhaps the beginning of a structure for looking at the manifestations of biomimesis as it relates to traditional and post-traditional ecological contexts.

Implicit to the observations, analysis and implementation of the biomimetic design process is a regard for the biophilic aesthetic as an attraction for life processes and characteristics. In materialized expression, interaction and interpretation, biomimesis is actually located on a continuum from the biophilic to the biophobic, that is an affinity and adherence to biological origin and the distancing from these sources to derivative. In this essay the manipulations and expressions of biomimesis have been reviewed from a classic biological context, to integrations in bioculturalism, the appropriations in the bioindustrial world and explorations in what may be described as biomimetic art. With this range of contexts in mind, perhaps we can begin to recognize the essential continuum that biomimetic pathways are reliant upon in their exchange between the affinity for life sources and their distance to derivative.

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