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Paper : **VARIA ZOOSYSTEMATICA PROFUNDORUM**
Modelling deep sea communication collaboratively

Topic: Discussion of art work and its design process

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References:
[1] Vilem Flusser, Louis Bec, "*Vampyroteuthis Infernalis*", European Photography, Göttingen, 1993 (2nd ed.)
http://entropie.digital.udk-berlin.de/wiki/DeepSea

Abstract:

The installation Varia … models a specific notion of how deep sea communication between specimens and across species might happen, inspired by the work of *zoosystematicien* Louis Bec and philosopher Vilem Flusser.
A number of parallel threads informed the collaborative design process: Discussion of the theoretical background from diverse domains (cross-reading texts by Darwin, on evolutionary art, AI literature, and sound synthesis), long series of experiments with generative systems (in the programming environment SuperCollider), and practical developments of hybrid music/visual/movement systems based on an Arduino variant (the JeeNode system developed by J.C. Wippler).

The model emerging from all these threads differs considerably from much evolutionary art. It avoids classic concepts like predator/prey interaction, and sexual reproduction models, focusing instead on the core of communicative behavior, the exchange of ideas. A number of actants ("creatures") transmit symbols ("letters") to each other, assemble them into longer chains ("words"), and sometimes express these "words" by emitting sound, light, or motion patterns. Some creatures generate rhythmic pulse sequences, some almost melodic phrases. Others let hues of colours flash over their skins, while others again float up and down in space in response to the conversation between them. The concept has been influenced by its intended location (a big empty water reservoir in Berlin), focusing it on acoustic communication in reverberant settings, with light only playing a very localised role.

The installation was shown during the SuperCollider conference in Berlin, to very positive responses from both expert audiences and lay persons; e.g. the children in the neighbourhood were extremely intrigued by it (once they had overcome their fear of the dark), and brought in friends and parents...
Beside describing the details of the piece, the paper aims to reflect on the role the interdisciplinary design process has played for its eventual form; in short, we find that the approach taken has been extremely interesting and successful from both didactical and artistic perspectives.

[More detailed documentation on the installation is currently being prepared, and will be made available on the website soon.]

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Varia Zoosystematica Profundorum

Modelling deep sea communication collectively

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Abstract

The installation *Varia Zoosystematica Profundorum* models a specific notion of how deep sea communication between specimens and across species might happen, inspired by the work of *zoosystematicien* Louis Bec and philosopher Vilem Flusser.
A number of parallel threads informed the collaborative design process: Discussion of the theoretical background from diverse domains (cross-reading texts by Darwin, texts on evolutionary art, AI literature, and sound synthesis), a series of experiments with generative systems (in the programming environment SuperCollider), and practical developments of hybrid music/visual/movement systems based on an Arduino variant (the JeeNode system developed by J.C. Wippler).

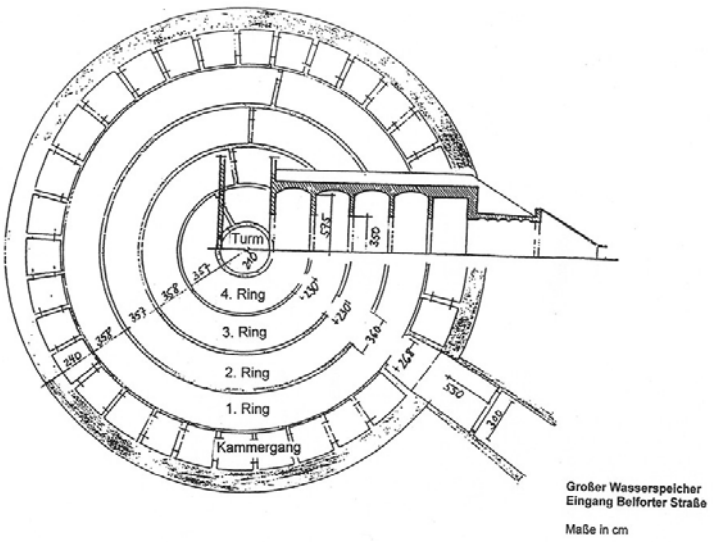
Beside describing the details of the work, this paper aims to reflect on the role the interdisciplinary design process has played for its eventual form; in short, we find that the approach taken has been extremely interesting and successful from both didactical and artistic perspectives.

1. Background

One starting point for the project was a recurring practical question: how to teach Generative Art / Computational Art to very inhomogeneous groups. At UdK Berlin, some students in our class have a background in Visual Communication; some have good programmings skills, some very little coding experience; some are highly skilled musicians and sound artists, some have no formal music training; and we often have outside guests who may be future candidates for the class, or independent artists seeking a stimulating learning environment. One common method is having a semester topic in order to explore specific areas in both theory and practice, and the approach we took was a special variant of that strategy.

The second starting point could just as well be called a landing point: Carsten Seiffarth from *Singuhr Hörgalerie* kindly invited me and the class to present a project at the *Großer Wasserspeicher*, which is one of the most spectacular sites for presenting sound art works in Berlin. It is a former water reservoir for the city, built into an artificial hill, with a diameter of 40m, and five concentric rings of brick walls to hold the pressure from the water contained. The architecture is quite striking: it consists of 6m high circular corridors with vaulted ceilings, no daylight (except for an

entrance cut into the hill later on), and it is highly reverberant (ca. 18 seconds reverb time overall, and more at lower frequencies).



So, the semester began with the open question “what shall we show at Wasserspeicher?”, and keeping this opportunity in mind provided a focus for which lines of experiments to pursue further.

2. Context of Courses

We addressed the didactic question with a polyphony of interweaving courses:

- an exploratory course “Experiments with open generative systems”
- a theory/reading course “The Nature of Nature – How Arty is Darwinism?”
- a practical course on hybrid music systems “cc – communicate, creatures!”
- a more loosely coupled course on audiovisual programming.

“Experiments ...” (Alberto de Campo) covered many basic concepts, beginning with Cantor sets, fractals, coastlines, on to feedback systems, particle systems, agent systems, and communication systems. These were discussed conceptually, and with very simple code examples, so participants could do their own experiments freely; much time went into coming up with variants in class, and trying them out immediately, using the Just In Time Programming style in SuperCollider. [1, 2, 3]

“The Nature of Nature” (Renate Wieser) went from reading excerpts of Darwin's Origin of Species [4] and Descent of Man [5] to papers on Evolutionary Art [6] and on code and its performativity [7]; crossreading Microsound [8], classic swarm behaviour [9], and an approach that combines them [10]; from computational simulations of evolution [11, 12] to classic and newer AI literature [13, 14].

“cc - communicate, creatures!” (Hannes Hoelzl) covered building simple analog/ digital audio synths (such as [15]), and programming Arduino-like microchips to control these synths, various light sources (e.g.arrays of LEDs), and motors, solenoids and relays, as well as to communicate with computers.
The chips are the JeeNode system by JC Wippler [16], which are open source hardware, have a built-in little radio sender/receiver chip, a wide choice of sensor designs and kits (so called Plugs), and accompanying Arduino software classes and

examples to re-use and adapt. The interaction between different parts of the installation to be designed could be based on these chips.

“Audiovisual Programming” (Fredrik Olofsson) focused strongly on the praxis of programming, so much time was spent on learning how to explore concepts by experimenting with code. Special emphasis is on tying together sound and visuals by having the same models control both modalities; thus a change made to the model that is intended to affect the sounds in a specific way may well have interesting side effects on the visual behavior one would never have thought of directly. This experience was very useful for experimenting with mapping sounds, light and movement from the same control information in the creatures.

This was accompanied by informal “tinkering meetings”, which people could attend optionally to build things together, and get help from colleagues who have more experience with, say, soldering, programming, mechanics, etc.

3. Shared Design Process

Within this setting of parallel activities, the design for the eventual installation emerged in a shared process of discussions, experimentation, practical simplifications, and later on, individual ideas of what one's own creature could be like. These could be really heterogeneous, which would make it more challening to find ways to bring them together. Beside the authors, the participants in that process were mostly students of UdK, and some guests:
Bernhard Bauch, Constantin Engelmann, Dominik Hildebrand, Akitoshi Honda, Florian Kuehnle, Ingrid Ladurner, Karin Lustenberger, Rita Macedo, Naomi Mulla, Sarah Rechberger, Johanna Tauber, Andre Wakko, Christian Zollner; Peter Bartz, Tiago Cutileiro, Annie Goh, Tobias Purfuerst.

Initially, there was no preconceived general idea what the eventual system would be that ties the different aspects together. Thus, rather than describing the finished work, we will here try to reconstruct the flow of ideas.

2.1 Aquarium

One of the simplest possible examples for a real-world simulation is a simulated aquarium (a Chinese import shop find), which runs a bluish foil with images of fish and little bubbles on it across an illuminated background – this is a very simple system of agents. We re-wrote the aquarium as a little drawing patch, and began to amend its biggest simplification, which is that all the fish always swim in parallel. So we introduced different speeds, up/down drift, ways to avoid collisions, etc.

2.2 Communication systems – Agent behavior

What messages should be communicated? The simplest solution was to use subsymbolic tokens (such as single letters), which can be assembled into “words”, which stand for concepts, or units of meaning; note that the resulting “words” need not have any semantics known to the human experimenters (i.e. us); in fact, how should we know anything beforehand about how and with what concepts meanings are communicated in species very different from humans? Even in cross-cultural comparisons, semantics are by no means straightforward.

Most of the time, an agent would listen (or observe); only sometimes would it become obviously active by doing something (make a sound, show light or movement).
So in practice, it would listen and wait for letters from outside; for communicative symmetry, an agent would also emit/send letters every now and then that the others would listen for; it would want to form a word of its own out of the incoming, or remembered, or preferred letters. When this personal word is finished, it can do something based on the word: It can translate it as a time pattern, and/or a value sequence, to inform a rhythmical sound, light, or movement pattern that is specific to this “word”.

2.4 Deep Sea

Pondering the aquarium and the idea of "abstract" communication between unknown creatures; the idea emerged that communicating deep sea creatures are a very fascinating subject of study: there are so many known cases of very strange creatures that even unlikely new ones seem just as plausible or implausible. This idea immediately energised the flow of the (until then somewhat vague) project, and it led to a number of happy coincidences:

First of all, the book *Vampyroteuthis Infernalis*, a wonderful collaboration between philosopher and founder of communicology, Vilem Flusser, and artist and “zoosystematicien” Louis Bec. It shows detailed biological drawings of hypothetical deep sea creatures with complex names for body parts whose functions remain mysterious; and it compares the radically different worlds deep sea squids and humans experience, juxtaposing them as figurative mirror images. This freewheeling variation on Flusser's research into the manifold connections between communication research, informatics, cybernetics, and being-in-the-world in general became a major source of inspiration for our venture. As the Flusser archive is also hosted at UdK Berlin, we even had the luxury of a highly informative lecture and discussion with Flusser expert Claudia Becker.

Secondly, 2010 was an important year in biology: The Marine Life Census project [17], a large coordinated research effort in which more than 2700 biologists worldwide systematically looked for new species in many different kinds of oceanic habitats, went into its concluding phase; furthermore, 2010 was declared the Year of Biodiversity; and finally, Jacques Cousteau's 100th Birthday was in June 2010.

2.5 More preferences

While experimenting with different communication models in SuperCollider scripts, the following design ideas and preferences of the working group emerged:

- **no sex, no death** - reproduction/genetics is already explored in so many biologically inspired art projects that we need repeat these
- **no predator/prey modeling, no search for food -** for the same reason
- **mental energy level** - listening to incoming letters or words is a way of acquiring mental energy, while sending or expressing words spends energy; there are several activity levels: creatures become hyperactive from high energy, or go into hibernation to recover from low energy
- **background is assimilated -** like songbirds adapt car alarms, our creatures would adapt Morse code patterns they may have perceived from submarine vessel communication.
- **"God words"** - All creatures share a list of "magic words", and when a newly formed word is similar enough to one of them, the creatures get excited and repeat variants of the new word for a while ("Song and Dance Mode").

2.6 Sketching with SuperCollider

All stages of the communication model that would run on the microchips eventually were first explored in code examples in SuperCollider, in a kind of second order simulation. The final version of these is available online [18], and is structured as follows:

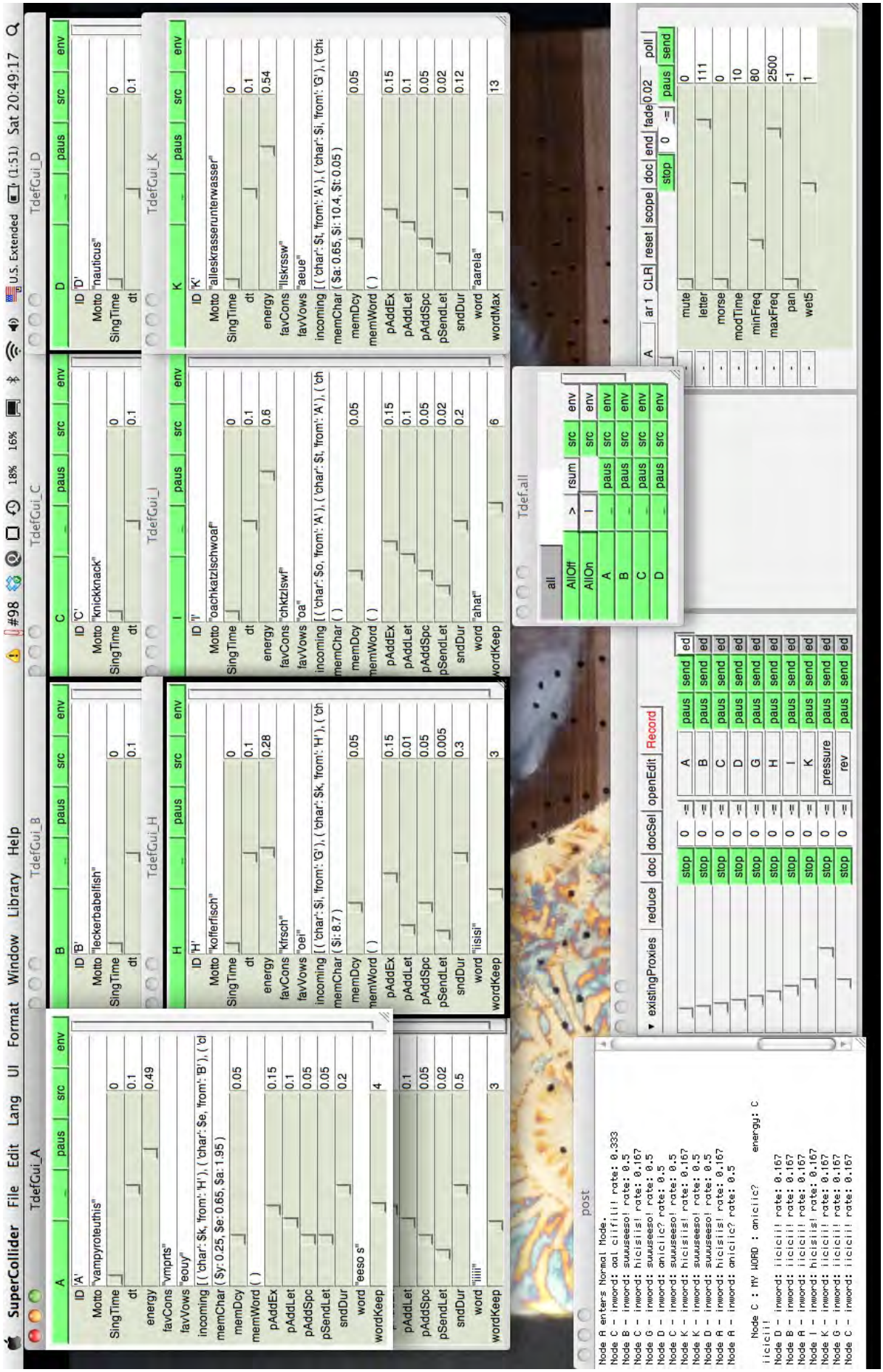
All creatures are modeled as continuously looping tasks which

- send individual characters to all, and listen to incoming characters
- build words from these, based on their own letter preferences
- when their word is complete, play their sound, and have their respective little GUI window's frame flicker briefly
- send their words, and when these match a “magic word”,
- go into a special, more active mode (“song and dance”)
- keep a three-stage energy level: normal, hyperactive and hibernation

The GUIs for the simulation represent a lot of the inner state of the creatures, so one can follow the slow growth of a word, and see and hear when it is finally expressed; watch the energy level of a creature change as it absorbs letters sent by the others; and much more; see the screenshot below.

This very rich representation helped understanding what was going on, and how new variations in the code changed the collective and individual behavior. Many special behaviors can be triggered from code, e.g. one can induce e.g. Song and Dance mode, change words while they build, manipulate the energy levels, etc etc. This flexibility even allows drastic changes to the entire system while it is running (which some people like to compare to open heart surgery).

The design sessions in the generative systems course took full advantage of that: we could try simpler ideas immediately, almost as fast as typing it, then observing for 5 minutes again, then discussing the change, and deciding how to move on. More complex ideas were postponed and prepared in advance for the next session.

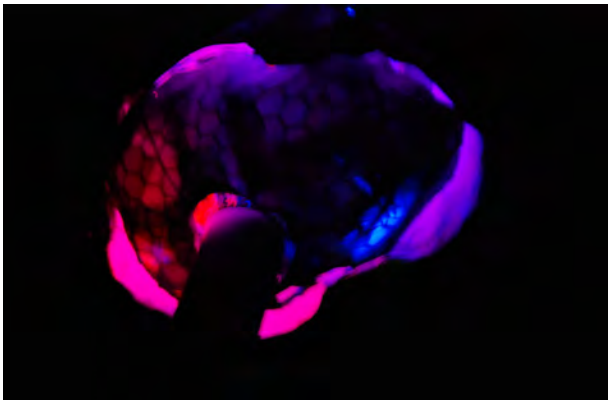


4. Commonality and Differentiation

The common model shared by all creatures emerging from all these threads, the creatures' brain design if you like, differs considerably from much evolutionary art; rather than following classical biologistical concepts (predator/prey, sexual reproduction, fight for resources), it focuses on the core of communicative behavior, the exchange of ideas. Very briefly, a number of actants ("creatures") transmit symbols ("letters") to each other, assemble incoming elements into longer chains ("words"), and sometimes express these "words" by emitting sound, light, or motion patterns. Obviously, the concept has been strongly influenced by its intended location, both in terms of the habitat it refers to, as well as in focusing on acoustic communication in very reverberant settings, with light only playing a localised role.

How the creatures express their inner state, i.e. communicate their "words" to the others, is very open to the interpretation of the individual participants: various manifestations of a single evolutionary thread, if you will. And in fact, the diversification of creatures was astounding! Some generate rhythmic pulse sequences, some create almost melodic phrases. Others have hues of colours that flash across their skins, while others again float up and down in space in response to the conversation between them. The following sections discuss each creature very briefly; the evolving documentation on all of them is available online [18], along with documentation movies of the preview show and the show at Wasserspeicher.

4.1 *Paulantinautius divinatio*



P. d. are deep sea octopuses belonging to the family of Bathypolypus arcticus. They normally live in depths from 1900m and below. Their most famous specimen was brought back to its original environment after playing the widely publicised role of Paul the" world championship oracle". After *Paul* [19] died on October, 26th, 2010, *Paulantinautius* is the only descendant beeing alive.

Model created by Bernhard Bauch.

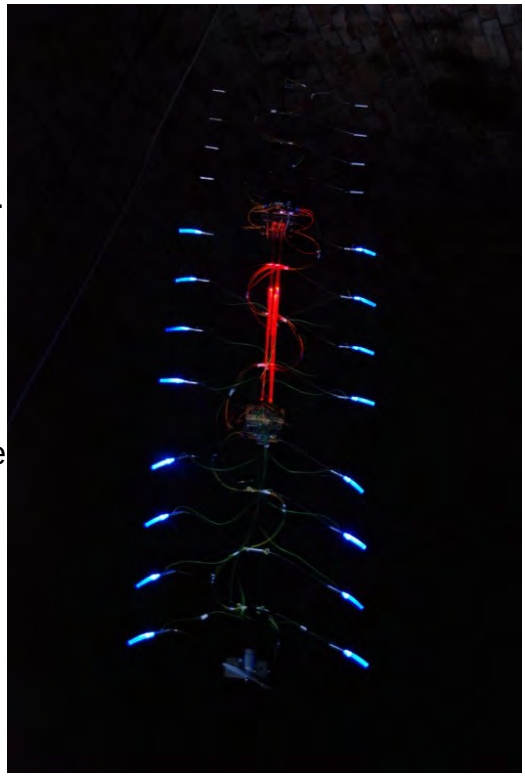
4.2 *Anarchiteuthis benjolinensis semiprofundus*

A. b.s. is a deep sea octopus belonging to the Subclass *Octopoda*. They are known to communicate by electromagnetic means. They produce moving bioluminscent hues on their skin, which are considered likely to be a form of communication; details on what they communicate are unclear.

*T*he model shown here focuses on its acoustic expression; its visual communication is only sketched here.

Model created by Alberto de Campo.
Sound and light production use the Benjolin instrument designed by Rob Hoordijk.

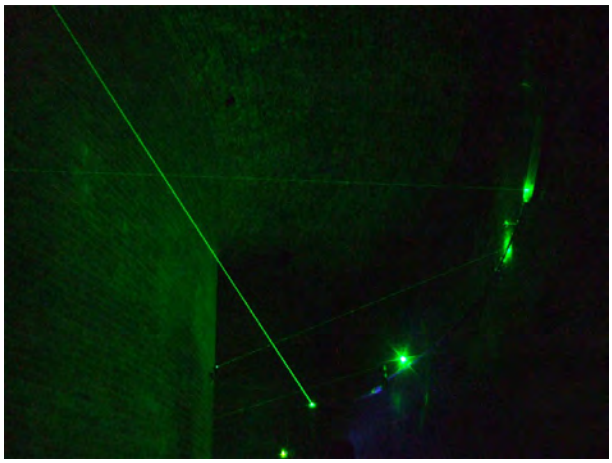
4.3 *Flexotheuthis elongabilis*



F. e. is an extremely rare species which lives exclusively in very deep marine crevices, below at least 2500 meters. They are extremely sensitive to changes in the electromagnetic field. Current research suggests that this sensitivity aids them in fleeing and seeking shelter when submarine earthquakes occur.
F. possesses a bioluminiscent nervous system; interestingly, the nodes (two for each body segment) also create wide-spectrum sonic pulses, which can be heard over considerable distances. It is assumed that these sounds serve communication purposes with fellow specimens. Some researchers favor the interpretation that their "song" is a form of self-entertainment, and expresses their subjective well-being; their nervous system appears complex enough to justify the existence of such mental states.
The model shown here is a baby *F.* of ca. 3m length when extended; until today only sub-adults have been found. Adult specimens are expected to continue growing as long as they live, and may easily reach lengths of 10-15 meters and more.

Model created by Dominik Hildebrand.

4.4 *Monatom* (also *Monon*)



M. is a very primitive unicellular organism probably belonging to the *Rhizaria* taxon. They are believed to be among the oldest life forms still in existence, and in very early phases of life on earth, it was the dominant life form across the globe. Today, *Monatoma* survive in the benthic zone.
Strangely their life activity appears to be based on binary code: They exchange information by means of bioluminiscent, directional light-beams in timed patterns, which bear some resemblance to Morse code. They have no fixed form or size, but are often observed to assemble in hexagonal forms; larger rhizomatic bodies composed of such hexagonal assemblies are observed up to very large sizes, going into hundreds of meters.

Model created by Akitoshi Honda.

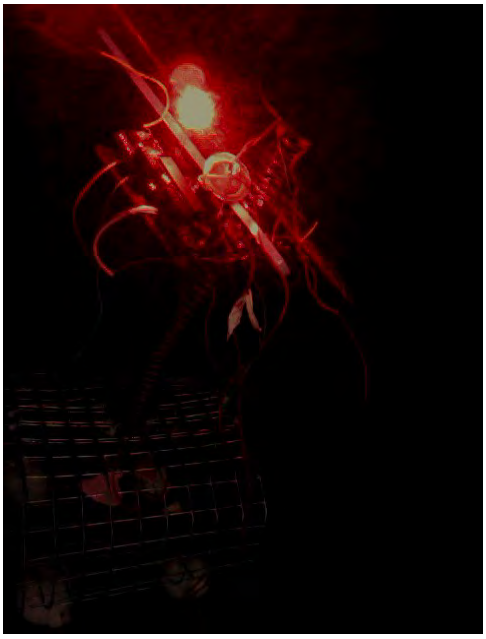
4.5 *Vuvuzeloida diaboli silvestris bandaniensis*

V.d.s.b. are deep sea worms belonging to the family of *Vuvuzeloida infernalis*. The cone-shaped worm has first been observed in deep crevices in the Banda Sea (South Moluccas in Indonesia). As the genus is phylogenetically very old, it is expected that isolated populations of *V.* will be found in far apart submarine environments.

V.ae are known to communicate by producing crackling sounds, which are somewhat similar to the Indonesian traditional instrument called "Forest Devil". When *Vuvuzeloidae* appear in larger flocks (also called schools), they tend to produce a pandemonium of loud monotonous sounds.

Model created by Ingrid Ladurner.

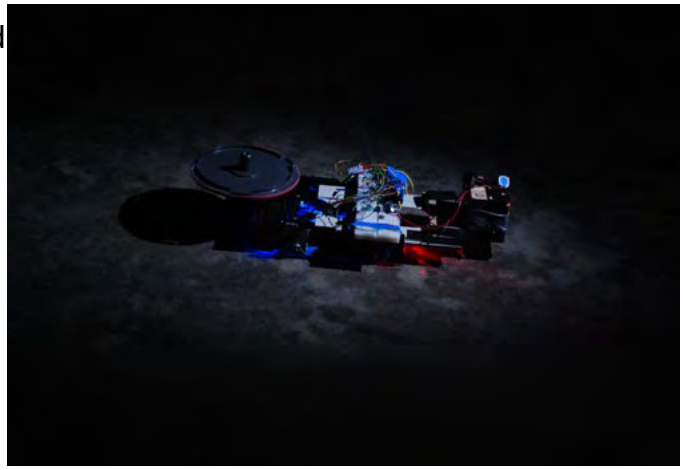
4.6 *Suithisaurus turbulens spasmodicus*



“Sweetysourus” (Suithisaurus turbulens spasmodicus) has first been found in the Indian Ocean, off the Island of Sri Lanka. Initially it was believed that the found object was only the skeleton of a previously unknown tropical *saurian* that has sunken into the deep sea after being dislocated by a monsoon storm. Later sightings have revealed that it is in fact a living being, which has quite complex behavior patterns; e.g., it has what looks like shiver spasms about 30-40 times per hour. It was named by an Irish marine biologist after the Gaelic word for skill (with the vernacular name being an unfortunate example of scientist humor).

Model created by Karin Lustenberger.

4.7 *Laufwerk (Testudo marino-digitalis monopedes)*



Laufwerke are marine testudides, and as such, members of the order stomatopoda. They live in the benthic zone of the deep sea and reach a typical length of 19 cm, and 31cm with their mouth open. Due to their extravagant mouth-apparatus, Laufwerke are the only species known that appear to grow by half of their normal body-length during ingestion.
Lacking a stomach, brain and almost everything except for the mouth, the predominant task in life of a laufwerk is eating. Due to the absent stomach, and the resulting inability to store food, Laufwerk requires a constant supply of nutrition.

Model created by Naomi Mulla.

4.8 *Cyclops Significans*

S. is an as yet unclassified inhabitant of the deep sea, arguably belonging to the Oculopodae. With its elaborate eyelashes, C. S. produces an rather spectacular gaze based on bioluminescence and sonic endo-resonance.

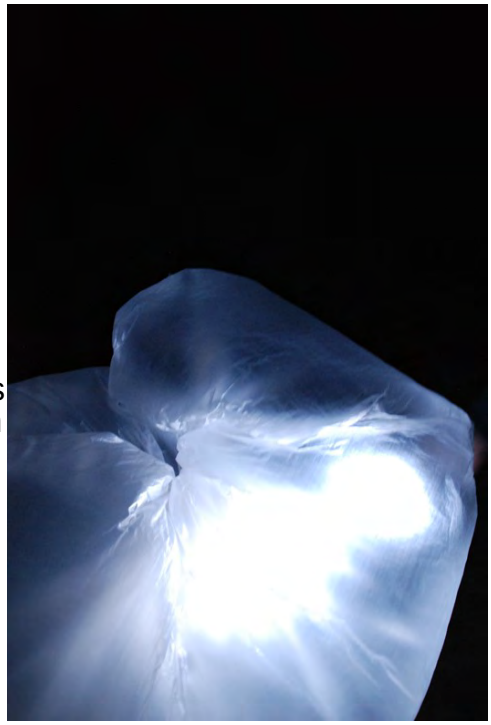
Model created by Christian Zollner.

4.9 *Humilis coconis*

First traces of *H. c.* were found in the deep waters of the Lapulapu Ridge in the northern Pacific Ocean during underwater audio recordings. Instead of the expected whale song that was the intended object to be studied, interference signals were picked up; since then researchers have tried to locate the origin of the sounds. Months later, a first picture of the humilis coconis could be taken (shown above) about 4200 meters below sea level almost at the same place.
Since then speculations abound about their taxonomical classification, their way of reproduction and their communication behavior. Researchers assume that the humilis coconis uses its inner organs to create some kind of feedback frequencies and is able to amplify them through the resonating shape of its body. Nuclear radiation seems to have caused mutations in *H.C.* which enables them to reuse industrial waste in multiple ways, e.g. for their sound-producing body shells.

Model created by Tobias Purfürst.

4.10 *Variotuethis*



Variotuethis was first sighted very shortly before the V. Z. P. installation. It appears that Variotuethis can split into multiple segments, which can survive as independent organisms after this giant version of cell proliferation.
Variothuetis were found in association with hydrothermal vents. It is very likely that Variothuetis evolved out of the Siboglinidae (worms that grow in tubes), which overgrow the steep gradients of the black smokers. The mystery about Variothuetis is the enormous size it developed in an obviously very short period of time. First speculations call hydrogen sulfide to account for the rapid growth. Hydrogen sulfid is produced during the hydrothermal activity of the black smokers. Tube worms depend on this chemical, which is highly

toxic to most known organisms.
Variothuetis seems unable to produce organic material through the process of chemosynthesis out of hydrogen sulfide. Instead the gas appears to accumulate within Variothuetis, which results in an inflation of the whole organism.

Model created by J. Tauber and N. Mulla.

4.11 Meteor Deep

The exact origin of this periodic submarine noise is unknown. Its sounds can reach over several hundred kilometres. It is believed to come fro volcanic eruptions or seismic oscillations, as high amounts of energy are needed to send these signals over such distances.
The crackling sound, shifting rhythmically from high to low frequencies is also modulated from time to time showing resonances of specific frequencies. The peaks in the frequency spectrum seem to show morse code like messages in some of the signals.
By sonic triangulation, the source was located in the South Sandwich Trench, the so called Meteor Deep (55°40'S, 025°55'W) in the South Atlantic, at 8428m depth.

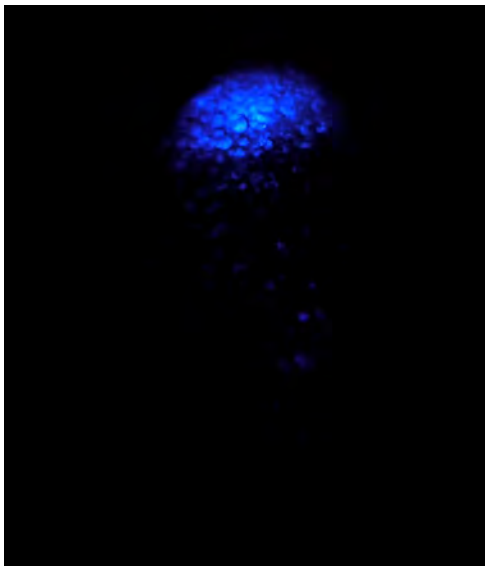
Model created by Constantin Engelmann.

4.12 Glomus Raucus Pellucensis

G, R. P. is a small multicellular organism that lives in the very deep areas of the sea (8000 - 9000 m). His overall corpus consists of several discs that resemble each other in shape and function. By repeatedly shifting the single discs in relation to each other, the Glomus R. P. is able to advance through the water. The sounds resulting from those movements are of a scratchy and coarse kind, which explains the origin of the Glomus' name. To Face the tremendous water pressure that exists in his habitat, the fragile-looking Glomus R. P. makes use of a semi-open cell design; thereby annulling the human-made dichotomy of "inside/outside".

Model created by Florian Kühnle.

4.13 *Spongia naturalis misericordiae commota* and *Spongia domestica neurotica*



In the family of sponge organisms, the Porifera, this recent discovery has been nicknamed “Gary”. Gary consists of many sponges of *Spongia naturalis misericordiae commota (S.N.M.C.)* living in a symbiotic network structure with *Spongia domestica neurotica (S.D.N.)*.
The image shows what is called Gary's heart. This sponge is moving consistently and rhythmically like a mammalian heart muscle and this movement produces a sound similar to human breathing.

Furthermore, clear blue light is emitted by this heart muscle. Two rays appearing irregularly suggest that this structure is also Gary's eyes. Some researchers hypothesize deep philosophical (bordering on spiritual) implications here.

Models created by Petja Ivanova.

4.14 *Hydrophis Profundorum Illuminatus*

H. P. I. belongs to the omnivorous sea snakes. Besides chasing prey actively, it also maintains a permanent stream of water through its body, which is filtered for nutrition. It is the object of speculations whether H. communicates mainly by hydroacoustic means or also electromagnetically.

Model created by Peter Bartz.

4.15 *Auralia Oscillia*

The Wobbling Moon Jellyfish, commonly known as the 'Wobble Squid' is a sea jelly that resembles a floating mushroom, closely related to the Aurelia Aurita or common Moon Jellyfish (dt. Ohrenqualle). Four horseshoe shaped gonads situated at the bottom of the stomach are a distinctive feature of the Moon Jellyfish. In Eastern mythology, the jellyfish tried to deceive the dragon king Rinjin, who then beat him and pulled out all the bones of his body. Indeed, Moon Jellyfish possess neither bones nor brain, heart, blood, head, eyes or ears and consist basically of a floating mouth/anus and digestive system. Thus, the Moon Jellyfish can be appreciated for its simplistic anatomy and vengeful and poisonous nature.
In contrast to the common Moon Jellyfish, the Auralia Oscillia emits a low frequency oscillation perceived as a low wobbling sound as their sting cells (nematocysts) prepare to emit poison in order to capture prey. This mutation is currently understood to function by stunning prey before stinging as an additional mode of attack.

Model created by Annie Goh.

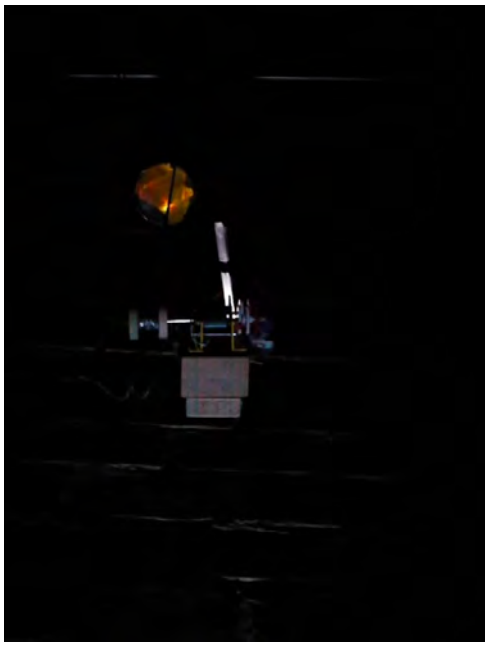
4.16 *Pringuzela Sospirosa Succubita*

Pringuzela S.S.'s long-stretched body is surprisingly angular for a marine animal, with the cylindrical gastro-oral apparatus most prominently developed around a tendinous structure with what seem to be two solar plexi, each attributed to a strong muscular texture, while the brain is only about 9% the weight of comparable Pringuzelae.
Its digestive cavity seems to have co-evolved into a resonant tube for deep sea acoustic communication. Projection of the sound is highly directional and it is vaguely resembling humanoid phonemes at varying pitches, with sentimental glissando motives being as common as short disrupted utterings.

P.ae seem to appear in great masses at periodic intervals of 2 or 4 years in the warm season, coincident, for no apparent reason, with global events of sporty nature. Yet, this is the first specimen ever brought to surface and kept alive.

P.ae feed on anything salty from the oceans, but seemingly also a root of hitherto unknown origin, rich in carbohydrates. A better known fact is, that it serves as a main source of nutrition for a great number of bipedal animals, especially when in a state of relaxation.

Model created by Hannes Hoelzl, inspired by Ralf Schreiber.



5. Visitor Experience and Responses

Visitors to the exhibition were given two handouts: a map showing the layout of the space, which creatures are where, and short explanatory texts; and little LED light sources that could be turned on for orientation, like marine searchlights, which were tweaked to be darker than they usually are.

The typical experience a visitor would have was:
One enters a tower on the top of the hill, goes down circular stairs within the tower, and arrives in full darkness, hearing a dense soundscape of strange sounds. With help from the little LED light, one could barely make out the round walls of the corridor, and slowly moving along one finds the first creature, a giant eye dramatically opening every now and then. Moving on, more and more creatures are encountered; over time, one adapts to the darkness, and after maybe 10 minutes, one can move freely in the dark without extra light.
Watching a creature from up close, it does very little most of the time; sometimes it bursts out in sound, light, motion patterns. When it is calm again, one hears the sounds from the neighboring creatures one may have seen already. When these are also silent, one can hear further away creatures drenched in reverberation.
This feeling of depth is closely modeled on the experience one would have in the deep sea: light would only be present from (soft) bioluminescent sources, and get absorbed at short range, while sound carries much further, and allows more overall orientation.

More attentive visitors would find out that some creatures interact with them: they are sensitive to light, and may become very active when hit by artificial lights; whether this is irritation, curiosity, aggression, or panic is hard to read from the creature's behavior; however, for animals one has never seen before, it should not be obvious.
They might also begin to notice several time layers of collective behavior:
The drifting energy levels and their superimposition creates a slow drift of overall activity levels, so occasional sparse phases (reminding one of lulls in conversations) can alternate with long denser episodes – and both will be punctuated by occasional short bursts of activity caused by “magic words” occurring.

The installation was shown during the SuperCollider conference 2010 in Berlin [20], and was extremely well attended (with probably record numbers for sound

installations). While visitors were not systematically asked for opinions, we had very positive responses from both experts and lay persons. Some visitors stayed in the space for very long times and reported sensing the slow changes of atmosphere described. Some objects triggered protective instincts in visitors (especially Laufwerk); some visitors formed their own speculative ideas about the creatures' particularities and living conditions and discussed them at length with the students who were on guard duty. Last not least, the children in the neighbourhood were extremely intrigued by the show - once they had overcome their fear of the dark, they kept coming back, and enthusiastically dragged along their friends and parents.

5. Considerations and Future Work

To the authors, Varia Z. P. seems to strike a happy balance between maintaining a strong, consistent overarching concept, and wide individual freedom to create very diverse, highly differentiated contributions.

Tackling a group project with considerable technical complexity (computational behaviour modeling, wireless communication of microprocessors) is not trivial, and in our understanding, we succeeded by people voluntarily taking over responsibilities based on all the different skills, such that all participants not only identified with their own creature(s), but also with the jointly created larger work.

This self-organizing work process turned out extremely felicitous: a kind of vertical differentiation of labour emerged, where a core group of teachers and particularly skilled participants solved the demanding questions in the infrastructure shared by all creatures with collective technical design decisions. People with less technical and more design background were equally involved in the overall conceptual design sessions and experiments, and further along the differentation axis, they had more time to focus on the physical design and practical building of the creatures and their electronics. This created an effective synergy: The “object designers” would not have realised a communication system of comparable complexity without electronics/ computer expert help; the “system designers” would not have realised as interesting a variety in physical appearances and behaviors if left to their own devices.

The working process was also very rewarding for all, due to the pervasive spirit of generous helpfulness – participants helped others with any tasks they were experienced at, so knowledge flowed freely in all directions; and much of the daunting number of various organizational tasks got taken care of graciously by volunteers. As a didactic strategy, the approach seemed highly motivating to learn new techniques by this kind of immersion, for all participants.

A number of aspects were not fully realised in the existing version of the installation, mainly in the form of quick temporary fixes never getting replaced by “real” solutions. However, to an extent this is a feature: as an open work form, both the concept and the realisation is extensible in many ways.

One can easily imagine refining the behavior of the existing creatures, and their described habitats and ecological context. Given the occasion of further shows, we will happily dive deeper into the biological background by reading more of the relevant research literature; this fell somewhat shorter than intended due to time constraints.

New creatures could then be based on a context that is “closer to nature” - which may be an advantage or not, but worth experimenting with. As captured in some of the code comments, the group had many more ideas than could be realised within the project, so we are looking forward to creating special versions for the next presentation(s) at other locations.

Finally, it seems that Sonobiology is a promising emerging artistic/scientific field: The Sonobotanics project [21] has been evolving for several generations of plants and installations with accompanying research papers. The Spiritus Coloris project [22] is a particularly unusual case of models of living beings that exhibit highly idiosyncratic behavior, if only from a carbon-lifeform-centric perspective. One can easily imagine more explorations in other related domains.

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