Re-thinking the design of bio-bio symbiotic relationships

Nørgaard, Mie; Merritt, Timothy

Publication date:
2012

Document Version:
Early version, also known as pre-print

Rethinking the design of bio-bio symbiotic relationships

Mie Nørgaard, Tim Merritt
Aarhus School of Architecture
Nørreport 20, 8000 Aarhus C, Denmark
{mie.norgaard,timothy.merritt}@aarch.dk

ABSTRACT
In this paper we discuss the three concepts comprising inter-species symbiotic relationships; mutualism, commensalism and parasitism. We do so to understand the currencies at play in different biological symbiotic relationships instigated and designed by humans, and to inspire a new way of thinking about the qualities of future bio-bio relationships engineered by man.

Author Keywords
DIYBio, symbiosis, bio-bio relationships, inter-species.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Edward Steichen's 1936 exhibition [6] featured flowers of the family *delphinium* created through 26 years of cross-breeding and genetic modifications by exposing the plants to chemicals. The result was freakishly large flowers impossible in nature but with an almost magnetic effect on the human eye. As one of the early examples of DIY biology, we take inspiration from and admire this work, but it also reminds us that with current technology, manipulation of life is now possible at many levels, with significant consequences for inter-species relationships.

In this paper, we choose not to focus on the ethical implications of the manipulation of life. In [8] the term "species-appropriate" mediated interaction was proposed as a way for designers to keep the design focused on supporting the organisms and their unique needs while enabling interaction. Recognizing that life is increasingly "programmable", (i.e. bioengineering, GMOs, etc.) there are surprisingly few resources for the designer to understand how different organisms interact with each other.

In order to understand the design space of interaction design and biology, one important step is to understand more about the functional aspects of symbiotic relationships. With attention to the unique costs and benefits for each partner in symbiosis, we can design more meaningful and sustainable interactive biological systems.

DIS 2012, June 11-15, 2012, Newcastle, UK.

Figure 1: The work of Hilary Berseth involves a mutualistic relationship with bees, which build honeycombs in shapes not found in Nature.

SYMBIOTIC BIOLOGICAL RELATIONSHIPS
The term "symbiosis" describes a relationship between members of two different species involving benefits to one or both organisms. The term covers three categories, which delineate three unique relationships between symbiotic partners according to the benefits and costs. *Mutualism* describes the association between two organisms in which each receives benefit and is most commonly developed between organisms with widely differing living requirements, for example, rumen bacteria live in bovine digestive tracts and help them digest the plants eaten. *Commensalism* describes the biological phenomenon where one of the individuals obtains food, shelter, locomotion or other benefits from the other without harming or benefiting the latter. Commensal relations are often seen between a larger host and a smaller commensal, as when the small remoras 'ride' on sharks, and feed on their leftovers. Finally, *parasitism*, describes the relationship between two biological species in which one benefits at the expense of the other, sometimes causing the death of the host. The beneficiary species (the *parasite*) can live on the body surface of the host or live inside the host. Fleas and lice belong to the former group, parasitic worms and bacteria to the latter. One form of parasitism known as social parasitism [3] involves an individual from one species enslaving one or more members of another species, or infiltrating and enjoying benefits from a colony made of individuals from another species. Cuckoos, for example do

not build nests of their own but deposit their eggs in the nests of other species and leave the burden of looking after the eggs and raising the fledglings to another species.

DESIGNED BIO-BIO SYMBIOSIS

In Nature, species have developed and refined complicated —often surprising— symbiotic relations over millions of years, but within the recent five thousand years, one species has made its own special contribution to the field. Today, mankind is capable of designing or engineering symbiotic bio-bio relations, which do not occur in Nature. By focusing on the cost/benefits of each member, we challenge designers to create systems that are mutually beneficial.

Designed bio-bio mutualism

When we, in the following, use the term designed or engineered bio-bio relationships, we refer to relationships that do not occur naturally, but have been tampered with or enabled by humans. Hilary Berseth's art work [1] is a designed relationship between bees and the human artist; the artist makes structures in wire and wax, and bees use them as support for creating fascinating and mind twisting honeycombs. Another mutualistic relationship involving two biological partners is the sugar lamps proposed by Anab Jain and Alex Taylor [7]. Here, genetically modified bacteria produce electricity while consuming a lamp-shaped block of sugar. The electricity is used to light an incandescent light bulb. One could argue that this relationship is parasitic because the bacteria dies after the sugar runs out, however, the human partner could keep the bacteria alive by supplying more sugar. Accordingly, we choose to understand this relationship as mutualistic because the bacteria get food and provide the human with energy turned into light.

Designed bio-bio commensalism

Humans have always used animals as a means to extend our own senses and abilities. Recently, we have started looking toward plants and micro-organisms to do the same. Genetically modified plants that react on chemicals leaked by landmines [5], cabbages that change color to draw attention to environmental health [4] and bacteria that glow according to the frequency of interpersonal communication [2] are all examples of our growing interest in tapping into other species' natural or modified abilities. The examples mentioned above could all be understood as commensal relationships between human and another species, because they only benefit one partner, in these cases the human.

Designed bio-bio parasitism

Man's interest in borrowing abilities from other species is not always harmless. Well into the 20th century, canaries were used to detect toxic gases in coalmines, dropping dead in their cage, serving as biological alarms. While this relationship undoubtedly is very valuable to the human party, it always ends with the death of the canary.

DISCUSSION

Humans have a long history of instigating and designing symbiotic relations with other species. Based on DIY and hacking tendencies in biotechnology, we expect the number and variety of symbiotic relations involving man will increase in the future, not least relations where the non-human partner has been biologically modified. In the light of such a development, we find that a discussion of the costs and benefits exchanged between species in symbiotic relationships are of great importance. We have refrained from discussing the ethically questionable inter-species relationships often found in farming and other industries which subject animals to modification in order to produce larger quantities of food, fur, etc. However the rise in demand for organic and sustainable production echoes this systemic and holistic approach. We propose that thinking in terms of the costs and benefits involved in inter-species relations, and seeing symbiosis as a framework for understanding inter-species relations, we can help future bio-bio designers think in new ways about what could motivate a symbiotic relationship, and how species could benefit from such. In future research, we will examine the aesthetic acceptance of these new systems (i.e. uncanny valley, taboo, hygge, etc.)

REFERENCES

1. Bonanos, C. *How Hilary Berseth Makes His Beeswax Sculptures*, New York Magazine (online), Oct 2008, http://nymag.com/arts/art/features/51163/.
2. Cheok, A., Kok, R., Tan, C., Fernando, O., Merritt, T., and Sen, J. Empathetic living media. In *Proceedings of the 7th ACM conference on Designing interactive systems* (DIS '08). ACM, NY, NY, USA, 465-473. 2008.
3. Deslippe, R. Social Parasitism in Ants. Nature Education Knowledge 1(8):27. 2010.
4. Fernando, O., Cheok, A., Merritt, T., Peiris, R., Fernando, C., Ranasinghe, N., Wickrama, I., and Karunanayaka, K. Babbage Cabbage: Biological Empathetic Media, VRIC Laval Virtual Proceedings, April 22-26, 2009, Laval, France. pp. 363-366.
5. Halper, M. Saving Lives And Limbs With a Weed, Time magazine, Business, Sunday, Dec. 03, 2006.
6. Hartmann, C. Edward Steichen Archive: Delphiniums Blue (and White and Pink, Too). Mar 8, 2011. http://www.moma.org/explore/inside_out/2011/03/08/edward-steichen-archive-delphiniums-blue-and-white-and-pink-too/
7. Jain, A. and Taylor, A.: Sugar Power. 2006-2008. http://www.anab.in/research/energyautonomy.html
8. McGrath, R. Species-appropriate computer mediated interaction. In *Proceedings of CHI2009* (CHI EA '09). ACM, New York, NY, USA, 2529-2534. 2009.