Selection of Publications

N. Koltick. *Autonomous Botanists* in the Proceedings of the ACADIA (Association for Computer Aided Design in Architecture) Annual Conference, Computational Ecologies: Design in the Anthropocene, Cincinnati, OH, October, 2015.

N. Koltick. Accidental Aesthetics: Philosophies of the Artificial. Proceedings of xCoAx 2015 Computation, Communication, Aesthetics & X, Glasgow, Scotland 25-26 June, 2015

N. Koltick. The Artificial, the Accidental, the Aesthetic…. Journal of Science and Technology of the Arts, [S.l.], v. 7, n. 1, p. 17-20, November, 2015. (Journal article edited from XCoAx conference presentation above for special volume coinciding with conference.)

N. Koltick. *With Space, No Longer With in: Provocations for a Newly Emergent Practice of Interiority.* ELISAVA Temes de Disseny, Issue 30, January, 2015.

N. Koltick. *Better Know a VLO, Speculative Philosophical Approaches to Very Large Organizations.* Globalizing Architecture / Flows and Disruption: Proceedings of the ACSA (Association of Collegiate Schools of Architecture) 102nd National Conference, April, 2014.

N. Koltick. *Tomorrow's Ecologies: a Synthetic Approach*. New Constellations, New Ecologies, Proceedings of the ACSA 101st National Conference. San Francisco, CA, March 2013.

& N. Koltick and M. J. Lutz. *A Field Guide to Generating Architectural Species,* Proceedings of the ACSA 101st National Conference. San Francisco, CA, March 2013.

"Interior Prosthetics" in (Ed.) Liss Werner, *[En]coding Architecture,* Carnegie Mellon University School of Architecture, Pittsburgh, PA, January 2014. ISBN: 0976294141

N. Koltick. *A Materiality of Agency: Speculations on the Impact of Biological Computation on Materiality.* Digital Aptitudes, Proceedings of the ACSA 100th National Conference. Boston, MA, 1- 2 April 2012.

N. Koltick. *Entropic Ecologies*, VOLUME, Vol.31, no. 1, p.150-1, 2012. Edited by: Arjen Oosterman/ Contributing editors: Ole Bouman, Rem Koolhaas, Mark Wigley. Co-editors for this issue: Liam Young and Kate Davies, Feature editor: Jeffrey Inaba. ISBN:9 789 077 966 310

Navigation to Articles is Provided in The Bookmarks Tab of the PDF Document.

ACADIA_2015

Computational Ecologies: Design in the Anthropocene

OCTOBER 19–25

CINCINNATI_OHIO

Proceedings of the 35th Annual Conference of the Association for Computer Aided Design in Architecture

EDITORS

Lonn Combs
Rensselaer Polytechnic Institute

Chris Perry
Rensselaer Polytechnic Institute

HOSTED BY

University of Cincinnati
College of Design, Architecture, Art, and Planning

TABLE OF CONTENTS

AUTONOMOUS BOTANIST: THE POETIC POTENTIALS OF A NEW ROBOTIC SPECIES

Nicole Koltick
Westphal College of Media Arts & Design
at Drexel University
Design Futures Lab

ABSTRACT
This project begins by asking questions about ethics and empathy towards robots, and contemplates the future of their behavior in ways not informed by pragmatics or economy. What if a robot had a hobby? How do robots make aesthetic decisions? What is a robot's point of view? It seeks to shift perception of robotic agency and allow the audience to embody the robotic gardeners' vision, behavior and influence its aesthetics. By amplifying perceptual differences between humans and robots and we allow for both tangible and virtual embodiment experiences from multiple scales and perspectives. This compelling design speculation seeks to deploy a variety of interactive computational techniques, exploring novel forms and behaviors in order to engage deeper philosophical issues surrounding aesthetics, non-human agencies, and the role of the synthetic in the future.

The *Autonomous Botanist* project currently in production proposes a robotic gardening activity that seeks to align the aesthetic with the artificial. It speculates on non-anthropocentric embodiment and perception. The line between the synthetic and the natural is increasingly blurred. The implications of new interactions with hybrid entities, spanning these worlds, form the jumping off point of our proposal. The development of a robot who performs relatable yet artificial activities speculates on the potential for robots who do not serve primarily pragmatic aims but rather ones who have "hobbies", aesthetic viewpoints and a novel set of behaviors to enact these activities. This project envisions a habitat for non-humanity. Autonomous botanists influence and develop a synthetic landscape nurtured by robots for robots; in essence they are flora-forming. This project seeks to explore the poetic potentials of a new robotic species. The robots, terrain, and embodiment scenarios within the project put forward a highly novel approach to autonomous systems and aesthetics.

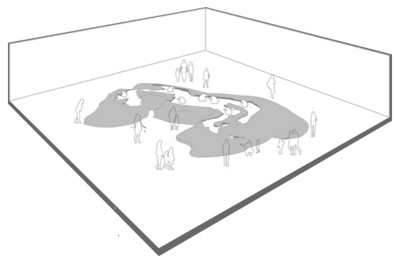


Figure 1
Project terrain perspective.

The project has three distinct components:

1 A physical terrain where the robots are operating *(Figures 1, 2, 3)*;
2 An embodiment gallery (physical or virtual) where users can remotely occupy the robot's perception and behavior *(Figure 4)*;
3 An online feedback loop which transmits the robot's vision imagery offsite and relays aesthetic assessment criteria back to the robots to govern behavior.

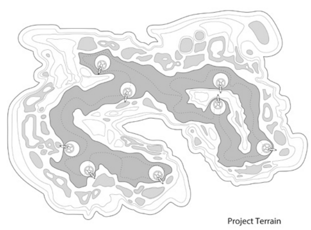


Figure 2
Project terrain plan.

Computers, autonomous systems, artificial intelligences, algorithms, software, hardware can all be considered under the umbrella of a set of computational ecologies. These ecologies are comprised of hardware, software, materials, information, humans, animals, rare minerals, energy, coal, solar power and on and on. The most recognizable elements in these ecologies, the discrete object understood to be a computer has been considered in many ways "mere" machines. We "tell" them to do something and they respond. This was perhaps the simplicity of their mechanism at the advent of computing. Originally conceived as a way to automate tedious mathematical operations they have surpassed these original conceptions, yet a persistent misconception reigns as to their status and interactions both within their internal processes and outward into their network logics. These entities have broad unexamined aesthetic potentials.

There have been a dizzying array of recent developments across all disciplines relating to computation, but there still remains a swath of knowledge which remains opaque to us. This resides in the realm of the fuzzy, cloudy, non-deterministic behaviors of non-linear emergent systems including the human brain. Artificial intelligence and computational ecologies intersect with this fuzzy realm. We are becoming ever closer to simulating human behaviors in both autonomous physical robotics systems as well as in artificial learning and intelligence techniques. The aesthetic realm more so than other potential behaviors and activities of computational systems seems to elicit discomfort and anthropocentric indignity. "How could a computer write as I do? What about subjectivity?" asks the fiction writer. I would argue that these computational ecologies which will contain embedded emergent intelligences harness the potential for a new type of relationship which moves beyond simplistic notions of subject and object. Emergent computational creativity has the potential to be affective in a multitude of unforeseen ways. This ability to engage in novel relationships with all manner of entities may be an under recognized feature of emergent intelligence. Imagining the potentially for a drastically diverse range of stances and affective capacities will provide us with an expanded concept these systems. As for the matter of computational pervasiveness in our everyday life will soon be so entangled if it is not so already that boundaries between self, network and "natural" versus "artificial" will advance their complicated intermingling. I argue that the aesthetic realm, an activity perceived as by humans for humans is a great place to begin examining our relationship with computational systems philosophically.

Figure 3
Terrain detail.

The *Autonomous Botanist* project pinpoints aesthetic behavior as an activity that has particular philosophical and intellectual resonance, and asks questions about our views of aesthetic behaviors in non-human entities. Historically aesthetic activity has been designated as an innately and solely human characteristic. Contemporary philosophers have begun to explore the deeper philosophical implications of how we view ourselves and how we might reimagine our relationships to the synthetic, including robots, artificial life, and artificial intelligence. A hallmark of these contemporary philosophical approaches, which fall under the broad heading of Speculative Realism, can be found in their non-anthropocentric stances (Harman 2010; Morton 2013; DeLanda 2013; Garcia and Ohm 2013; Shaviro 2014). Recent influential work includes Rothenberg's (2011) exploration of non-human aesthetics through animals' aesthetic behaviors. Posthumanist scholars also offer insight with new perspectives on hybrid entities and synthetic species (Hayles 1999; Badmington 2003; Morris 2009). Bogost (2012) explores how various machines and devices "see". These new forms of phenomenology (Harman 2005; Yi 2010; Sparrow 2014) are not meant to be an anthropocentric reading of how machines will be like "us", but rather a means to speculate on the variety of ways they will be quite different.

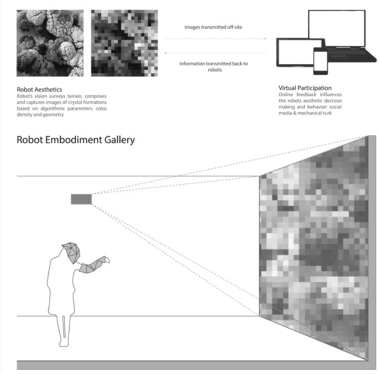


Figure 4
Embodiment gallery diagram.

This project is interested in exploring the potentials of non-human aesthetics in autonomous systems including robots. The work is grounded through tracing the history of philosophical approaches to aesthetics and its role in our identification of self (Whitehead 1920; Heidegger 1962; Hofstadter and Kuhns 1964; Hegel and Knox 1979; DeLeuze 2003; Shaviro 2009; Stengers and Chase 2011; Gage 2011). The project then transitions into a speculative realist examination of the so-called artificial. This project takes these core philosophical ideas and intersects them with speculations involving tangible designed objects. The current proposal posits a scenario by which we might come to potentially embody a robot's perspective through viewing and experiencing its performance of an activity requiring sensitivity, discernment and agency. This work combines research conducted in several key areas including Computational Creativity (Saunders 2002; Duch 2006; Pease and Colton 2011; Colton and Wiggins 2012), Social Robots (Moravec, 1988; Breazal, 2002; Vallverdu, 2012), Human-Technology Interactions (Dunne and Raby 2001; McCullough 2004; Dunne 2005; Nomura, Tatsuya et al.

2006; Christian 2011; Buiu and Popescu 2011; Bratton 2015), Robot Ethics (Asaro 2006; Beavers 2010; Kin, Abney and Bekey 2012), and Emotional and Aesthetic Potentials of Artificial Systems (Trappl 2002; Fellous 2004; Parisi and Petrosino 2010; Sugano, Morita and Tomiyama 2012). Recent design precedents includes autonomous robot gardeners (ROGR) currently being developed by students in partnership with NASA to grow food in deep space applications (Granath 2014). cyber-Garden 4.0 by ecoLogic Studio (Poletto et al. 2011) and Robot Garden developed by MIT's Computer Science and Artificial Intelligence Lab to help children learn to code through a tangible dynamic garden environment (Conner-Simons 2015). Artificial intelligence and autonomous systems research are dramatically evolving fields and their intersection with the aesthetic is an underdeveloped area of philosophical and design inquiry.

Figure 5
Robot with 3D-printed flexible skin.

Computational creativity is a rapidly evolving field of artistic practice and this project adds to that body of work through the development of a series of custom robots *(Figure 5)*, a distinct environment for them to influence and a series of interactive experiences to encourage dialogue surrounding autonomous systems, aesthetics, and agency. This project ties together artificial intelligence, robots and aesthetics in a unique and compelling fashion. The pairing of the physical with the virtual allows users to interact with the project in a variety of ways from multiple perspectives. The project has multiple points of entry for a diverse range of viewers. The partnering of multiple processes and agencies creates a compelling multi-layered exploration.

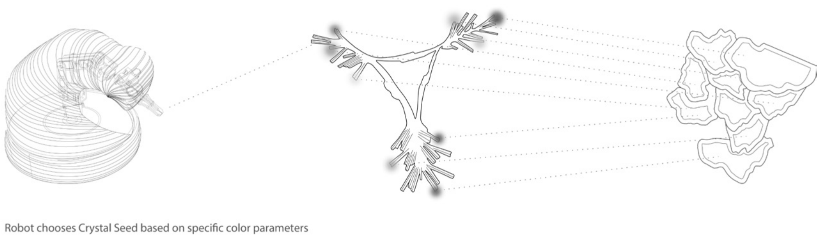


Figure 6
Robots aesthetic decision making.

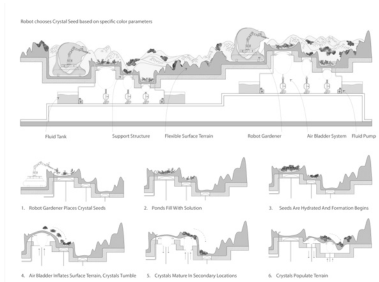


Figure 7
Robot terrain diagrams.

This project hinges on a series of interconnected relationships and a continuous interplay between the natural and the synthetic, the real and the virtual. There is a concerted effort to evoke natural formations and interdependent relationships between, robot, environment, and viewer. The evocation of the natural through a completely synthetic ecology further emphasizes the blurred line between artificial and biological entities. It becomes apparent that what appears to be natural is something quite other. The crystals form a continually evolving landscape; the robot places the crystal seeds *(Figure 6)* and the shifting terrain utilizing custom air bladders *(Figure 7)* further influences the development of the resultant landscape *(Figure 8)*. The synthetic garden, the robots *(Figure 9)*, and the crystals *(Figures 10, 11, 12, 13)* are all carefully developed to offer an incredibly delicate and beautiful environmental experience. The project is interested in exploring robotic aesthetics not only through behavior but also in form and materiality. The robot currently in development *(Figure 14)* is conceived as a distinct hybrid species exhibiting animal and mechanical criteria in a formally compelling composite.

Figure 8
Terrain prototype detail.

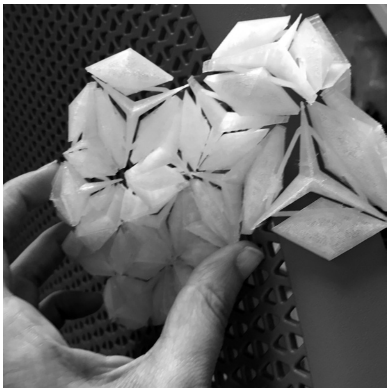


Figure 9
3D-printed robot skin detail

Figure 10
Crystals in development

Figure 11
Crystals.

Figure 12
Crystals in landscape.

This project provokes dialogue in several areas surrounding technology and culture by posing a series of questions:

> What is the role of newly emergent technological species in society?
>
> How can we explore and blur the dividing line between the natural and the synthetic?
>
> Should we have empathy for non-biological species?
>
> How will our behavior be affected as synthetic species assume expanded roles in our society?
>
> How can we introduce a non-anthropocentric view through this project?
>
> How can we begin to speculate on non-human aesthetics?

This project pairs the intersection of aesthetics with several emerging areas of technology (autonomous robotic systems, artificial intelligence, virtual reality). It seeks to speculate on non-anthropocentric embodiments, perspectives, and perceptions. The lines between the synthetic and the natural are increasingly blurred. With this blurring enter new questions surrounding agency, legitimacy, and empathy. The implications of new interactions with hybrid entities spanning these worlds form the jumping off point of our proposal. Artificial intelligence is making rapid advances, and its intersection with the aesthetic is an underdeveloped area of inquiry.

Issues of perception and embodiment of this new "species" will be explored through the development of viewing systems and interactive interfaces which allow visitors to experience the point of view of the robots within their environment. This very specific form of augmented reality will challenge viewers to inhabit the robots' perspective in view, mobility, and ergonomics. This project pairs virtual embodiments with tangible physical objects and systems. The deployment of robots to seed and maintain a beautiful crystal garden challenges viewers on their preconceived ideas about robotic systems and provokes questions about artificial life, digitally augmented systems, and synthetic entities.

ACKNOWLEDGEMENTS

Research Assistants: Jay Hardman and Elena Sabinson.
Engineer: Mike Hogan.

Figure 13
Top view of crystals in terrain.

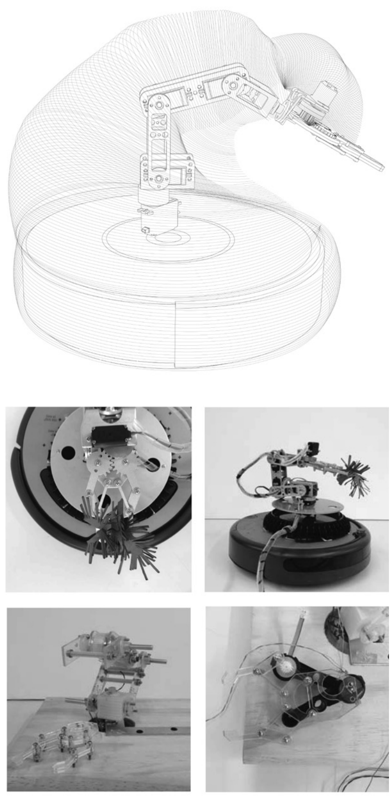
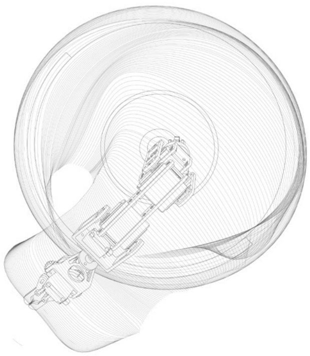
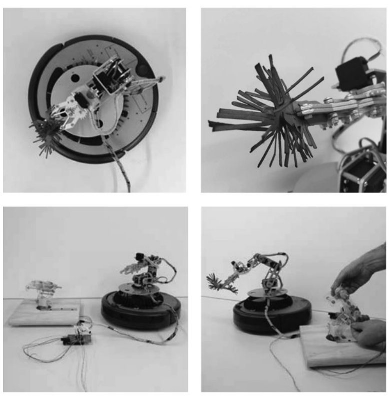


Figure 14
Robot in development.





REFERENCES

Asaro, P. M. (2006). What Should We Want from a Robot Ethic? In International Review of Information Ethics 6(12): 9-16.

Beavers, A. (2010). Robot Ethics and Human Ethics. Special issue, Ethics and Information Technology 12(3).

Buiu, C. and N. Popescu. (2011). Aesthetic Emotions in Human-Robot Interaction: Implications on Interaction Design of Robotic Artists. In International Journal of Innovative Computing, Information and Control 7(3): 1097-1107.

Bogost, I. (2012). Alien Phenomenology, Or, What It's Like to Be a Thing. Minneapolis: University of Minnesota Press.

Bratton, B. (2015).Outing A.I.: Beyond the Turing Test. In Opinionator, New York Times, February 25 2015. Web February 24 2015.

Breazeal, C. L. (2002). Chapter 5, The Physical Robot; Chapter 10, Facial Animation and Expression. In Designing Sociable Robots. Cambridge, Mass.: MIT Press.

Carr, L., M. Iacoboni, M.-C. Dubeau, J. C. Mazziota, G. L. Lenzi. (2003). Neural mechanisms of empathy in humans: a relay from neural systems for imitation to limbic areas". Proceedings of the National Academy of Sciences 100(9): 5497-5502. DOI: 10.1073/pnas.0935845100.

Christian, B. (2011). The Most Human Human: What Talking with Computers Teaches Us About What It Means to Be Alive. New York: Doubleday.

Colton, S. and G. A. Wiggins. (2012). Computational creativity: the final frontier? In ECAI 2012: 20th European Conference on Artificial Intelligence, eds. L. De Raedt, C. Bessiere, D. Dubois. Amsterdam, Netherlands: IOS Press BV.

Conner-Simons, A. (2015). Can an LED-filled "robot garden" make coding more accessible? CSAIL's 100-plus blooming, crawling, swimming bots teach basic programming concepts." MIT News, February 18, 2015. Accessed July 17, 2015. *http://newsoffice.mit.edu/2015/can-led-robot-garden-make-coding-more-accessible-0218*.

Deleuze, G. (2003). Francis Bacon: the Logic of Sensation. London: Continuum.

Duch, W. (2006). Computational Creativity. In IJCNN '06 International Joint Conference on Neural Networks, pp. 435-442. IEEE: . DOI: 10.1109/IJCNN.2006.246714.

Dunne, A. (2005). Post-Optimal Objects. In Hertzian Tales Electronic Products, Aesthetic Experience, and Critical Design. Cambridge, Mass.: The MIT Press.

Dunne, A. and F. Raby. (2001). Design Noir: The Secret Life of Electronic Objects. Basel, Boston, Berlin: Birkhauser.

Fellous, J.-M. (2004). From Human Emotions to Robot Emotions. In Architectures for Modeling Emotion: AAAI Spring Symposium, Stanford University, CA.

Gage, M. F., ed. (2011). Aesthetic Theory: Essential Texts. New York, London: W. W. Norton.

Garcia, T. and M. A. Ohm. (2014). Form and Object: A Treatise on Things. Edinburgh: Edinburgh University Press.

Granath, B., ed. (2014). University Students Developing Robotic Gardening Technology. NASA: Technology, July 7, 2014. Accessed July 17, 2015. *http://www.nasa.gov/content/university-students-developing-robotic-gardening-technology*.

Harman, G. (2010). Towards Speculative Realism: Essays and Lectures. Winchester, UK: Zero Book.

Harman, G. (2002). Tool-Being: Heidegger and the Metaphyics of Objects. Chicago: Open Court.

Hayles, N. K. (1999). How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics. Chicago: University of Chicago Press.

Heidegger, M. (1962). Being and Time, tr. J. MacQuarrie and E. Robinson. London, SCM Press.

Hegel, G., W. Friedrich and T. M. Knox. (1979). Hegel's Introduction to Aesthetics: Being the Introduction to the Berlin Aesthetics Lectures of the 1820s. Oxford: Clarendon Press.

Hofstadter, A. and R. Kuhns. (1964). Philosophies of Art and Beauty: Selected Readings in Aesthetics from Plato to Heidegger. New York: Modern Library.

Lin, P., K. Abney and G. A. Bekey. (2012) Robot Ethics: The Ethical and Social Implications of Robotics. Cambridge, Mass.: The MIT Press.

McCullough, M. (2004). Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing. Cambridge, Mass.: The MIT Press.

Morris, J. (2009). Can Computers Create Art?. New York: Atropos.Press.

Morton, T. (2013). Realist Magic: Objects, Ontology, Causality. Ann Arbor, Mich.: Open Humanities Press.

Nomura, T., et al. (2006). Measurement of Negative Attitudes Toward Robots. In Interaction Studies 7(3): 437-454.

Parisi, D., and G. Petrosino. (2010). Robots that Have Emotions. In Adaptive Behavior 18(6): 453-469.

Pease, A. and S. Colton. (2011). On Impact and Evaluation in Computational Creativity: A Discussion of the Turing Test and an Alternative Proposal. In Proceedings of the AISB Symposium on AI and Philosophy.

Poletto, M., C. Pasquero, A. Bugli, N. Puckett, Ecologic Studio. (2011). Cyber Gardens 4. In Workshop, SmartGeometry 2011, Copenhagen, Denmark. Accessed March 2, 2015. *http://smartgeometry.org/index.php?option=com_content&view=article&id=65%3Acyber-gardens&catid=37&Itemid=56*.

Rothenberg, D. (2011). Survival of the Beautiful: Art, Science, and Evolution. New York: Bloomsbury Press.

Saunders, R. (2002). Curious Design Agents and Artificial Creativity: A Synthetic Approach to the Study of Creative Behaviour. Ph.D. Thesis. Sydney: The University of Sydney, Faculty of Architecture.

Shaviro, S. (2009). Without Criteria Kant, Whitehead, Deleuze, and Aesthetics. Cambridge, Mass.: The MIT Press.

Stengers, I. and M. Chase. (2011). Thinking with Whitehead: A Free and Wild Creation of Concepts. Cambridge, Mass.: Harvard University Press.

Sparrow, T. (2014). The End of Phenomenology: Metaphysics and the New Realism. Edinburgh: Edinburgh University Press.

Sugano, S., H. Morita, K. Tomiyama. (2013). Study on Kawaii Motion: Classifying Kawaii Motion Using Roomba. In Advances in Affective and Pleasurable Design. Boca Raton, FL: Taylor & Francis.

Trappl, R. (2002). Emotions in Humans and Artifacts. Cambridge, Mass.: The MIT Press.

Whitehead, A. N. (1920). The Concept of Nature: Tarner Lectures Delivered in Trinity College, November 1919. Cambridge: Cambridge University Press.

NICOLE KOLTICK

Nicole Koltick is Assistant Professor in the Westphal College of Media Arts & Design at Drexel University and the Founding Director of the Design Futures Lab where she leads a graduate research group in critical design practices investigating the intersection of artificial intelligence, robotics, ethics, design, and aesthetics. Nicole writes extensively on the philosophical and theoretical implications concerning concepts of the "natural", the "synthetic", aesthetics, the rapidly evolving digital landscape, and implications of emerging computational ecologies. Nicole is currently pursuing a Ph.D. in Computational Design Theory at the European Graduate School in the area of Philosophy, Art and Critical Thought. She received a Master of Architecture degree from UCLA and a BFA in Art with University Honors from Carnegie Mellon University. Nicole is a 2014 MacDowell Fellow and she has recently completed papers on dark data, aesthetics of emergence, materiality and agency in the future, and speculative realist approaches to design.

TABLE OF CONTENTS

xCoAx2015

Proceedings of the third Conference on
Computation, **Communication**, **Aesthetics** and **X**.

xCoAx 2015
Computation
Communication
Aesthetics
and X

Glasgow
Scotland
2015.xCoAx.org

Accidental Aesthetics: Philosophies of the Artificial

Nicole Koltick
Drexel University
nrk37@drexel.edu

Keywords: artificial aesthetics, philosophy, speculative realism

This paper will examine a range of philosophies surrounding aesthetics and begin to speculate on a metaphysical framework surrounding artificial aesthetics. Tracing earlier arguments from Hegel and Kant and extracting significant developments in newer variants of speculative realist philosophies, this paper seeks to critically engage the realm of aesthetics and computation from a metaphysical viewpoint. These metaphysics touch on issues of non-human agency, inter object relations, and aesthetic theory in relation to computational entities and autonomous systems. The ability of these systems to operate outside of human cognitive limitations including thought patterns and constructions which may preclude alternative aesthetic outcomes, afford them in some ways limitless potential in relation to aesthetics. Aesthetics here are not narrowly constrained by a human ability to recognize or appreciate these outputs. The designation of the accidental or provisional is utilized as an alternative approach to the production and assessment of aesthetic occurrences.

This project is partially funded by FEDER through the Operational Competitiveness Program – COMPETE – and by national funds through the Foundation for Science and Technology – FCT – in the scope of projects PEst-C/EAT/UI4057/2011 (FCOMP-Ol-0124-FEDER-D22700) and PEst-OE/EAT/UI0622/2014.

UNIVERSITY OF THE WEST of SCOTLAND
UWS

U.PORTO
FACULDADE DE BELAS ARTES
UNIVERSIDADE DO PORTO

UNIVERSITÀ DEGLI STUDI DI BERGAMO

Hochschule Anhalt
Anhalt University of Applied Sciences

CCA: Centre for Contemporary Arts

cf. Creative Futures Institute

i2ADS.

COMPETE
PROGRAMA OPERACIONAL FACTORES DE COMPETITIVIDADE

QREN
QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL
PORTUGAL 2007.2013

UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional

FCT
Fundação para a Ciência e a Tecnologia

The Artificial, the Accidental, the Aesthetic…

Nicole Koltick
Director, Design Futures Lab, Department of Architecture + Interiors, Westphal College of Media Arts & Design, Drexel University, Philadelphia, PA, USA
-----
nrk37@drexel.edu

ABSTRACT

How do we define, discuss or assess aesthetics within a contemporary philosophical framework? The indefiniteness that accompanies attempts to formalize a definition of the aesthetic is a primary focus of this paper. This lack of a definition has occupied philosophers for hundreds of years in attempts to delineate the boundaries of an elusively formless concept. This formlessness speaks to the incredibly evasive character of such a pervasive feature recognized in both natural and artificial systems, agents and artefacts. With the rapid growth of artificially intelligent systems and an astounding diversity in computational creativity, in what ways may we approach aesthetics? How is the aesthetic recognized, determined and produced? This paper seeks to critically engage issues of non-human agency, inter-object relations, and aesthetic theory in relation to computational entities and autonomous systems. The ability of these systems to operate outside of human cognitive limitations including thought patterns and constructions which may preclude alternative aesthetic outcomes, afford them in some ways limitless potential in relation to aesthetics. The designation of the accidental or provisional is utilized as an alternative approach to the production and assessment of aesthetic occurrences of the non-human.

KEYWORDS

Artificial Aesthetics; Philosophy; Speculative Realism; Computational Phenomenology.

1 | INTRODUCTION

How do we define the aesthetic today? I am not writing here about a specific codified beauty or rarefied sublimity. Rather these subjective definitions and attempts to delineate boundaries, result in vastly incomplete, exclusionary criteria that do little to further the discussion of this aspect of creative experience. Using the designation of the *accidental* in relation to aesthetics posits that outcomes, products, thoughts and recognitions of the aesthetic are related to an unfolding and singular relation or encounter which is not expected – whether in behaviour, form, affect or outcome. My assertion here of the pervasiveness of the *accidental* as an underlying feature of the aesthetic, stands in opposition to the use of the term *accidental* as a throw away or pejorative designation. Here it is interpreted as a desirable and affective feature, one that is both ubiquitous and yet under-examined philosophically. The *accidental* alludes to perceptions, interactions, causes, and effects not entirely premeditated or conceived, nevertheless yielding effects both discernible and registered. Imagining the potential for a drastically diverse range of aesthetic instances will provide us with an expanded concept of the potentials for artificial entities in both form and behaviour.

2 | ELUSIVE AESTHETICS

The aesthetic as a term and an area of philosophical inquiry has posed significant challenges due to the elusive nature of capturing and locating the aesthetic. Hegel (1979, *pp. 5, 25, 33*) in his *Lectures on the*

Introduction of Aesthetics in the 1820's recognized that, "a study of this kind becomes wearisome on account of its indefiniteness and emptiness and disagreeable by its concentration on tiny subjective peculiarities." Most historical approaches to the topic identify the presence of an aesthetic void, which eludes precise description or location, both cognitively and materially. This indefiniteness and emptiness can be identified as a pertinent feature of the aesthetic. When we are dislodged from our default mode of interpretation and cognition, when the present moment unfolds with unexpected variability, a disruption of our cognitive expectations occurs and we experience a sort of indefiniteness.

This disruption and its affective capacity can be predicated in one's own aesthetic encounters with any number of phenomena which may then be translated into aesthetic products or simply remain in a singular aesthetic experience with oneself. The question then becomes, can artificial systems embody indefiniteness? This question may return to the sensual realm the artificial embodies. Autonomous systems, non-human agents and artificial entities have continuously evolving inputs be they informational or physical and they are capable of registering each new composition of sensory inputs as unique and singular encounters. The structuring and legibility of this registration is highly variable and could be expressed through generation of an aesthetic activity, output, artefact or relation. The way these entities register disruptions when encountering something novel and the outputs they may enact in response is an area that warrants greater metaphysical attention in relation to aesthetics.

The one consistent feature in discussions of the aesthetic historically manifests in a continually elusive definition, description or location, both cognitively and materially of these phenomena. The void or vagueness in description has been alluded to with numerous evocative yet vague adjectives and nouns including cloudy, the essence, the rift, the remainder. It is clear that aesthetics pose significant challenges in delimiting and describing what exactly they are. Philosopher Steven Shaviro (2009) reiterates Kant's statement that, "there is no science of the beautiful." The aesthetic and its related effects cannot be located to one key mechanism. It eludes specific definition and resides alongside other mysterious and opaque processes relating to emergent phenomena including human and non-human complex systems. This aesthetic void removes itself from direct contemplation or description and is a persistently fuzzy and elusive entity. Examining approaches to translation, metaphor and symbols are often helpful as they also coincide with considering how the realm of the aesthetic meets the binary. In order to move from a traditional approach to aesthetics, which hinges on human subjectivity, taste and discernment, current approaches to non-human aesthetics provide a potential way forward.

3 I NON-HUMAN POETICS

There have been several recent works that attempt to reconcile non-human aesthetics. Recent influential work includes David Rothenberg's compelling book, *Survival of the Beautiful* (2011) which locates beauty as a fundamental part of evolutionary processes and broadly investigates non-human aesthetics. Recently Tom Sparrow (2014) has put forward a has argued that we are at the end of phenomenology, charging that it is, "no longer apparent how phenomenology is to be carried out or how it differs from, say, thick empirical description or poetic embellishment." Ian Bogost's book, *Alien Phenomenology* (2012) put forth a compelling account of how various machines and devices "see". This was not meant to be an anthropocentric reading of how machines will be like "us" but rather a means to speculate on the variety of ways they will be quite different. This work offers a speculative realist approach to machine embodiment, yet it also carries with it the hallmark features of phenomenological philosophies which are concerned with the sensual realm and frequently overlap with the aesthetic.

Poetic language is a common feature and or symptom of phenomenology. When faced with phenomena that are imprecise and incredibly difficult to define, poetics and their affective quality act as an intermediary plane of communication. They use this not quite here, not quite there dislocation. Poetics belonging to the aesthetic realm allow us to probe and hint at the sense we may gather from the "real"— but cannot be described or located in any specific way.

The ability to transport, disrupt and point attention to a dislocation from established patterns, identities and constructions, aligns with my conception of the accidental as a fundamental feature of all aesthetic phenomena – recognizable or not. Therefore, although the phenomenological method in its insistence on the subject/object distinction is admittedly flawed, the phenomenological realm, that of sensation, still has much to offer in our contemplation of this void. Poetics may rub up against and glimpse the "real" much more accurately than metaphysical descriptions. But still we are left with an utterly formless framework to approach these phenomena.

4 | ACCIDENTAL RELATIONS

Poetic language uses a relational strategy and we could thus explore and identify the identification and production of novel relations between entities of all manners, as one framework for locating and generating aesthetic phenomena. Computational systems offer us the ability to generate and analyze an infinite number of novel relationships varying in form, output and legibility. Bogost (2012) began by thinking about how these artificial entities feel and comprehend the world through a variety of hardware and software. We could further extend this work and explore more thoroughly computational phenomenology including advanced sensing and imaging capabilities at extreme scalar ranges, eluding human perception. There is a staggering variety in the way these systems surprise us. Their potentials are already providing us with new understandings of what embodiment may look like from radically diverse points of reference.

Google's recently released images from the inner layers of their neural networks are but one example (Mordvintsev, Olah and Tyka, 2015). The images, widely circulated, are relatable in that they are comprised of many features that are recognizable to humans with slightly strange perturbances and surreal differences. While these are incredibly compelling they have been interpreted and presented from a highly anthropocentric vantage point. They have been trained by humans and "learn" from human generated imagery. The neural networks' ability to riff on these inputs and the deviations it can produce at any level of its internal layers display quite clearly how many novel relations it can generate in rapid order. These systems possess infinite capacities to generate accidental relations.

Several prominent speculative realist philosophers examine relations in a vastly inclusive manner to include all manner of objects living, non-living, mineral, animal, biological, imagined, and so on… The endless proliferation of objects or things is a main focus of Tristan Garcia's recently translated text, *Form and Object* (2014, p. 1). He states the problem at hand:

> *…there are more and more things. It is increasingly difficult to comprehend them, to be supplementary to them, or to add oneself to oneself at each moment, in each place, amidst people, physical, natural, and artefactual objects, parts of objects, images, qualities, bundles of data, information, words, and ideas—in short, to admit this feeling without suffering from it.*

Our ability to name, identify and verbalize these quickly becomes tricky. How many phenomena do we even have words for? The aesthetic develops, accentuates and manufactures its own set of unique relationships and phenomena. Timothy Morton (2013) devotes substantial attention to examining relationships between objects. There is a particularly compelling argument he makes in regards to aesthetics, stating, "It might be better to think of a transfer of information—it might be better to think that causality is an aesthetic process." The flat ontological designation he assigns to information, intimates that data has a particularly unique role, in that it can manufacture and enable the proliferation of novel interactions between any manner of entities both real and imagined. In this way computational or artificial approaches may operate around the aesthetic in less mediated and by extension more accidental ways. So a computation that engages irrationality, that is not seeking to mimic or please but rather one that is looking for and is capable of generating novelty in interpretation, representation and translation may produce far superior aesthetic encounters and by this I mean more unexpected.

5 | CONCLUSION

The implication that chance or randomness is entwined with creativity is not a new insight

(Hoffstadter, 1979). But conventional designation and production of the aesthetic and by association creativity rely on a narrow and ill-defined set of judgements. The human is able to recognize, appreciate and locate aesthetic qualities. Humans have made great strides in programming creativity artificially. But these activities have still been interpreted in fairly conventional terms. The Google images referenced above suffer from these types of assessments.

A focus instead on the pervasiveness of the accidental, and the embedded infinite permutations of accidental relations, allows us to begin to reformulate our conceptions of artificial aesthetics. We can instead look towards the ability to generate a multiplicity of novel interactions of varying spatiotemporal specificities. Speculating upon aesthetics is but one approach by which we may engage future computational ecologies. By reframing the ways in which we designate, produce and assess the aesthetic we can begin to engage the synthetic, the accidental and the computational in entirely novel ways, both philosophically and creatively.

REFERENCES

Bogost, I. (2012). Alien phenomenology, or, What it's like to be a thing. Minneapolis, MN: University of Minnesota Press.
http://dx.doi.org/10.5749/minnesota/9780816678976.001.0001

Garcia, T. (2014) Form and Object: A Treatise on Things (Cogburn, J. and Ohm, M. A., Trans.). Edinburgh: Edinburgh University Press.

Hegel, G.W.H. (1979) Hegel's Introduction to Aesthetics: Being the Introduction to the Berlin Aesthetics Lectures of the 1820s (T. M. Knox, Trans.) Oxford: Clarendon Press.

Hofstadter, D. (1979). Gödel, Escher, Bach: An Eternal Golden Braid (pg. 863). New York, NY: Basic Books.

Mordvintsev, A., Olah, C., & Tyka, M. (2015, June 17). Inceptionism: Going Deeper into Neural Networks. Google Research Blog. Retrieved from http://googleresearch.blogspot.com/2015/06/inceptionism-going-deeper-into-neural.html.

Morton, T. (2013). Realist Magic: Objects, Ontology, Causality (pp. 65, 71). Ann Arbor, Mich.: Open Humanities Press.

Rothenberg, D. (2011). Survival of the Beautiful: Art, Science, and Evolution. New York, NY: Bloomsbury Press.

Shaviro, S. (2009). Without Criteria Kant, Whitehead, Deleuze, and Aesthetics (p.1). Cambridge, MA: MIT Press.

Sparrow, T. (2014). The End of Phenomenology: Metaphysics and the New Realism (pg. 8). Edinburgh: Edinburgh University Press.

BIOGRAPHICAL INFORMATION

Nicole Koltick is an Assistant Professor in the Westphal College of Media Arts & Design at Drexel University and the founding Director of the Design Futures Lab where she leads a graduate research group in critical design practices investigating the intersection of artificial intelligence, ethics and empathy in robotic systems, design and non-human aesthetics. Nicole writes extensively on the philosophical and theoretical implications concerning concepts of the “natural”, the “synthetic”, aesthetics, the rapidly evolving digital landscape and implications of emerging computational ecologies. She has recently completed papers on dark data, aesthetics of emergence, materiality and agency in the future. Her research lab develops full-scale design objects for the future, most recently producing a large-scale synthetic ecology with a new species of robots entitled NESL (Nurturing Emergent Synthetic Life). www.designfutureslab.com

Architecture
Atmosphere
Authorship
Delayering
Design
Disposition
Distribution
Experimental practices
Integral design
Light
New consumers
Occupation
Project
Representation
Retail
Rooms of the city
Sociocultural
Space design
Space theories
Strategic habitat
Trends
Triple bottom line
Urban space
Well-being
Work space

Domestic terrain
Interactivity
Interiority
Technology

Nicole Koltick

"By examining the possibility for unseen forces to emerge in more performative ways, the interior offers a broad array of untapped potential for designers to mine and amplify."

Nicole Koltick is Assistant Professor at the Antoinette Westphal College of Media Arts and Design at Drexel University, a principal at the lutz/koltick research practice and Director of the Design Futures Lab, where she leads a graduate research group in critical design practices and speculative proposals relating to the interior.

With Space, No Longer Within

As new technologies, materials and signals begin to transgress interior space, they hold the potential to increase conceptual resolution and resonance. Formerly benign typologies now have the capacity to exert a more powerful influence that may enable a transition to being with—rather than within—space. The shifting terrain of the interior and its resulting spatial upheaval suggest that the opportunities afforded by increasing resolution may include the potential to inject semantic value into a formerly vacant territory. This article will present a series of case studies of recently completed speculative prototypes for the domestic interior.

Interactions and interactivity would seem to be of foremost concern when contemplating the design of an interior space. Interior enclosures are for the express purpose of sheltering, enabling and facilitating human interactions. Yet earnest or well-intentioned attempts to produce interactive space do not necessarily yield spaces with conceptual resonance. Projects that explore the terrain of the interactive have most often been considered as temporary installations and serve more as entertainment or passing fancies. Usman Haque critiques the limited semantic value of such work, arguing for a more nuanced and embedded relationship between technology and inhabitant: 'Nor is it about making another piece of high-tech lobby art that responds to flows of people moving through the space, which is just as representational, metaphor-encumbered and unchallenging as a polite watercolour landscape.'[1] Many of the projects discussed here utilise technology but in very particular, strategic ways. Technology is not deployed for novelty but rather to elicit a particular type of attention to otherwise unseen dynamics or potentials. This paper will examine conceptual approaches to interiority that culminated in full-scale working prototypes. These projects challenge assumptions about a priori interior conditions. They resist simplistic notions of interactivity and aim to query the underlying cultural assumptions and societal norms relating to the appropriateness of objects and environments. Examining the gap between what is required and what is desired, the works are intended to engage visitors in contemplating the role of objects and environments that form the background of day-to-day prosaic life.

Usman Haque's allusion to a polite landscape painting dovetails quite nicely with discussions of contemporary interiors practice and the disciplinary values of elegance, appropriateness and taste level which are paramount. Programmatic concerns are also foregrounded but often constrained by concerns of hierarchy, efficiency and *ease*. The value-added proposition of many designers is their access to a broad array of luxury objects, surfaces and finishes and their ability to deploy these to pleasing effect. Bruce Sterling's discussion of metahistory is

1 Usman Haque, 'The Architectural Relevance of Gordon Pask,' *Architectural Design*, vol. 77, no. 4 (2007), p. 61.

helpful in understanding the unquestioned assumptions that lie in the background of these practices. These are assumptions that are often unstated and under-recognised but which form the bases of what is considered normal and acceptable versus aberrant and anomalous. Metahistories are omnipresent and, 'it's through metahistory that people come to realize that new things are proper things, new objects that can fit into a metahistorical context are seen as progressive advancements. Otherwise, they are considered alien impositions or curiosities.'[2] If we were to trace the metahistory of interiors practice we would discover cultural norms, issues of taste and respectability. Historical inspiration prevails alongside the deployment of a wide array of antique objects that contain their own embedded histories related to use. Aberrant interiors are not often encountered and very rarely requested, one would suspect. Historically, more than many contemporary design disciplines, interior practice is lacking in substantial theoretical inquiry. The service aspect of the discipline seems to supersede questioning in any substantial way the embedded assumptions that comprise the activities of practice and the myriad of activities enacted in the resulting finished projects. The lack of a thriving speculative tradition contributes to this void. The discipline could use a much more robust conceptual vein, a so-called 'paper interiors' practice. This would operate much as the paper architecture tradition in which many younger architects produce and explore ideas in their early experiments related to the built environment. Anthony Dunne's 'Design for Debate' agenda is an important precedent for this type of work. 'This shift from thinking about applications to implications creates a need for new design roles, contexts and methods. It is not only about designing for commercial, market-led contexts and methods, but also for broader societal ones. It is about designing not only products that can be consumed and used today, but also imaginary ones that might exist in years to come.'[3] This type of activity is noticeably absent from a large subcategory of interior design and interior architecture programmes at university level and therefore this speculative practice was deliberately structured as a primary focus for the projects presented below. These collaborative projects were completed as year-long master's level theses, aiming to expand the resolution of the domestic terrain by investigating the ability to establish and broaden relations between inhabitants and environment. The range of activities and exchanges within space was queried regarding opportunities to amplify and disrupt. Each project will be examined for its specific stance towards normative assumptions of use and performance. The projects were displayed in the summer of 2013 and, as a group, offer a compelling set of provocations for a newly emerging practice of interiority.

2 Bruce Sterling, *Shaping Things*, The MIT Press, Cambridge, Massachusetts, 2005, p. 39.

3 Anthony Dunne, 'Design for Debate,' *Architectural Design*, vol. 78, no. 6 (2008), p. 91.

Boundaries

The work discussed below attempts to call into question some of the metahistory surrounding interior environments and objects related to interiors practice. The injection of semantic content into a traditionally static terrain can be expressed in a variety of surprising and challenging ways, which are explored by the projects on several important fronts. The first examines material substrates. Materiality offers a powerful mediating force within environments. By triggering and exposing unseen material energies and forces, we can begin to speculate on an emerging relationship with these active entities. So we are no longer *surrounded by* but *interacting with*. Sean Lally, an architect whose work explores material energies and thresholds, explains that 'material energies, for the most part, are either reflected, selected or internally created, taking on a rather minimal amount of responsibility themselves … thus they have been relegated to conditioning predefined interiors or to acting as special effects in creating moods and atmospheres.'[4] Such minimal responsibility calls into question the role of the designer in exploiting and recovering this powerful but undervalued participant. Several of the projects discussed here begin to call into question the notion of boundaries, ambient phenomena and that which is unseen. Petra Blaisse, a prominent hybrid interiors practitioner, argues for a conceptually nuanced approach to the design of interior spaces. 'It has now become clear that it is necessary for us to reconsider our profession: to start from zero and reintroduce the invisible, the subconscious, the action-reaction: the sheer biology of things … Let's start regulating processes in a less obvious, visible way and begin shaping environments that will evolve into things unforeseen.'[5] The operational terrain of the interior presents a multitude of potential interactions between living and non-living entities. While these interactions have traditionally been mediated by placement and selection of furniture and finishes, another layer of the interior is unseen and yet incredibly powerful. By examining the possibility for unseen forces to emerge in more performative ways, the interior offers a broad array of untapped potential for designers to mine and amplify. These forces also harness the ability to act in surprising capacities. Usman Haque outlines such potential in future environments, and asks himself, 'If on the other hand, a designed construct can choose what it senses, either by having ill-defined sensors or by dynamically determining its own perceptual categories, then it moves a step closer to true autonomy which would be required in an authentically interactive system.'[6] Biological, computational and material logics may all be configured and unleashed to offer entirely new modes of occupation and relations with environments.

4 Sean Lally, 'Twelve Easy Pieces for the Piano,' *Architectural Design,* vol. 79, no. 3 (2009), p. 11.

5 Petra Blaisse, 'Border Conditions,' *Architectural Design,* vol. 79, no. 3 (2009), p. 84 and ff.

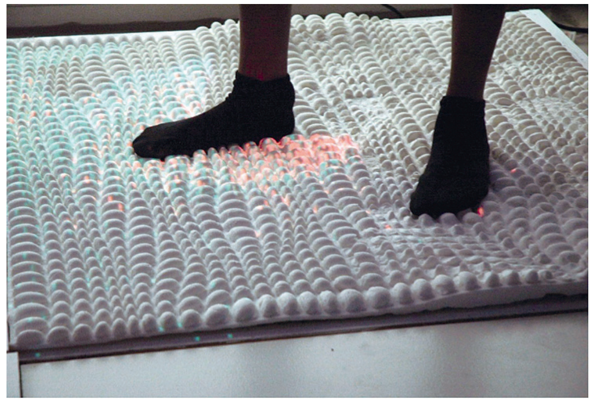
6 Haque, 'The Architectural Relevance of Gordon Pask,' p. 58.

7 Rachel Armstrong, 'Designer Materials for Architecture",' *Architectural Design*, vol. 78, no. 6 (2008), p. 89.

Re-Surface

The *Re-Surface* project originated in an investigation of the potential of synthetic biology in interior environments. Several prominent practitioners have been exploring the interaction between biotic matter and architectural space. One such researcher is Dr Rachel Armstrong, who remains optimistic in her predictions that 'the future implications for architecture in terms of nanoscale modifications to living processes are exciting in that they will form the basis of designer-led, generally responsive materials with innovative properties that will have a broad range of applications in our experience of the built environment.'[7] The *Re-Surface* project involved the creation of a series of novel surfaces for domestic environments, which were developed and exhibited in tandem, conceived as a speculative product showroom. Each of the surfaces explored materiality at the biological level and invoked synthetic programmable bacteria in various forms. Three were the main surfaces developed, a kitchen counter, a flooring surface and a wall surface, prototyped and

▼ Tashia Tucker and Design Futures Lab, *Re-Surface*, Synthetic Bio Floor Surface. © 2013 Nicole Koltick.



manufactured for gallery display. Interdependent digital equipment was deployed to enable interactive capabilities for each surface.

This project set up an interesting dichotomy and role reversal in terms of the typical reaction to bacteria in our environments. In stark contrast to anti-bacterial soaps and sprays, it presents bacteria as beneficial agents. Many of the visitors to the show who interacted with the surfaces expressed considerable discomfort at the mere idea of bacteria being deployed in this manner, a reaction that speaks of a general ignorance of the enormous role bacteria play in the interior micro-biome and how they operate invisibly in ways both beneficial and harmful. In interiors this invisible agent has the potential to be deployed more specifically and performatively. In this project the bacteria are invoked and simulated (through digital simulation and projection), with the exception of the bacterial cellulose wall substrate. Despite the simulation, users still responded strongly and squeamishly upon coming into contact with the surfaces, a reaction that alludes to a powerful metahistory of our impressions about bacteria in our environments and notions of surfaces as being sterile substrates on which we enact our daily activities. As Lois Weinthal states, 'the interior has traits embedded within it that are not always explored strategically, for example the presence of wear and dust signals the action of nature upon the structure and with it, material and artistic opportunity.'[8] This opportunity abounds at multiple levels in interiors, and the biological micro-biome is but one powerful layer to be exploited. In this project we succeeded in introducing a powerful semantic overlay on fairly standard surface conditions by unleashing the unseen force of bacteria in our environments.

The floor surface invoked programmable bacteria that would respond to environmental contaminants on the feet, including pathogens, pet dander and odour-causing microbes, among other substances. In response to the presence of these, the bacteria would essentially attack and neutralise these entities. The floor surface's spatial and formal characteristics were informed by microscopic bacterial structures and then digitally designed and fabricated. Visitors were able to step on this surface and coloured bacteria would appear to swarm around the users' feet as they walked around. A swarming algorithm was developed in conjunction with this project and the wall surface, with varying

▲ Tashia Tucker and Design Futures Lab, *Re-Surface*, Bacterial Cellulose Growing, Wall surface installed. © 2013, Nicole Koltick.

behaviours based upon actual bacterial swarming properties.

The wall surface introduced an additional layer of complexity into the narrative of the project by developing a bacterial cellulose substrate. Essentially, we were simulating bacterial movement upon a bacterially generated surface, a fairly new material now being developed in experimental applications ranging from health care to fashion. The development of the material involves fermenting a bacterial soup made of simple household ingredients. The mixture is allowed to generate over several weeks until a skin is formed, which is then harvested and dried. The resulting material is incredibly strong and lightweight, similar in consistency to paper but highly

8 Lois Weinthal, *Toward a New Interior. An Anthology of Interior Design Theory*, Princeton University Press, New York, 2011, p. 20.

resistant to tearing. The project led to the growth of an extremely large sheet of the material, which was then used in a wall surface that involved an interactive simulation with visitors waving their hands and the simulated bacteria forming openings in a swarm-like motion. The swarming algorithm was developed with a collective behaviour biologist. This surface demonstrates the potential for light sensing bacteria to respond to our gestures and swarm accordingly, thus creating openings in a denser field, which could be used to modulate privacy and/or light penetration in spaces. Users were delighted to interact with this installation and, despite our reassurances that it was a simulation, many people were still sure that they were 'seeing' actual bacterial behaviour. The *Re-Surface* project is an attempt to visualise under-recognised or ignored phenomena that seeks to expose the potential for these unseen agents in our environment and engage us in more overt exchanges. To quote Armstrong, these 'new emergent relationships and identities will exist at this intimate level that will rival the alleged uniqueness of animate matter and challenge our definitions of life. Synthetic materials will exhibit molecular connectedness with networks, which, in turn, have the potential to make intimate connections with living systems. They will become part of us.'[9] It seems appropriate then, that interiors practice should begin to contemplate these emerging intimacies.

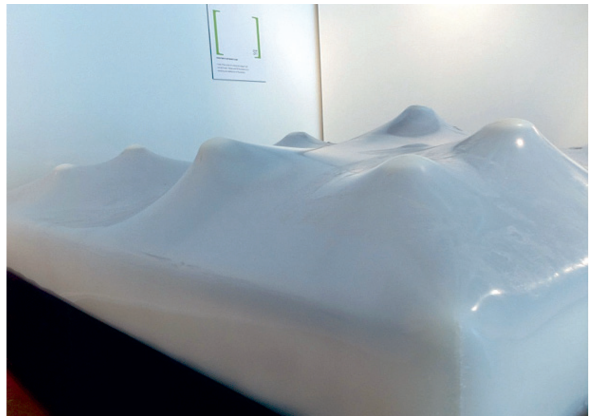
Transactions/Exchanges

The interior has been traditionally understood as a background against which transactions and exchanges are enacted. Surfaces, objects and enclosures will insert themselves more dynamically into these exchanges in the near future. Speculating on these possibilities offers a fertile terrain from which one can operate. The *Situated Interactive Terrain* (SIT) is a prototype for a new form of sleeping experience. This project takes the fundamental activity of sleep and seeks to introduce a secondary agent to form a new kind of exchange between body and furniture. The terrain is a fully actuated surface consisting of robotic actuators covered by a custom silicone membrane, embedded with an array of sensors that detect the position of occupants. Upon certain inputs including movement, temperature and sound, the surface can enact a wide range of moves to gently nudge and guide an occupant during rest. Potential applications include gently rolling someone over when snoring, or repositioning a user into an optimal spinal position while sleeping.

This object has an interesting relationship with its users in that the majority of its interaction occurs when one is unconscious, so there is an implicit trust that must be established with the object. Unlike other interactive or smart objects which one may encounter, this transaction requires one to surrender to the agency of the piece. Its logic and decisions are enacted without the possibility of direct immediate removal, withdrawal or cessation of the experience.

Speculating and prototyping such experiences allows participants in this scenario to weigh the utility of such an experience against a perceived loss of control or overt intrusion into an incredibly

▼ Katie McHugh and Design Futures Lab, *SIT (Situated Interactive Terrain)*, © 2013 Nicole Koltick.



9 Rachel Armstrong, 'Artificial Evolution: A Hands Off Approach For Architects,' *Architectural Design*, vol. 78, no. 6 (2008), p. 85.

personal activity more concretely. This piece has a fair amount of intelligence in its current iteration, but it is also conceivable that in the near future it could develop a far more extensive range of abilities. Dream assistance, intimacy enhancement, nightmare negation … the possibilities are both intriguing and frightening. Science fiction author and provocateur Bruce Sterling discusses such exchanges quite regularly, 'No material thing can ever achieve full and utter acceptability. People are too ductile to have their problems solved … A "thing" is no more stable than the humans who cherish it. Properly understood, a thing is not merely a material object but a frozen techno-social relationship.'[10] Techno-social relationships and notions of acceptability will become increasingly foregrounded as objects and environments begin to assume more assertive functions in our daily environments. Past behaviour indicates that people are quite willing to absorb a perceived loss of agency to gain benefits in convenience. What is less clear is how people will begin to accept more open intrusions into private spheres of their life. Once static objects and surfaces begin to appear more extensively and in ways that are much more intimately entwined with us, exchanges take on a heightened importance. Our devices have penetrated the threshold of our domestic spheres but there is still the potential to retreat into analogue domestic space. What happens when this backdrop becomes foreground instead?

Thresholds

In contemplating unseen forces in interiors, thresholds remain incredibly evocative. Boundaries demarcated by spatial cues can obscure more subtle ambient thresholds related to atmospheric, informational or cultural phenomena. *S(c)ent Message*, a new communication device which uses scent as a method of exchange, is inserted in a wall surface to act as an ambient signalling position. The scent is deployed through an environmental device; upon receipt of an incoming message, the device releases a custom-programmed scent in its environment. The fragrances are gradually diffused and occupants would not be immediately aware of incoming messages, so the messaging system is discretely integrated in the existing activities of inhabitants. The scent library for this device is consistent with a highly personalised and calibrated emotional resonance.

"Once static objects and surfaces begin to appear more extensively and in ways that are much more intimately entwined with us, exchanges take on a heightened importance"

The communication device has two main components, the scent transmitter and the scent receiver. The transmitter is a small object with nuanced gradients of colours correlated with specific emotional states. The sender of the message chooses an emotional state, which is then transmitted to the distant receiver location. The emotional communication that reaches the recipient is translated into their personal scent language. Scent has very strong connections to emotion and to memory processing procedures in the brain. Thanks to this ambient system, one's personal space subtly favours a remote emotional exchange between two parties. The space forms an envelope in which the exchange is enacted. Imbued with a molecular infusion, space itself, rather than sounds, images or text, becomes a medium. Scent in the air is but one unseen entity present in interior space, but electrical, informational and atmospheric exchanges could also be called forth.

10 Bruce Sterling, *Op. Cit.*, p. 68.

▲ Laura Nejman and Design Futures Lab, *S(c)ent Message*. © 2013 Nicole Koltick.

Thres (hold) is a project that examines the progression from the exterior public domain into the interior private domain. Instead of relying on spatial allocation alone, the project contemplates ambient exchanges that include electromagnetic fields, mobile phone signals and informational intrusions across space. Historically, the inside/outside demarcation has been a fertile area of inquiry for architects. Adolf Loos's approach to the interior 'seems to establish a radical difference between the interior and exterior, which reflects the split between the intimate and the social life of the metropolitan being: "outside," the realm of exchange, money and masks; "inside," the realm of the inalienable, the nonexchangeable, and the unspeakable.'[11] In this project the zone of threshold is extended significantly in space. The threshold experience is established as a progressive experience with corresponding physical reactions including light and colour attenuation and a wash of air. The enclosure of the threshold is a custom digitally fabricated space and it deploys sensors, light and space to guide the viewer.

The intent here is a decompression experience, a metaphorical cleansing of the exterior. The project seeks to set up a more deliberate experience of transitioning between very disparate modes of behaviour and exchange. One key feature of this project is its dual purpose as a Faraday cage, a device that blocks all electronic signals so that users are physically barred from receiving all data. Upon leaving the threshold people are reconnected to their networks and provided with relevant information relating to the interior, including its current occupants.

These projects explore the potential of interiors in a myriad of compelling ways, offering a glimpse into future issues that may arise in further intrusions of active agencies in our objects, materials and surfaces. Contemplating a relationship *with* space rather than *within* forces us to move beyond simplistic notions of interactivity and responsiveness. The complexity of relationships, exchanges, boundaries and thresholds positions the interior as an incredibly evocative space for speculative practice.

11 Beatriz Colomina, 'Interior,' in Lois Weinthal, *Op. Cit.*, p. 491.

PAPERS FROM THE 102ND ANNUAL MEETING OF THE ASSOCIATION OF COLLEGIATE SCHOOLS OF ARCHITECTURE (ACSA)

GLOBALIZING ARCHITECTURE / FLOWS AND DISRUPTIONS

102ND ACSA ANNUAL MEETING

APRIL 2014 IN MIAMI BEACH, FL

Better Know a VLO: Realist Approaches to Very Large Organizations

The Very Large Organization (VLO) may be thought of as manifesting not only at large scales spatially and temporally, but also at very small scales. At both of these extremes, such organizations hold compelling implications for how we contend with complex, highly entangled sets of relations between entities. Extreme scales, both large and small, exceed our ability to have physical hands-on knowledge of phenomena. Instead the means by which we operate on these scales are necessarily mediated. The ways we figure, translate and operate on large organizations are inextricably entwined with questions of objectivity, representation and scale. This paper will examine current approaches to such problems and question how these may be influenced, expanded and challenged through emerging realist philosophical thought and aesthetic approaches.

NICOLE KOLTICK
Drexel University

The translations and layers of abstraction that color our understanding of very large organizations result in a series of rather subjective revisions, deletions and additions. Particularly suspect approaches would be those that claim a rationalist or deterministic understanding of networks and systems, which in fact embody chaotic and emergent phenomena at all scales of inquiry. Looking to philosophers such as Alfred North Whitehead and Gilles Deleuze, we can trace an argument for the legitimacy of aesthetic responses including affecting and being affected as one very distinct way of knowing. In addressing scalar extremes, I will attempt to sketch out a realist philosophy that seeks to engage objects and phenomena on the contradictory, illusory and slippery terms by which they present themselves. Aesthetic approaches have long been regarded as irrational, frivolous and not up to the task of dealing with large-scale, complex organizations. This paper will contend that aesthetics may indeed be a wholly appropriate means of response, one particularly suited to the disciplines of art, architecture, writing and philosophy in their engagement with such systems. The work of Steven Shaviro puts forth an idea of “critical aestheticism.”[1] This critical aestheticism is interested in realist approaches while also acknowledging the intangible and elusive plane of operation that encompasses the emotional and sensual response. This offers a novel stance by which we might engage new orders of magnitude. In addition to older philosophical work on the subject, the emerging realist philosophies of speculative realism and object-oriented ontology offer a potent set of conceptual tools to contend with a world that, as we focus in (or zoom out) to lesser or greater orders of magnitude, is revealing itself to be increasingly contradictory—at once somehow more real and yet increasingly harder to grasp.

This paper will call into question persistent biases which privilege static attempts to introduce clarity where fuzziness reigns. We will examine emerging developments across disciplines that reveal the existence of multiple entangled realities exerting influence on one another in beautiful and unpredictable ways. We will finish by examining aesthetic approaches and narrative tools from film and fiction that may offer an unsettling yet powerful approach to contend with very large organizations. These futures both large and small are messier yet more magical, terrifying and beautiful than we might have imagined.

> But a realist for whom the world is filled with objective tendencies and capacities waiting to be actualized by skillful interventions, tendencies and capacities that provide a myriad of opportunities and risks, is in a much better position to take advantage of these insights. This, among other things, is what makes realism a better strategy to confront the political, economical, ecological, and technological problems of our time.[2]

SCALAR TRANSLATIONS

At very small scales (the genetic, the nano-scale, the microbiological…) and at very large scales (information networks, shipping channels, distribution networks, ecologies, food webs, climate patterns…), our understanding is necessarily mediated by descriptions and images. There has always existed a certain amount of skepticism toward the mediated experience. In his essay on "Visibility," Calvino questioned this divide; "We are bombarded today by such a quantity of images that we can no longer distinguish direct experience from what we have seen for a few seconds on television."[3] This is a well-established quandary today, and levels of media saturation have accelerated to an unimaginable degree since 1986 when Calvino penned this sentiment. From the realms of entertainment and design to the workplace, our daily lives are inundated with representations and visualizations that shape our comprehension of these complex entities. While components of very large entities may be visible to the naked eye, we still require assistance to perceive the bigger picture through mediated satellite imagery, aerial photography and various cartographic applications. Google Maps has recently begun offering time lapse imagery spanning several decades, giving us a fascinating glimpse at geological and topographical shifts that one could never see or intuit in another way. This imagery, compiled through the Landsat program since the 1970's, offers a stunning overview of change from a vantage point that we have never had access to before.[4] The GIF (Graphics Interchange Format), a bitmap sequence of images, is a fairly light (in terms of data) way to package and animate a series of images, and has become an increasingly popular means of visual communication on social media platforms like Tumblr as well as numerous other websites. It is more expressive than a single image with its evocation of movement and time, yet with its low frame count lacks the continuity of the typical 24 or 30 frames per second of a video clip. It seems the ideal medium for compiling Landsat imagery to display radical geographic shifts. In many ways the ease with which we can access this data belies the complex and entangled dynamics that lead

1

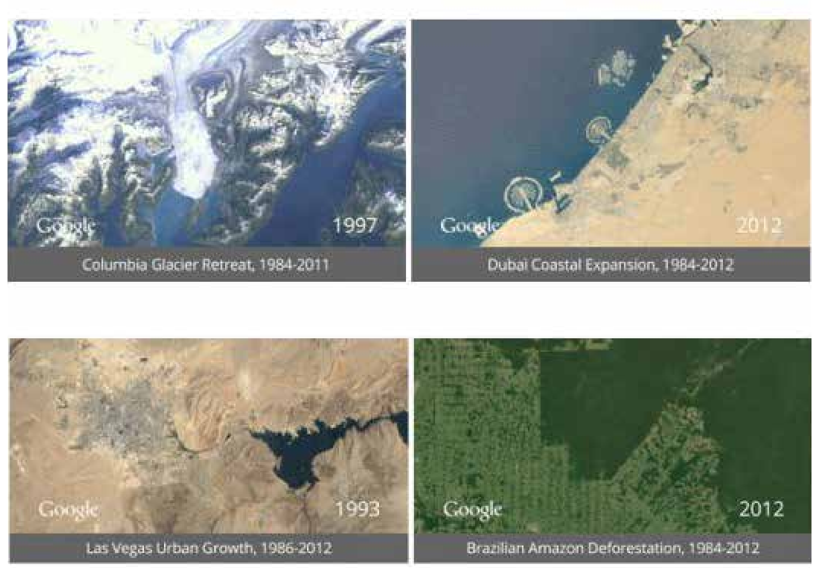
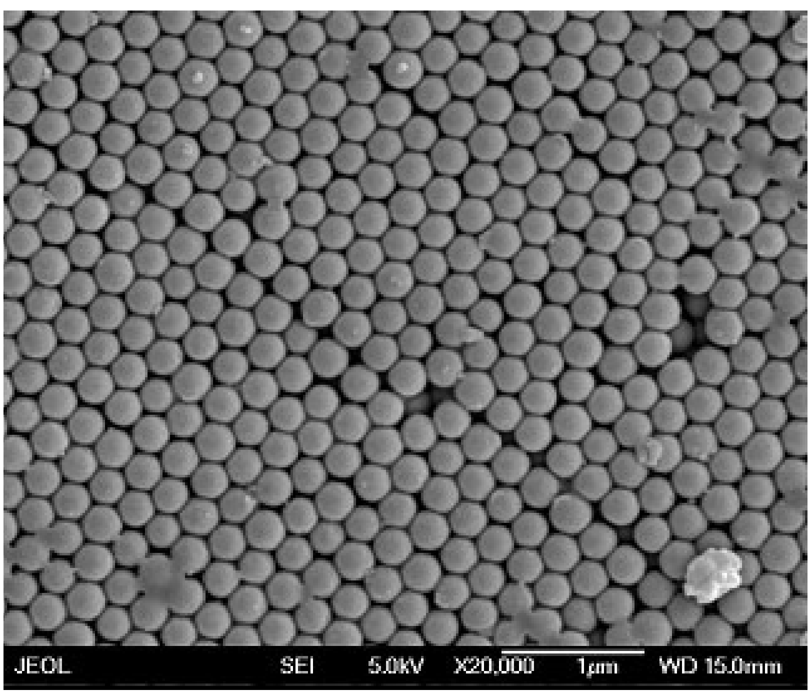


Figure 1: Google LandSat Imagery. Google. Google LandSat GIFs. Digital image. *PC World*. N.p., 9 May 2013. Web.

to these changes. From vast increases in urban densities to rapidly deforested biomes, these global changes, when viewed in a small GIF on a screen, seem very matter-of-fact. And of course in a certain sense they are. Yet these vast, complex shifts involving humans, animals, materials and information are reduced to mere pixels, quickly digestible from a comfortably distant vantage point. These large scale events have occurred and they are now neatly packaged for us in a GIF. How bad could it have been? They may elicit in us feelings of amusement, horror or curiosity, but when viewed on our screens it is hard to envision the specificities that accompanied these drastic changes. The vantage points of any number of agents actually involved in these scenarios, when compiled together, would provide an exhausting and multifaceted account of this reality, but when viewed from above in a GIF somehow those details seem insignificant. In a blog post for the *New York Times*, W.M. Ferguson questions the limited range of this medium: “as irresistible as I find GIF loopiness, I can’t help wondering if it’s contributing to some future death of narrative. I mean, surely not every human emotion can be rendered in a few dozen repeated, low-resolution images.”[5] Yet what is gained in this very precise distillation, the quality we find in the most successful or viral GIFs, is an affective moment, condensed and transcribed yet retaining its essential aesthetic potency. Its capacity to evoke is compressed and extended through wide dissemination. In grappling with complex urban population shifts or global climate change, the GIF flattens these changes into mere visual effects. Can the experience of GIFs in general, be aligned primarily with emotional and affective experiences not reliant on complicated narratives, but rather on a more primal sort of recognition? Aesthetic intuitions can be understood as solely separate from formalized concepts. Shaviro explains that, “rational ideas are precisely thoughts that no content can fill; and aesthetic ideas are intuitions that admit of no concept. Once we leave the realm of the understanding, we discover a fundamental asymmetry between concepts and intuitions, such that each of them exceeds the powers of the other…Aesthetic ideas are no more moral than they are conceptual. Beauty is felt, rather than comprehended or willed. Intuition is decoupled from thought.”[6] This decoupling of the moral is significant, as analysis of very large organizational scales would seem to warrant an investigation into political realities and critical stances relating to these constituents. The political is of course an important agent in many large organizations and networks but is understood here as only one of many systems and therefore does not warrant specific privilege and furthermore does not supersede more emotional, intuitive experiences at multiple scales.

Now let's shift to the small scale for a moment. At this scale similar issues abound, but rather than a loss of resolution or detail we encounter an increase in resolution. Yet the things we see at this nano-scale are mediated by technology and human intervention. That is, things at this scale are not simply magnified, in that we train a very strong lens on them until they appear. Rather, these entities are manufactured and translated through technological means. The way we see entities at this level necessarily involves mediation through electrons and other means. At this scale, "it is frequently not possible to make things without depicting them visually – and, quite often, it is not possible to represent them without the procedure of making."[7] In this way, there is a strange relationship between seeing and making that further impacts the way we understand these entities. Daniel Black explains that "the actual investigation and manipulation of matter at the nano-scale requires a more literal appropriation of the nano-scale for human sensation, and this is dependent upon the use of machines designed to imbue that which is unavailable to perception with aesthetic qualities. Nanotechnology research is fundamentally an aesthetic endeavour in that it depends upon the production of new sensory experiences."[8] Fields that engage nano-technology rely on the production of these sensory experiences to facilitate insights and conjectures into behaviors at this scale, and conversely these techniques prompt and guide them in their continuing investigations. Both the nano and macro examples examined here involve the isolation of phenomena and do not engage conditions at the edges or boundaries of these investigations. Particles by definition have no scalar boundaries. They can be assessed at variety of scales depending on the nature of the investigation. Particle scientists define a particle as a "small discrete quantity of matter that has an interface with the surrounding environment… There is no rule governing how large or small an object must be to be considered a particle. Some define particles as ranging from one nanometer



2

Figure 2: Nanoscale Material. University of Florida. Nanoscale Material Image. Digital image. *Particle Science and Technology*. University of Florida, n.d. Web.

to one millimeter. Some place no size restriction at all - a heavenly body such as a planet or a star might be considered to be a very large particle."[9] At both scalar extremes, we rely on technology to mediate what we see and facilitate ways for us to comprehend entities at these scales. Does the way we engage these entities with distinct methodologies predicated by a given scale allow us sufficient space to speculate on co-existent phenomena at all scales?

COMPLICITIES OF SCALE

The concept of complicity in relation to scale warrants investigation. Do large organizations possess a certain immovability or fixed quality that precludes contemplation of their smaller constituent parts? Does the default scale at which we assess these entities tend to condemn speculative approaches that seek to include possible ripples and cascading effects as insufficient or frivolous in the face of the very large? It calls to mind the elaborate banking system which as everyone has heard *ad infinitum* is *too big to fail*. Are large organizations *too big* to query locally? There exists a fairly consistent bias towards approaching objects at this scale through the lens of analysis. Diagrams, visualizations and data are deployed which attempt to quantify and tame a messy set of relationships and discrete entities interacting at multiple levels. This requires careful distinction in deciding what to analyze and at what level. These modes of depicting the Very Large Organization strip away numerous other realities present within the entity including specificity of material, atmosphere, sound, scent, appearance and tactility. These nuances are equally lacking in both extremely large and small scale representations. As Black describes this representational tension at the molecular scale, "within the broader neo-Platonist opposition between perfect idea and flawed sensation to which information discourse is indebted, the molecule becomes a miraculous entity able to mediate between the realms of form and matter. It reactivates the idea of the Platonic solid as the perfect, beautiful, but infinitesimally small geometric building block."[10] Does this not apply to objects in the VLO as well? The molecule as small piece of matter which can be manipulated has a counterpart in the VLO, whether it is represented as node, intersection, plot point or nexus. Does the frightening and sublime immensity of the VLO become more manageable when condensed to a diagram or seen as pixels on a satellite image? Changes and interventions appear fairly equitable across the flattened terrain and are rendered clean, contained, manageable and neatly connected. While these organizations demand efficiency to serve their intended functions, they tend towards glossy impenetrability at this scale. How do we contend with their reality in its messier, darker corners? At a fine level of detail, we cannot know the myriad specifics of interactions and complexities enacted in relation to a VLO. These relationships span beyond the human and encompass details, reactions and effects that are nested both between and within at multiple scales. How can we simultaneously consider their large scale homogeneity while also considering the local, messy and heterogeneous built scale?

Why is a certain scale seen as more amenable to understanding these dynamics? The very large should not necessarily preclude a nuanced investigation of the numerous small scale interactions embedded within. We can never know *everything*, but that should not warrant ambivalence to specific local effects. A realism that seeks to embrace the discrete set of relationships in their localized specificity as they are intersecting with agents across time and space could operate through aesthetic practices and effects. This *aesthetic criticality* is interested in alternative ways of knowing and operating on organizations, specifically by focusing on what has been unseen or unrecognized.[11]

LOCAL *REALITIES*

How can we define operational strategies that enable us to contend with the messy reality of these entities? As we think about how to operate or design at these scales, or even approach some level of understanding beyond the generalized and abstract, points of entry become important. Do the multiple embedded constituents that comprise the very large warrant examination? Large scalar analysis often seems to be loaded with *a priori* judgments which may leave one vulnerable to any number of blind spots. We have a number of representational tools available to assist analysis, yet the goals of analysis are anything but clear. In the book *Prismatic Ecologies*, Jerome Cohen introduces a novel approach to the large-scale through an analysis of color. He takes as a departure point the exact problem of objectivity in confronting these scales: "No observer can even conceptualize this shifting mesh of power lines, generators, engineers, distribution nodes, consumers, conveyors, geographic expanses, appliances, managers, weather and electrical flow in its entirety: there is no divine or objective on a web within of such deep relations."[12] Objects are densely entangled in a complicated mesh of networks. VLOs and every other manner of organization and entity, both large and small, are similarly entangled in a series of relationships, exchanges and translations. At this point, it may be useful to take a look at just a few examples of strange, beautiful and compelling realities found in nature that are specific and highly complex, yet evade representation by conventional means.

Recent developments in neuroscience, animal behavior and biophysics have revealed a great deal about non-human systems of perception and the ways in which other species interact with the world. Ants, for example, are now understood to be incredibly complex social creatures that utilize a variety of strategies to sense, communicate and navigate within an environment. "Ants use a variety of cues to navigate, such as sun position, polarized light patterns, visual panoramas, gradient of odors, wind direction, slope, ground texture, step-counting and more. Indeed, the list of cues ants can utilize for navigation is probably greater than for humans. Counter-intuitively, years of bottom-up research have revealed that ants do not integrate all this information into a unified representation of the world."[13] Rather than relying on one overarching strategy for navigation, ants use distinct modules for disparate tasks. Ants process a variety of information and default to secondary modes of operation in response to local conditions. In addition to their diverse navigational toolkit, ants participate in a myriad of interactions with other species, some beneficial and some detrimental, like the interaction between the parasitic fungus Ophiocordyceps and Carpenter ants in the genus *Camponotus*. This fungus takes control of an ant's motor functions, modifying the ant's behavior in a way that is precisely to the benefit of the fungus, helping to replicate and spread fungal spores.[14] This mind control tactic is species-specific, in that this particular fungus has evolved to infect a particular type of ant. A number of other similar host-parasite interactions exist, where in each case a species of fungus specializes on a particular insect species. This type of intervention is fascinating in terms of the subtle entanglement between fungus, ant and environment, and the way that these relationships are upended and manipulated to such productive ends on the part of the fungus, in an exquisite interdependence. It is worth noting that this reality on the ground is taking place in a location featured in the above mentioned Google Landsat GIFs. This small scale, localized interaction would obviously never register at that scale. And this interaction is but one of an untold number occurring, each incredibly specific and real, that sum together into an ecosystem, another example of a VLO operating with amazing intricacy, precision and mutability. Attempts to visualize ecosystems and their dynamics face similar problems of flattening and resolution as described above. We may need to enlarge our operational stances to begin to register these disparate entities and entanglements and their affective possibilities.

AFFECTIVE CAPACITIES

Complex organizations are the sum of a vastly entangled set of relational exchanges that present challenges not only in representation but also in orientation. The presence of contradictory positions is an underemphasized feature of organizational systems at all scales. Realist philosophies seek to expose the seemingly endless contradictions that present themselves, as numerous instances abound to suggest that the true nature of interdependence and causality is much more fantastic, nuanced and messy than any simple representation will allow. In his book *Realist Magic*, Timothy Morton lays out a very compelling argument for how causality is, in fact, aesthetics. He explains "that causality is the way objects talk to one another, apprehend one another, comprehend one another: causality is the aesthetic dimension."[15] This view holds that aesthetics are implicated in everything we see, feel and influence at all scales. Such an incredible specificity is contradictory and hard to pin down. It does not follow one set of rules, orders or derive from a set meaning. Morton further argues that, "large complex systems require causality theories that are non-deterministic just like very small quantum scale ones."[16] These non-deterministic realities make it all the more challenging to reconcile our static and limited representational approaches with the messy, probabilistic realities of causality at all scales. These contradictory conceptual realities preclude a singular approach. Therefore an aesthetic approach which is interested in the nuanced ways of affecting and being affected by these organizations is one of many possible ways forward. The aesthetic tradition of architecture and its intersection with the phenomenological realm suggests that some potential may lie in examining and amplifying affective capacities in local, smaller scale interactions.

Aesthetic stances have an equally valid claim to approaching the problem of Very Large Organizations. Through its subtle and complex focus on a variety of subjects, amplified through light, color and sound, film remains an intensely evocative medium, able to affect in a nuanced yet open way. In the 2013 film *Upstream Color*, Director Shane Carruth depicts a beautifully entwined narrative that has moments of coherence while also dissolving into ambiguity. It becomes hard to pinpoint or locate one clear narrative, or a fixed subjective position. A review by Richard Brody teases out the philosophical slant of the movie and notes, "Carruth is perhaps the first filmmaker whose drama is based in the first-hand experience of relativity."[17] The film has a fantastical narrative in which human and animal share an entwined consciousness, and experiences in one realm have subtle implications for the other. The point of view, soundtrack and overall structure of the film are both aesthetically stunning and conceptually enigmatic. The film portrays a shifting terrain, with multiple realities slipping into one another and displacing notions of causality and connectivity between sequences. The allusion to relativity is apt, as the film's narrative and temporal consistency is continually upended, revealing a contradictory and illusory aura. Carruth chooses to depict realities in the film at multiple scales. A parasite is filmed at a very small scale, where we witness its beginning cell division. Later we see it in multiple forms, both exterior and interior to the human body, at several points squirming sub-dermally through a character's skin. Eventually the viewer begins to intuit an outward effect of this initial relationship, when multiple subjects and systems overlap and blend into one another. Color, light and sound are instrumental in the conveyance of these impressions, and the portrayal is unsettling, confusing, perplexing and incredibly beautiful. When our depictions fail to cleanly resolve the narrative, we are left to piece things together or speculate on the gaps. In this way, the film provides a useful alternative model for approaching complex organizations. Once we remove our default structures and conventions, we are left to engage with a reality that is messy, tangled and unresolved. A central challenge in contending with VLOs is the problem of relating to these realities in more expansive ways, apart from the constrained narratives of efficiency, order and legitimacy that they have established by virtue of their very largeness.

3

Figure 3: Stills from Shane Carruth's Film, Upstream Color. Carruth, Shane. Stills from Upstream Color. Digital image. *A Bittersweet Life*. N.p., June 2013. Web.

Objects and organizations at all scales possess an infinite multitude of potential aesthetic encounters, and speculation is but one means by which we might engage with such confounding entities. Aesthetics should not be judged solely on criteria that privilege reason over all other conditions. Shaviro, in expanding on his reading of Whitehead, states: “affect precedes cognition and has a much wider scope than cognition. Understanding and morality alike must therefore be subordinated to aesthetics. It is only after the subject has constructed or synthesized itself out of its feelings, out of its encounters with the world, that it can then go on to understand that world—or to change it.”[18] This stance places feelings, and by association the aesthetic, as fundamental to contemplating any sort of action. The aesthetic, in its particular alignment with the evocation of *affect*, can be understood as a powerful tool in engaging with local realities. These constituent local interactions could have far reaching radiating effects, which could in fact be more expansive and impactful than a solution derived by hierarchical analysis at the large scale.

By looking closely, without prejudice at the numerous realities in their local specific expressions we can generate more speculative assemblies. This implies a novel intervention and new approach toward these organizations. It is the illusion of flatness and the seemingly incontrovertible legibility of the very large and small scale that presents the greatest fallacy. In fact, the affective sincerity that arises from disorientation may be closer to reality in its contradictory, illusory essence. Instead of demanding clarity, we should contend with these scales from a position of *awe.*[19] This paper has argued for the need to reexamine our views of objects and their relations to one another within networks. Aesthetic practice, if it is to usefully operate within, on and around the Very Large Organization, should embrace the weird, uncanny reality all around us. Indeterminacy, inter-objectivity, entanglements and their innumerable specificities matter. A sense of unease, the feeling that we do not quite understand how it all comes together, is a necessary launching point if we are to intervene in a compelling sensorial or aesthetic way. There remains something incredibly valuable about the contradictory aesthetic response.

ENDNOTES

1. Shaviro, S. *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics*. Cambridge, MA: MIT, 2009, xiv.
2. DeLanda, M. “Ontological Commitments.” *Speculations* IV, 2013, 73.
3. Calvino, I. and Patrick C. *Six Memos for the next Millennium: The Charles Eliot Norton Lectures 1985-86*. Cambridge: Harvard UP, 2009, 92.
4. Badger, E. “A Terrifying, Fascinating Timelapse of 30 Years of Human Impact on Earth.” *Atlantic Cities*, 9 May 2013.
5. Ferguson, W. M. “On the Aesthetics of the Animated GIF.” *The 6th Floor.* NY Times, 01 May 2013. .
6. Shaviro, S. *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics,* 10.
7. Daston, L., and Galison, P. *Objectivity*. New York: Zone, 2007, 402.
8. Black, D. “An Aesthetics of the Invisible: Nanotechnology and Informatic Matter”, *Theory, Culture, Society*, 7 published online before print, Aug 18,2013.
9. “Particle Engineering Research Center.” At the University of Florida, n.d. Web. 21 Jan. 2014.
10. Black, D. “An Aesthetics of the Invisible: Nanotechnology and Informatic Matter”, 2-3
11. Shaviro, S. *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics,* xiv.
12. Cohen, Jeffrey Jerome. Introduction. *Prismatic Ecology: Ecotheory beyond Green*. Minneapolis: University of Minnesota Press, 2013, xxiv.
13. Wystrach, A. “We’ve Been Looking at Ant Intelligence the Wrong way.” *The Conversation*, 30 Aug. 2013.
14. Harmon, K. “Undead-End: Fungus That Controls Zombie-Ants Has Own Fungal Stalker.” *Scientific American*, 8 Nov. 2012.
15. Morton, T. *Realist Magic*. Michigan: M Publishing, 2013, 66.
16. Morton, T. *Realist Magic,* 70.
17. Brody, Richard. “The Cautionary Rhapsody of “Upstream Color”.” *The New Yorker*, 6 Apr. 2013.
18. Shaviro, S. *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics*, 15.
19. Braver, L. “On Not Settling the Issue of Realism.” *Speculations* IV, 2013, 14.

ACSA 101

NEW CONSTELLATIONS NEW ECOLOGIES

ABSTRACT BOOK

ACKNOWLEDGEMENTS

ACSA wishes to thank the conference co-chairs, Mark Goulthorpe, Massachusetts Institute of Technology, and Amy Murphy, University of Southern California, as well as the topic chairs, reviewers, and authors for their hard work in organizing the Annual Meeting.

EDITORS/ANNUAL MEETING CO-CHAIRS

Ila Berman, California College of the Arts
Ed Mitchell, Yale University

TOPIC AND SESSION CHAIRS

101_1 Waste(lands) + Material Economies

Matter: Excess vs. Optimization
Jason Payne, University of California, Los Angeles

Practicing Industry
Hugh Hynes, California College of the Arts

Less is More: Creativity Through Scarcity
Elizabeth Golden, University of Washington
Gundula Proksch, University of Washington

101_2 Energy Circuits + Artificial Ecologies

Energy Circuits
Sean Lally, University of Illinois at Chicago

Synthetic Ecologies
Marcelyn Gow, Southern California Institute of Architecture

Architecture's Next Companion Species
Mason White, University of Toronto

Ecological Infrastructures: From Bubbles to Territories
Lola Sheppard, University of Waterloo

Eco-logics
Helene Furjan, University of Pennsylvania

101_3 Genetic Systems + Non-standard Modes of (Re)Production

Figuring Differentiation
Chris Hight, Rice University

Digital Craft: Material, Technology and Performance
Heather Roberge, University of California, Los Angeles

Mass Customization + Non-Standard Modes of (Re)production
Branko Kolarevic, University of Calgary

101_4 Exchange Terminals + Interactive Technologies

Sensing the City
Jason Johnson, California College of the Arts

Living Bits + Bricks
Carlo Ratti, Massachusetts Institute of Technology
Nashid Nabian, Massachusetts Institute of Technology

Negotiated Territory
John McMorrough, University of Michigan

101_5 Enclaves / Territories + Expanding Megalopolises

Securing the Perimeter
Elijah Huge, Wesleyan University

Rapid Cities: Prototyping Urban Growth
Mona El Khafif, California College of the Arts

Strategies Beyond the Compact City
Felipe Correa, Harvard University

Infrastructural and Ecological Urbanisms
Julia Czerniak, Syracuse University

101_6 Populations / Networks / Datascapes: From Cloud Culture to Informal Communities

Guerilla Ecologies
Ulrike Heine, Clemson University
Dan Harding, Clemson University
Aaron Bowman, Clemson University
Bernhard Sill, Hochschule Trier | University of Applied Sciences

Discursive Networks
Ana Miljaki, Massachusetts Institute of Technology
Amanda Reeser Lawrence, Northeastern University

Urban Geographies of Multiculturalism
Armando Montilla, Clemson University

Urban Code
Laura Kurgan, Columbia University
Nicholas de Monchaux, University of California, Berkeley

101_2 Energy Circuits + Artificial Ecologies
Synthetic Ecologies

Marcelyn Gow, Southern California Institute of Architecture

Date: Thursday, March 21, 2013, 2:00 PM - 3:30 PM

Synthetic Ecological Frameworks

Bradley Cantrell, Louisiana State University
Frank Melendez, Louisiana State University

Responsive technologies play a pivotal role in the evolving relationship between constructed environments and responsive ecological systems. Current models of machine/human interaction are slowly evolving to encompass more complex methods of simulated intelligence and nuanced response. The research presented attempts to formulate approaches to abiotic and biotic responses that directly interface with ecological and infrastructural systems across a variety of scales. This research posits a framework for understanding ecological interfaces and examines a series of pragmatic and speculative projects that support this line of inquiry.

Several technologies are converging to drastically change the landscape of responsive technologies including autonomous robotics, distributed intelligence, biotic/abiotic interfaces, and ubiquitous sensing networks. As a composite, these technologies fundamentally alter our ability to imagine constructed systems in highly nuanced relationships between environmental and ecological processes. These new relationships require an expanded view of networked and object oriented relationships between designed devices, ecological entities, and regional influences.

Noise Control: Designing with Entropic Processes

Daniel Norell, KTH Royal Institute of Technology

Noise Control offers a specific approach to design where noise is understood as a productive rather than destructive force. This approach is distinct from others in architecture, where the noise produced by entropic processes is simply accepted as inevitable, or from those that celebrate the purely picturesque nature of matter in a state of decay. Noise Control draws from an eclectic collection of sources ranging from contemporary dis-courses on matter and digital design, to disciplinary history and neighboring disciplines. It argues that the distortion produced by noise can be productively associated with the precision of digital design in order to produce specific material sensibilities. These sensibilities lean towards the strange, because of their pe-culiar pairing of immediate, sensory experiences of matter with a slower set of associations that rely on manipulation of vaguely familiar objects.

The Thin Green Line

Dora Epstein Jones, Southern California Institute of Architecture

The current fashion and trend of green roofs and vegetal walls denote a preference for thin planes and surfaces. This "thinness" in turn points to a language of postmodern reversals from artificial to organic, or as described here, a "trick." "The Thin Green Line," a title taken from a documentary on frog extinction, instead argues that while greening is an environmental necessity, it should also challenge us to think differently about architectural aesthetics and the hegemony of certain formal languages. Taking some cues from philosophies of deep ecology and Heidegger's postwar revisions to techne, this paper sees the thin plane as a key player in architectural consciousness. Using an example from a gallery installation by Griffin Enright, it instead offers a re-imagined poetic of green tectonics.

Tomorrow's Ecologies | A Synthetic Approach

Nicole Koltick, Drexel University

Our dreams, aspirations and intimations provide whispers of a near future that is seamless, wild and yet contained. How much are we willing to relinquish in order to meet the future? A philosophical approach that seeks to engage in a speculative realist agenda may help us to contend with new systems that will only increase in specificity, scope and scale. Old notions of nature and the illusions of a dominant relationship to the biological world will not serve us well as we begin to imagine new futures. These persistent and oft times imperceptible biases hold us back as we formulate new modes of operating within an increasingly expanding and intertwined digital, biological, cultural, informational and material space. The synthetic future which we can see on the horizon looms forward from a present that is still very much grounded in the static. We can catch glimpses of a future that may be both illuminating and frightening. We can suggest that we would like our enclosures to be transformative, adaptive, evolving. What about sentience, agency and control? What of chaos, risk and unintended consequences? Can we abandon the reassuring tropes of modernism that assert that control and dominance assure us a temperate and insulated existence? We have become comfortable operating in linear and reliable ways. We seek to retain one foot on land while stepping out into new territories. To embody and engage with the future that we are rapidly beginning to see before us will require a leap into conceptual and operational approaches that redefine our relation to objects, materials and environments. This way of thinking is easily dismissed as fiction. It is simpler to imagine slight augmentations and gradual upgrades to our existing systems. The division between inside and outside, nature and artifice, us and them has served as a reassuring balm that is slowly cracking and revealing itself.

The increasing awareness of the incredible complexity and subtle entwinement of various phenomena and systems, forces us to drastically adjust the definition of our relationship to the world. Contemporary philosophers have attempted to grapple with these new developments and apply them to a more nuanced and speculative way of approaching the objects, relations and substances of the world. The mechanisms and behaviors of complex systems, chaotic action and the role of emergence all suggest that past notions of a static and linear operational agenda will not be productive as we move forward. In approaching the future there is a delicate revisionism that must occur that necessitates a broad and resilient philosophical and theoretical underpinning through which to grapple with these decisions. Things have become much less solidified, much less cohesive and much fuzzier. This paper offers up a series of strategies that may be useful in approaching the synthetic ecologies of tomorrow.

101_2 Energy Circuits + Artificial Ecologies
Eco-logics

Helene Furjan, University of Pennsylvania

Date: Friday, March 22, 2013, 11:00 AM - 12:30 PM

A Field Guide to Generating Architectural Species

Nicole Koltick, Drexel University
Matthew Lutz, Princeton University

The question posed by this session topic, of how architecture may begin to draw from the tools, techniques and concepts of ecology, is of critical importance to the future of our discipline. Examining the overlaps between these two fields in an effort to extract useful insights from the rapidly developing science of ecology and put these to work in the context of architecture in a meaningful way, going beyond mere metaphor, will require a clear understanding of the levels of organization with which ecology is concerned. The science of ecology is a relatively young field and, like the discipline of architecture, has experienced rapid growth in recent years with the development of sophisticated computational techniques, specifically in the area of theoretical ecology. While it is tempting to apply the metaphor of an ecosystem as a complex set of interacting components and feedbacks directly into the realm of architecture, it may be even more productive to examine the specific mechanisms that ecologists study at various scales and levels of organization and ask what parallels may exist in architecture and urbanism. Both architecture and ecology are concerned with the articulation of form, structure and pattern emerging at multiple scales in response to environmental conditions.

We may begin by asking, why has ecology suddenly become such a fertile area of inquiry for architects in recent years? Certainly, the easy answer is to draw the obvious connection between the now omnipresent concern with sustainability in the built environment, and a simplistic understanding of the field of ecology, as one that is primarily concerned with conservation of the earth's natural systems. However, ecology is in fact a quantitative science concerned with the myriad interactions between organisms and their environment, which uses a well developed arsenal of theoretical models in conjunction with experimental studies at multiple scales to understand these complex interactions. A more useful and productive understanding of the connections between these two diverse fields requires us to abstract things a bit, and understand both ecology and architecture as disciplines that are primarily concerned with problems of pattern, scale and complexity, and with comprehending complex interactions of material and energy that operate across many nested levels of organization. In combination with advances in computational power and an increasingly sophisticated understanding of complex systems, architects have begun to mine the field of ecology in all its manifestations for useful metaphors, mechanisms, processes and tools. In the following paper, I will explore a handful of concepts drawn from the science of ecology that may be useful for further speculating on the increasingly productive overlap between these two disciplines.

Niche-Tactics: The Giraffe Model

Caroline ODonnell, Cornell University

"Niche-Tactics: The Giraffe Model" draws analogies between niche-thinking in evolution theory, and architecture. In the former, the animal is inseparable from its environment. More specifically, since many animals co-exist in one environment, the animal is a product of its own reading or abstraction of that environment.

Through Charles Darwin, D'Arcy Thompson, James Gibson and Greg Lynn, the relationship of the form of an organism with its site is developed, particularly focusing on the giraffe as an extreme example of deformation. The giraffe, existing as it does as an expression of a reaction to site becomes a model for architecture which might consider site more fundamentally, with the consequence of an architecture whose site and form are in dialogue, with obvious, but perhaps secondary, performative benefits.

While the vernacular might be considered to align with niche-thinking, it is presented as an imperfect model, burdened as it is with its own image of itself and its necessity to reproduce that image. Evolution, since it is not coming from or on a trajectory towards any ideal is liberated to mutate into alternative forms, as long as they "fit."

The paper concludes with several historical and contemporary examples that, rather than falling into the traps of "contextualism" (which, in the worst case, has become known as an architecture of carbon copies, merely continuing the existing characteristics of adjacent buildings) articulate a relationship between the architectural form and site that is distinct, legible, and in many cases, monstrous.

Tomorrow's Ecologies | A Synthetic Approach

Presented at *New Constellations, New Ecologies,* ACSA 101st National Conference hosted by California College of the Arts. San Francisco, CA, March 2013.

Koltick, Nicole. "Tomorrow's Ecologies: A Synthetic Approach." ACSA 101st Proceedings, New Constellations, New Ecologies (2013): Print.

Our dreams, aspirations and intimations provide whispers of a near future that is seamless, wild and yet contained. How much are we willing to relinquish in order to meet the future? A philosophical approach that seeks to engage in a speculative realist agenda may help us to contend with new systems that will only increase in specificity, scope and scale. Old notions of nature and the illusions of a dominant relationship to the biological world will not serve us well as we begin to imagine new futures. These persistent and oft times imperceptible biases hold us back as we formulate new modes of operating within an increasingly expanding and intertwined digital, biological, cultural, informational and material space. The synthetic future which we can see on the horizon looms forward from a present that is still very much grounded in the static. We can catch glimpses of a future that may be both illuminating and frightening. We can suggest that we would like our enclosures to be transformative, adaptive, evolving. What about sentience, agency and control? What of chaos, risk and unintended consequences? Can we abandon the reassuring tropes of modernism that assert that control and dominance assure us a temperate and insulated existence? We have become comfortable operating in linear and reliable ways. We seek to retain one foot on land while stepping out into new territories. To embody and engage with the future that we are rapidly beginning to see before us, will require a leap into conceptual and operational approaches that redefine our position to objects, materials and environments. This way of thinking is easily dismissed as fiction. It is easier to imagine slight augmentations and gradual upgrades to our existing systems. The division between inside and outside, nature and artifice, us and them has served as a reassuring balm that is slowly cracking and revealing itself.

The increasing awareness of the incredible complexity and subtle entwinement of various phenomena and systems, forces us to drastically adjust our conception of our relationship to the world. Contemporary philosophers have attempted to grapple with these new developments and apply them to a more nuanced and speculative way of approaching the objects, relations and substances of the world. The mechanisms and behaviors of complex systems, chaotic action and the role of emergence all suggest that past notions of a static and linear operational agenda will not be productive as we move forward. In approaching the future there is a delicate revisionism that must occur that necessitates a broad and resilient philosophical and theoretical underpinning through which to grapple with these decisions. Things have become much less solidified, much less cohesive and much fuzzier. This paper offers up a series of strategies that may be useful in approaching the synthetic ecologies of tomorrow.

Synthetic relations

In looking at the mechanisms and specifics of a variety of complex systems and ecologies ranging in scale we begin to recognize some consistent realities. The interaction of these parts call into question traditional ideas of part and whole, complete object and subset, figure and ground. Manuel DeLanda in his book, Philosophy and Simulation: The emergence of synthetic reason, pursues a rigorous unpacking of these mechanisms and relationships at various scales. In all of these systems he locates the presence, "...of a contingent accumulation of layers or strata that may differ in complexity but that coexist and interact with each other in no particular order: a biological entity may interact with a subatomic one, as when neurons manipulate concentrations of metallic ions, or a psychological entity interact with a chemical one, as when a subjective experience is modified by a drug" [1] These layers or strata can each have their own complex dynamics and mechanisms operating at a particular physical and temporal time scale and dependent on any number or type of feedback or signal. The interaction of these layers will vary widely in differing localities, objects and systems. A steady feature of emergent behavior in systems involves properties, tendencies and capacities. While we are fairly comfortable with working with a given set of properties for an object or system; tendencies and capacities suggest a much fuzzier reality. A tendency can be assessed in probabilistic terms but there will always exist anomalous or aberrant outcomes. Capacities suggest the potential limits of a system or behavior but do not suggest minimums or give insight into potential dysfunction. Both of these also involve a variety of interdependent exchanges of material and/or information and there exists a wide terrain of indeterminacy. These properties may produce considerable anxiety. While looking at an organism from the outside, it appears as if things are orderly, constrained and quite deterministic. But as the philosopher Timothy Morton suggests if we look at bit closer,

> ...at a microlevel, it becomes impossible to tell whether the mishmash of replicating entities are rebels or parasites: inside-outside distinctions break down. The more we know the less self-contained living things become. Chemistry and physics discover how malleable and fungible things are, down to the tiniest nano-scale objects. We dream about total manipulation."[2]

This dream in its current form is predicated on an incomplete understanding of these mechanisms. When dealing with capacities and tendencies rather than actualities or set protocols, the intent would manifest in a loose but fuzzily cohesive way.

These tendencies and capacities are unpredictable due to the layered and embedded relationships present in these systems. As DeLanda suggests, "the objective reality of emergent properties can be established by elucidating the mechanisms that produce them at one scale and showing that emergent entities at that scale can become the component parts of a whole at a larger scale."[3] This relationship between part and wholes can be interrogated at many levels and involve material as well as informational and relational entities. This approach to component logic is much different than what we may be attuned to in current architectural production. Components here are understood as discrete but yet integrated entities that have stable features and behaviors but are not viable or desirable as distinct stand alone entities. The component is a subset ecology or dynamic system with its own rules and feedback mechanisms. These feedbacks may interact in either a positive or negative way and signal to other components in varying ways both above and below them in the overall informational hierarchy. The part or component here is understood not as a distinct unit which is reducible or able to be engaged singularly in any recognizable form. The whole is not simply the sum of its parts but rather the interrelationship both within the parts and with each other within any describable "whole".[4] Graham Harman in reviewing the recent philosophical work of Tristan Garcia describes his approach to living things. "Each thing can be viewed as having a self, halfway between that which is a thing and that which a thing is (in other words, its components and its situation). A living thing is "a thing that intensifies its self—that is to say, a thing which renders more intense the different between that which is in it and that in which it is."[5] This self that is differing in intensity suggests a whole that is slightly more coalesced, rather than fundamentally distinct or separate. The self maintains a relationship at multiple levels with both its component parts as well as exterior adjacencies. Ontological reductionism is meant to be avoided and one cannot simply take apart a whole and expect the composite sub parts to function outside of its system of interrelations. Marcum & Verschuuren explain that, "the characteristics which result from the organization of the physical elements of life are not physical themselves; rather, their nature is relational and, therefore, informational. These characteristics organize and integrate novel relations between events... Life does not obtain the necessary information from its physico-chemical elements alone, but generates it from entities based upon the codification of the relationship of these elements and their environment."[6] Moreover these interrelations are governed by complex system dynamics and exhibit chaotic and unpredictable behavior at times. This highly enmeshed set of relationships that comprise these systems will need to originate in a drastically different way than we have approached building or design in the past.

Homeostasis

In designing or speculating on the synthetic, one needs to confront the nature of boundaries and distinctions that may comprise constituent parts and the resultant or desired whole. In a given ecology or organism a state of homeostasis involves a set of interrelated control mechanisms and involves sensing and reacting among different subsystems to regulate and modulate the balance of the whole. Homeostasis is an ideal state that is the opposite of stasis. It is in constant flux but in very subtle and nuanced ways and tied to the feedback received and given from parts of the system or sub systems to other parts as well as integrating external information. In a synthetic approach, homeostasis would be an ideal state of interactions. This is clearly in contrast to traditional static and linear assembly methodologies. It is productive to ask what is the whole? Is there a clear boundary or separation from exterior to interior, inside to outside, living versus non-living? Is there an arbitrary distinction made? Is one thing clearly coalesced into form and another is not? Do these declared wholes still not have exchange, feedback and relations with entities that lie beyond any imposed delineation?

At all levels of investigation and inquiry we could find examples to erode or weaken the legitimacy of these distinctions. The author Charles Eisenstein asks,

> Is a cell really autocatalytic? What about a human being? No. At best we can say that each contains autocatalytic systems and systems-within-systems. Each requires a "food set" of molecules that it cannot produce itself. A human being cannot produce sugar from sunlight, nor the free molecular oxygen our metabolism requires, nor a number of essential amino acids, fatty acids, and vitamins[7]

Far more than a trite cliché of interconnectedness and interdependence, this set of relationships and the complex dynamic that exists in the feedback and interactions between them is a fundamental requirement for resilient living systems and subsystems. In thinking operationally about a synthetic approach, querying the part/whole relationship is fundamental. Eisenstein argues that, "…the resulting organism is often no more viable—that is, no more capable of survival and replication—than an isolated human organ or cell. Most life forms are so utterly dependent on symbiotic relationships with other life forms as to call into question the validity of the phenotypic definition. Without the bacteria in their rumens, for instance, cows would be unable to digest cellulose and would quickly starve. Is the bacteria part of the cow, or a separate organism?"[8] Bacteria, emotions, data, insects, weather; our current world holds a stunning multitude of discrete objects and relations which are interconnected and interacting in ways both subtle and more pronounced. These relations can be followed down to a very minute scale and followed up to ever larger systems and interdependencies. In approaching these systems in an operational way, what is the role of determinism and control? This has resonance with design/architecture as we seek to define the operational terrain. What is getting designed and at what scale and level of system? How does one confront these requisite interdependencies and relationships? There is a certain amount of risk, uncertainty and unpredictably that need to be accepted.

Uncertain Entanglements

> *If there is anything monstrous in evolution, it's the uncertainty in the system at any and every point. Amazingly, the contamination of variation, speciation and so on is the reason why evolution works at all. Contamination is functional…It's like language. For meaning to happen, language must be noisy, messy, fuzzy, grainy, vague and slippery.*
>
> Timothy Morton [9]

Issues of control and agency are paramount as we approach the synthetic. In our present design processes we cling to control. Eisenstein critiques our present relationship to technology, stating, "we can control reality only through reducing it: reducing complex ecosystems to the managed forest, the monocultured farm, the suburban lawn; reducing complex chemistries in herbs and food to just so many "active ingredients" and vitamins; reducing the complexity of human social relationships to the orderliness of a planned society." [10] This control has a variety of deleterious and unattended consequences; environmental degradation, social alienation, catastrophic outbursts of violence or unforeseen side effects. It has been easy enough to dismiss these failures as accidents, fate or bad luck. If instead we reorient our attention to the discrete variety of interacting parts and agents we will realize that these linear attempts at control have always been fiction. Alisa Andrasek suggests that, "recognizing the active participation of nonhuman forces in events and understanding that the agency spawns beyond just the human provide a ground for alternative ways of addressing design ecology". [11] The acknowledgement of these underlying and oft overlooked forces provides us with a whole new set of potential vectors to confront. These vectors can embody an unlimited array of potentially novel behaviors and agendas. They also may interact in any number of ways at multiple scales. The vast variety of potential states and outcomes creates a very messy situation to attempt to engage. Francoise Longy asserts that the ontological entanglements that arise when dealing with these intricately interdependent entities reflect the messy reality of these entities.[12] Entanglement suggests a rather sloppy and nested set of relations that resists simplistic visualization or hierarchical clarity. The implicit relations in synthetic ecologies are entangled both conceptually and physically. Rather than a rigid set of explicit operations, a synthetic ecology could comprise thousands of subsystems each operating on their own set of protocols with each possessing a certain specific capacity or tendency and ability to interact with other subsystems. These subsystems could be inspired by existing biological mechanisms in terms of performing metabolic functions or sensing various substrates and reacting to other subsystems. We could easily speculate on a range of more novel and interesting performance capacities. Instead of designing a space or topology we are instead interested in typologies or the potential of external wholes. DeLanda suggests that we specify the structure of the space of possibilities. [13] This space is not physical but rather a space of potential and involves the capacities and tendencies referenced above. He identifies these possibility spaces as well as the vast and nuanced variety of mechanisms contained within as the fundamental components to understanding and discussing emergent phenomena. These two domains give us a lot of area through which to begin to work. Mechanisms are specific actions or phenomena and can include chemical, biological and environmental processes. The possibility space as synthetic terrain provides a wide operational ground.

The nascent field of evolutionary design seeks to, "supplement traditional design methods with evolutionary algorithms that explore uncharted portions of design space."[14] The ability to search this space of possibilities and find potential optimal configurations is a compelling framework for a synthetic approach. This could be termed an implicit approach and the design process is only loosely controlled and seeded. Preliminary research has indicated that this implicit strategy produces solutions to complex problems that in a more reliable and diverse way than explicit approaches. [15] An implicit approach requires us to develop a comfort with the opaque presentation of a myriad of subtle and often imperceptible interactions occurring. Similar to the way RNA and DNA are invisible and illegible without extensive mapping operations, they still code for protein expression which ultimately regulates phenotypic appearance and behavioral interactions at multiple scales. These surface level appearances are thus visible to us while the embedded operational mechanisms are not. In speculating or conceiving a space of possibilities we must be open to emergent outcomes. The condition of emergence in a given set of interactions, "namely (a) properties that can be attributed sensibly to the system as a whole, but not to the parts of which it is made up, and (b) new causal powers that go beyond the causal powers of its parts."[16] Even if we had a fairly good sense of the information or rules encoded within a given system, the evolutionary mechanisms inherent to biological systems or hybrids will entail a certain amount of drift.[17] This drift would manifest as subtle or more pronounced shift in behavior or appearance at one or multiple levels and could affect features, behavior or appearance of a given system and would by its very nature, be unpredictable.

An implicit approach to the synthetic requires an empathic approach to the subsystems embedded within. This empathy acknowledges the unsettling and yet very real opacity of the mechanisms at play and accepts uncertainty over specificity. This risk of contamination, of error, of the unsettling or the tragic has always been present. It will be helpful conceptually to embrace these darker aspects and acknowledge their presence alongside the many benefits. Timothy Morton states quite evocatively, that, "naturalness is a temporal illusion: like seasons, things seem static because we don't notice them changing, and when they do change, there is a rough predictability to the way they do so. Horror and disgust arise when the neat aesthetic frame breaks. In this ecological age we must take stock of these unaesthetic reactions."[18] It is clear that explicit linear operations and simplistic discrete assemblages are insufficient as we approach synthetic ecologies. This relinquishment of hegemonic authorship is quite hard to accept. We attempt to bargain or pursue quarter or half-measures. Can we have a slightly emergent system? A moderately entropic ecology? This ignores the interdependency and entanglement at all levels of these complex systems. If we are to operate within these systems or approximate their robust homeostatic properties we must engage with them on these terms.

Insertion

When approaching the densely entangled realities of biological and synthetic biological systems we need to move beyond an explicit design agenda. Instead of arising from a flat ground it may be strategic to consider how we insert behaviors, agendas and performance into an existing series of interactions, ecologies and negotiations. The approach to this terrain, requiring the conceptual dismantling of a tabula rosa or empty ground, necessitates a nuanced approach. In a resilient ecology or set of relations, the removal or insertion of additional elements may be compensated by the presence of redundancy in the system or the ability to form new interactions and operational programs. This reflects a homeostatic condition of balance which is not dependent upon fixed states but rather maintains a balance between multiple smaller interactions and is able to absorb various disturbances to the organism or ecology. In a highly diversified set of interactions the capacity to absorb new insertions seems promising. We need to determine what are we inserting to and what are we inserting? The biological theory of endosymbiogenesis may be instructive here.

Endosymbiogenesis is the process of incorporation of simpler organisms into higher organisms. Lynn Margulis, the biologist who pioneered the theory proposed that, "serial endosymbiogenesis explains the evolution of the modern eukaryotic cell as the progressive incorporation of simpler organisms... normally bacteria import resistance-encoding genes from other bacteria via viruses, conjugation, and other means. And it's not just resistance.

Recent studies have demonstrated that the genes for photosynthesis are also transferred horizontally among bacteria."[19] This process evokes a multitude of design potentials for strategic operation through insertion. We could seek out and insert simpler organisms, mechanisms and subsystems to form a robust synthetic ecology. The use of subsystem components that are already operating with an internal logic and homeostatic balance would replicate a process that is assumed to be quite common in biological assemblies over time and space. There are an intriguing number of biomedical innovations that offer some glimpse into structural and formal possibilities Tissue engineering techniques utilize either artificial or donor biological organs as scaffolding on which to propagate new organs. These scaffolds comprise, "intricate three-dimensional webs of fibrous proteins and other compounds that keep the various kinds of cells in their proper positions and help them communicate".[20] Soon it seems that we will have a vast and divergent tool kit of potential biological and synthetic hybrids that perform a multitude of functions. By assembling these components into larger interrelated, entangled systems perhaps we can speculate and generate novel hybrid ecologies which exceed the most enticing promises of their embedded parts.

Latency

We have acknowledged the inherent uncertainty that exists in emergent systems. The diversity of interactions contained within as well as evolutionary mechanisms combines to elicit a variety of possible outcomes and potentials. Latency offers another conceptual strategy for engaging the synthetic. By embedding a series of latent operations one would provide the broadest possibility space. One not just relying on random mutations, accumulations and insertions but instead building on previously evolved intelligences embedded in the system. A flexible toolkit of possible latent behaviors and functions could respond to mutations or a given set of environmental thresholds or events. Understanding that linear control and fixed formal expressions will not be very resilient we need a way to have a range of behaviors and performances embedded into any given ecology. Latency offers us the potential to further expand our possibility space and provide a more robust and variant performance. We can embed both intentional insertions and more latent behaviors to maximize the synthetic ecologies survival. The concept of an atavism is useful here. An atavism is a throwback or reversion to an earlier state of being or an embodiment of a previous operational state. It has been speculated that cancer is an atavism from our previous genetic operating system. Davies and Lineweaver detail this genetic upgrade:

> By 600 million years ago,…the genetic apparatus of the new Metazoa 2.0 was overlain on the old genetic apparatus of Metazoa 1.0. The genes of Metazoa 1.0 were tinkered with where possible, and suppressed where necessary. But many are still there, constituting a robust toolkit for the survival, maintenance and propagation of non-differentiated or weakly-differentiated cells-–`tumors'—and when things go wrong (often in senescence of the organism) with the nuanced overlay that characterizes Metazoa 2.0, the system may revert to the ancient, more robust way of building multicellular assemblages—Metazoa 1.0. The result is cancer. In evading one layer of genetic regulation–-turning proto-oncogenes into oncogenes–-cancer mutations uncover a deeper, older layer of genes that code for behaviors that are often able to outsmart our best efforts to fight them[21]

Cancer as atavism is of a genetic variety, relating to instructions or operational logics which engage in an alternate regulatory response. In synthetic ecologies the inclusion of atavisms and latent potentials could compose yet another layer. Morton describes that, "organisms are palimpsests of additions, deletions, and rewritings, held together mostly by inertia."[22] The palimpsest is continually overwritten but traces of the old remain and new relationships may emerge between the two. The more we are able to let go of singular narratives and clean categorizations and accept and encourage the chaotic and very messy realities of these operations, the better to approach the synthetic.

This paper has avoided the inclusion of specific architectural precedent because at the moment while there are very tantalizing whispers of the beginning of deployment of the biological synthetic into our built fabric we remain quite far from a technological toolkit to approximate synthetic ecologies. Architects such as Francois Roche, Phillip Beesley and Zbigniew Oksiuta explore the boundaries of spatial enclosure and each seeks to interrogate new material and biological systems and their potential impact on architectural matter. The synthetical hybrid work of this vein will surely increase as our access to new methodologies from science and technology further infiltrate our discipline. In embracing the darker and more unsettling aspects of biological systems we can begin to speculate our possible engagement with the synthetic realities of tomorrow.

Notes:

[1] Manuel DeLanda, (2011). *Philosophy and Simulation: The emergence of synthetic reason* (*Kindle ed.)*. New York, NY: Continuum, Intro chapter,par.9.

[2] Timothy Morton (2010). *The Ecological Thought*. Cambridge: Harvard University Press, 36.

[3] DeLanda, *Philosophy and Simulation: The Emergence of Synthetic Reason,* Chapter 1,par.9

[4] James Marcum, & Gerard Verschuuren (1986). Hemostatic Regulation and Whitehead. *Acta Biotheoretica*, 35(1-2), 123-133. doi: 10.1007/BF00118370

[5] Graham Harman, (2012). Object-oriented France: The Philosophy of Tristan Garcia. continent., 2.1, 6-21. Retrieved from http://continentcontinent.cc/index.php/continent/article/viewArticle/74, accessed 9/11/12., 14.

[6] Marcum & Verschuuren, Hemostatic Regulation and Whitehead, 124.

[7] Charles Eisenstein, (2008). *The Ascent of Humanity*. Retrieved from http://www.ascentofhumanity.com/chapter6-6.php, accessed 9/14/2012

[8] Eisenstein, *The Ascent of Humanity*. Chapter 6-6.

[9] Morton, *The Ecological Thought*, 66.

[10] Eisenstein, *The Ascent of Humanity,* Chapter 6-3.

[11] Alisa Andresek, "Open Synthesis// Towards a Resilient Fabric of Architecture", Log 25 Reclaim Resi[lience]stance// (2012), 54.

[12] Francoise Longy. (2009). How Biological, Cultural and Intended Functions Combine. In U. Krohs & P. Kroes (Eds.), *Functions in Biological and Artificial Worlds : Comparative Philosophical Perspectives* Cambridge, MA: MIT press. 58.

[13] DeLanda, *Philosophy and Simulation*, Intro Chapter, par.8.

[14] Wybo Houkes, (2009). The open border: Two cases of concept transfer from organisms to artifacts. In U. Krohs & P. Kroes (Eds.), *Functions in Biological and Artificial Worlds : Comparative Philosophical Perspectives* Cambridge, MA: MIT press. 237.

[15] Houkes, The open border: Two cases of concept transfer from organisms to artifacts. 232.

[16] Peter Kroes, (2009). Technical artifacts, Engineering Practice and Emergence. In U. Krohs & P. Kroes (Eds.), *Functions in Biological and Artificial Worlds : Comparative Philosophical Perspectives* Cambridge, MA: MIT press. 280.

[17] Pablo Schyfter, (2012). Technological biology? Things and Kinds in Synthetic Biology. *Biology Philosophy*, 27, 29-48. doi: 10.1007/s10539-011-9288-9, 35.

[18] Morton, *The Ecological Thought*, 44.

[19] Eisenstein, *The Ascent of Humanity*, chapter 6-8.

[20] Henry Fountain, (2012, September 15). Body builders, a first: Organs tailor-made with body's own cells. *New York Times*. Retrieved from http://www.nytimes.com/2012/09/16/health, accessed September 17, 2012

[21] Paul Davies and Charles Lineweaver., "Cancer tumors as Metazoa 1.0: Tapping Genes of Ancient Ancestors" 2011 *Phys. Biol.* Volume 8, Issue 1, accessed September 10,2012, DOI:10.1088/1478-3975/8/1/015001

[22] Morton, *The Ecological Thought*, p. 64.

A Field Guide to Generating Architectural Species

MATTHEW J. LUTZ
Princeton University

NICOLE KOLTICK
Drexel University

The question of how architecture may begin to draw from the tools, techniques and concepts of ecology, is of critical importance to the future of our discipline. Examining the overlaps between these two fields in an effort to extract useful insights from the rapidly developing science of ecology and put these to work in the context of architecture in a meaningful way, going beyond mere metaphor, will require a clear understanding of the levels of organization with which ecology is concerned. The science of ecology is a relatively young field and, like the discipline of architecture, has experienced rapid growth in recent years with the development of sophisticated computational techniques, specifically in the area of theoretical ecology. While it is tempting to apply the metaphor of an ecosystem as a complex set of interacting components and feedbacks directly into the realm of architecture, it may be even more productive to examine the specific mechanisms that ecologists study at various scales and levels of organization and ask what parallels may exist in architecture and urbanism. Both architecture and ecology are concerned with the articulation of form, structure and pattern emerging at multiple scales in response to environmental conditions.

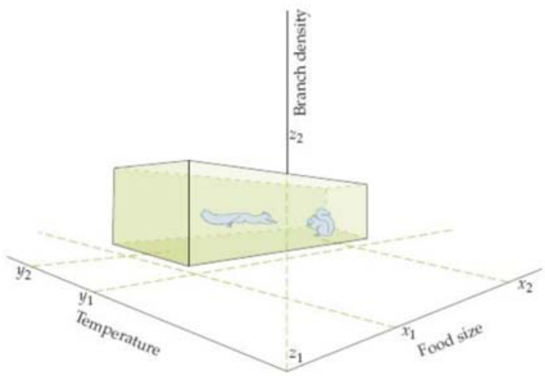
We may begin by asking, why has ecology suddenly become such a fertile area of inquiry for architects in recent years? Certainly, the easy answer is to draw the obvious connection between the now omnipresent concern with sustainability in the built environment, and a simplistic understanding of the field of ecology, as one that is primarily concerned with conservation of the earth's natural systems. However, ecology is in fact a quantitative science concerned with the myriad interactions between organisms and their environment, which uses a well developed arsenal of theoretical models in conjunction with experimental studies at multiple scales to understand these complex interactions. A more useful and productive understanding of the connections between these two diverse fields requires us to abstract things a bit, and understand both ecology and architecture as disciplines that are primarily concerned with problems of pattern, scale and complexity, and with comprehending complex interactions of material and energy that operate across many nested levels of organization. In combination with advances in computational power and an increasingly sophisticated understanding of complex systems, architects have begun to mine the field of ecology in all its manifestations for useful metaphors, mechanisms, processes and tools. In the following paper, I will explore a handful of concepts drawn from the science of ecology that may be useful for further speculating on the increasingly productive overlap between these two disciplines.

In 1989, on the occasion of his receipt of the MacArthur Award, theoretical ecologist Simon Levin published a paper entitled “The Problem of Pattern and Scale in Ecology.” [1] The themes discussed in this article represented some of the fundamental questions confronting the field of ecology at that point, and many of these remain to this day important areas of inquiry. Generally, Levin discussed the problem of scaling up from observations of behaviors or phenomena at one scale to the outcomes that these interactions produce at higher levels. A key factor in understanding these dynamics is to ascertain how information is transferred from one scale to the next, and how large scale patterns feed back upon and inform local interactions. Understanding the emergent properties of dynamical systems is of great interest to a number of fields, of which architecture and ecology are two examples, but there are certain overlaps between these two areas that make them more relevant to one another than might first be apparent. The complex systems studied by ecologists may be more productive for architecture than, say, purely physical systems which may exhibit similar properties, due to the inherent agency embedded in ecological interactions. New methods of architectural production enabled by computation have endowed architecture, too, with myriad degrees of agency. No longer is architecture a process of sculpting inert matter, but for a growing number of practitioners it has become an exercise in designing responsive and robust systems that are imbued with a set of behaviors specified by their designers and set into motion. The question of agency has risen to the forefront of the discussion, and the designer occupies a distinctly different role in these new modes of production. Agency is now distributed throughout a project, and the role of the designer is as much about assigning this agency to various elements as anything. Systems of interacting components behave fundamentally differently when individuals possess some internal motivation, and are no longer simply responding to external forces. The systems being deployed by practitioners working with agent-based models are thus fundamentally different from earlier digital modes of production that simulated physical forces in order to deform a surface or vector field, and are also distinct from parametric systems which have a fixed number of possible outcomes. Designers working with generative self-organizing systems require a set of tools and a language for dealing with the outcomes of their design experiments. The discipline of ecology offers an extraordinarily useful framework for understanding these complex interactions due to the multiple levels of nested organization with which it is concerned. In his paper, Levin described every organism as an "observer" of its environment, each operating according to its own spatial and temporal logic. Strategies such as seed dispersal or dormancy may alter the spatial scale that an organism effectively occupies. The process of defining which entities within an architectural project play the role of the observer, and at what spatial and temporal scales these agents observe and operate on their environment, will become more and more important as agentbased design methodologies continue to mature and develop.

NICHE THEORY

The Niche theory of the niche is one of the fundamental concepts of modern ecology,. G generally described as the role a species plays in a given ecological community, the concept has undergone several distinct First described by Joseph Grinnell in 1917, the original sense of the term referred to the specific set of habitat conditions within which an organism was typically found, . As a linguistic construct, we may even trace the connection between architecture and ecology under discussion here back to this initial deployment of an architectural metaphor designating the position of a species as a "recess." This definition allowed for the existence of "empty niches" within a community. Later, Charles Elton refined the working definition of the niche to indicate the role that an organism plays. This definition persists as the "recess-role" niche. Competition between species is one of the most fundamental mechanisms in ecology, and one of the primary concerns of niche theory. These early concepts of the niche were supported by the competitive exclusion principle, which states that two species cannot coexist when competing for the same resource, but one species will always win out. In a series of well-known experiments, Georgy Gause demonstrated this by pitting two species of paramecia against one another. When competing for the same resource, one species always won out as the competitive dominant.

However, while this principle is apparent in highly controlled laboratory settings, it is difficult to identify in the natural world. In recognition of this conundrum, G. Evelyn Hutchinson published a paper in 1959 entitled "Homage to Santa Rosalia, or Why Are There So Many Different Kinds of Animals?" [2] In this lecture, he outlined his revised the conception of the niche, in 1959 as an n dimensional hypervolume.



Hutchinsonian niche in 3 dimensions, from [7].

Each axis of this hypothetical volume represents some quantity such as temperature or food size, and the area contained within the volume, or the "niche space" indicates the range of those quantities within which a species can survive. This approach went a great deal further in explaining the rich diversity of forms in nature, as it allowed for the differentiation of resource use according to qualities such as food size, as opposed to the relatively limited number of species that would be predicted by the competitive exclusion principle. In the context of architecture, such a framework may be useful in imagining how we might begin to generate a wide diversity of forms and entities. Hutchinson's concept of the niche would be further refined by MacArthur and Levins in 1967, who proposed the

Resource-Utilization niche, focusing on a few critical niche axes instead of the practically infinite variety allowed by Hutchinson. MacArthur and Levins' framework also allowed for the identification of points of limiting similarity, where species became too similar to coexist, and demonstrated the possibility of convergence and divergence of coexisting species.

When we consider the breeding and cultivation of new architectural species through the use of evolutionary algorithms, identifying such points of limiting similarity may prove useful in determining what differentiates the novel architectural species that inhabit the synthetic ecologies we develop.

As in ecology, the concept of the niche as a driver of architectural production may be understood in several ways, but Hutchinson's description of the n-dimensional hypervolume seems relevant to any discussion of niche space in architecture. Just as individual species evolve a suite of adaptations in both physiology and behavior to thrive under a specific set of environmental conditions, so too must any architectural intervention respond to its local environment. Thus, at the scale of the building, the typical concerns of sustainable design such as solar radiation, outside temperature, precipitation and water availability, would all seem to be easy starting points as potential niche axes in selecting for massing and large scale building forms that are responsive to local climatic conditions. An ecological redefinition of architecture, while not confined merely to concerns with sustainability, would nevertheless certainly build from these as an initial framework. This is merely a recognition that environmental factors shape the development of morphology and behavior at all scales. However, environmental factors alone do not determine the plethora of forms and organizations found in nature, and thus designers may begin to articulate a whole slew of additional niche axes.

The niche concept may also be useful at smaller scales, integrated into the design process at earlier stages as designers evolve a series of species which compete for some resource and begin to differentiate into a number of forms each specializing on one particular invented resource. The process of designing with evolutionary algorithms is still in its infancy, but will begin to take on a more significant role as designers working with agent-based generative tools seek to differentiate more and more novel forms, patterns and organizations. The most productive aspect of agent-based design approaches lies in the ability to invent any number of possible narratives for how and why agents interact with one another, and how these interactions are translated into form.

PARASITISM / MUTUALISM

Ecological concepts need not be deployed only in the service of form generation in architecture. Associations such as parasitism and mutualism offer the potential for reframing power relations between entities that may prove to be useful as well. New, parasitic forms of architecture might serve to disrupt power structures by feeding off of the excess or waste products generated by the powerful. Parasitic architectures may be deployed that are capable of co-evolving with their hosts, receiving some information and responding in real time.

Of course, these are merely speculations but the important point is that, as architecture operates within a distinct sociopolitical milieu, the operational lessons that the discipline draws from the study of ecology may be applied to these forms of relations and interactions as well. Such reframing of power relations through strategies of parasitism may in fact play out at the scale of urbanism more so than in an explicitly architectural context. These strategies are already in use and do not necessarily require the intervention of a designer, as can be seen in the increasingly common practice of stealing electricity from the "host" power grid that occurs in any number of slums around the world.

Like these parasitic interventions, strategies of mutualism may also be applied to the power relations mediated by architectural and urban forms. Some of the most well-studied examples of mutualism in nature involve the interactions between Acacia trees and the ants that inhabit them. These ants are provided with shelter in the hollowed-out thorns of the trees as well as food in the form of nectar and specially manufactured protein-rich nodules. In return, the ants provide defense to the plant from herbivores as well as other insects, and even go so far as to clear out new seedlings around the trees that might grow to compete with the Acacias for light and other resources.

One could imagine a number of iterations of how such a system might play out architecturally, with some proto-architectural robotic species inhabiting the exterior of some larger structure, and providing services for its host such as cleaning, maintenance or processing of waste products in exchange for the provision of energy and shelter. In a more bucolic version of this type of mutualism, perhaps a plant community could be given a series of nooks on a façade in which to take root, being provided with stored rainwater in return.

SPATIAL PATTERNING AND SELF-ORGANIZATION

Some of the most relevant examples of ecological interactions for architecture take the form of self-organizing processes which form discernible patterns at larger scales. While the rules governing interactions between individuals may be local and relatively simple, the patterns that emerge from these interactions are coherent and legible at much larger spatial scales. Typically, these local interactions take the form of short range activation combined with long range inhibition, as described by Alan Turing in 1951 [3]. Positive feedback dominates interactions at short distances, while negative feedback takes over at longer distances.

Such patterns can be observed in a number of biological and non-biological systems, from the development of spots and stripes on animals to patterns on seashells. In spatial ecology, as well the interactions between individuals can generate striking patterns at higher levels. An ecological example of one such system involves mussels, which move incrementally across the floor of tidal flats. Individual mussels benefit from aggregating together, decreasing their risk of predation and attaching to one another to prevent being carried away by tidal forces. However, these benefits are outweighed once a certain level of density is reached, beyond which levels of competition between individuals for food particles become too great. Thus when clusters become too large, negative feedback kicks in and some portion of the cluster begins to disperse [4].

These types of self-organizing processes underlie systems that display pattern formation at multiple scales, and could be a useful organizing principle for new forms of planning, incorporating self-organized development where individuals cluster together in order to maximize access to resources such as water or transportation hubs but where the benefits of aggregating cease once a certain level of density is reached.

In addition to merely responding to the local environment, many organisms actively modify their environments as well. While the entire enterprise of architecture is essentially the process of humans modifying their environment in such a way, we might also imagine individual buildings or components taking a more active role in the modification of their local environment. Wendy, the recent installation by HWKN at PS1, offers one intriguing possibility for how this type of local environmental modification might occur at an architectural scale, as buildings may begin to actively clean the air in their immediate environment, but we can imagine more and more responsive and active types of environmental modification as technology continues to advance and intelligence becomes embedded in increasingly smaller entities. Well known examples of such environmental modification in the natural world include termite mounds and beaver dams, feats of ecosystem engineering that are permanent or semi-permanent, but interesting examples exist of more provisional and temporary constructions as well. Much of what we have discussed so far remains in the realm of design processes, however we might also look to insights from behavioral ecology to speculate on the ways in which an architecture reconceived according to ecological principles might become more open and responsive to its environment, capable of adaptation and reconfiguration.

COOPERATION AND SELF-ASSEMBLAGES

The army ant *Eciton burchellii* represents one of the most striking examples of cooperation found in nature. Living in massive colonies of hundreds of thousands of individuals, these ants are capable of dramatic feats of engineering and coordinated activity, even though each individual is essentially blind. In their daily swarm raids across the rain forest floor, these predatory ants flush out small arthropod prey, forming a complex dendritic trail network by which prey items are returned to their nest site. High levels of traffic flow are maintained along this trail network and highly coherent traffic lanes emerge spontaneously, generated solely through the local interactions between individuals [5]. This system was one of the earliest examples of self-organization in nature to be investigated with computational models, in a study from 1991 in which the authors implemented a simplified agent-based model to capture the process of positive feedback which occurs when an individual ant responds to a pheromone deposited by another, and in turn lays down more pheromone, thus reinforcing the trail to a food source [6].

Figure 2: Network patterns emerging from different prey distributions, from [6].

This simple mechanism has powerful consequences, as these repeated interactions can lead to the development of large scale patterns in the characteristic branching form of the army ant raiding network. The authors further showed that for different distributions of prey, alternate macro scale patterns would emerge corresponding to the food sources and trail patterns of different species of army ant.

In addition to the compelling self-organized patterns created by their trail networks, and the optimized traffic flow maintained across these networks, Eciton burchellii possesses a unique morphological adaptation which allows them to literally form structures out of their own bodies. A set of hook-like claws at the end of each leg allows these ants to join themselves together in various configurations, allowing the ants to quickly construct provisional architectures in response to environmental conditions. While these structures take many forms, two of the most interesting in the context of architecture are bridges and bivouacs. These structures, described as self-assemblages, are dynamic and responsive, and may be considered as a kind of living architecture.

The bridges created by army ants are used to cross over gaps in the heterogeneous landscape of the forest floor. They serve to optimize the flow of traffic along the raiding trail, speeding the transport of prey items back to the bivouac, a temporary nest structure. The truly amazing thing about these bridges is that they are self-regulating, meaning that ants within a bridge can sense the flow of traffic crossing over them, and dismantle a bridge when it is no longer required. At the scale of the entire swarm raid, the numerous bridges along the trail act serve as a kind of responsive terrain smoothing system, forming and breaking apart as traffic conditions change. Again, these bridges are entirely selforganizing as individual ants respond to bottlenecks and traffic flow, measured at the local scale by the increasing or decreasing number of contacts from neighbors. This phenomenon has sparked great interest in the field of swarm robotics, and has quite interesting implications for the development of new models of architecture based on the interactions of simple autonomous agents capable of attaching themselves together into larger structures.

Like the bridges created by E. burchellii, the bivouac, or temporary nest structure that they inhabit is also formed entirely out of the bodies of individual ants, linked together into long chains which then further link to form curtains, walls and floors. Perhaps even more impressive due to their sheer size, these structures are highly organized and may consist of hundreds of thousands of individuals.

As a consequence of the sheer quantity of food required to sustain an entire army ant colony, these colonies cannot remain in one fixed nest site but must be nomadic, and so have evolved the capacity for building an entire nest structure out of their own bodies, one which is dismantled and constructed anew in a different site each day when the colony is in its nomadic phase.

The architectural implications of such a nomadic, distributed system capable of dismantling and reassembling in different configurations, able to adapt to local site conditions, are profound. In addition to the appealing concept of responsive, selfassembling architectures, we might also draw from the army ant example the concept of a distributed sensing network, wherein components of architectural subsystems may disperse out into the environment, or search across or within portions of a structure in response to human or environmental inputs.

We have described some of the building blocks of ecological systems, the basic interaction rules that determine the distribution and abundance of species, as well as the morphology and function of individuals through the mechanisms of natural selection. The big question, of course, remains: how do we make these concepts operational in the context of architectural production? Clearly there is no simple answer to this question, and numerous strategies will be developed by practitioners in the coming years as tools, techniques and insights drawn from the study of ecology continue to infiltrate into the design studio. In order to utilize these concepts in a productive way in the context of architecture, we need to speculate about what constitutes an architectural species or an individual, what defines a community, and at which scale and what point in the design process we are proposing to incorporate these concepts. Most of the general concepts discussed here are scale-independent, allowing architects the luxury of inventing any number of narratives for how such interactions may play out, at scales ranging from the component to the building to the city.

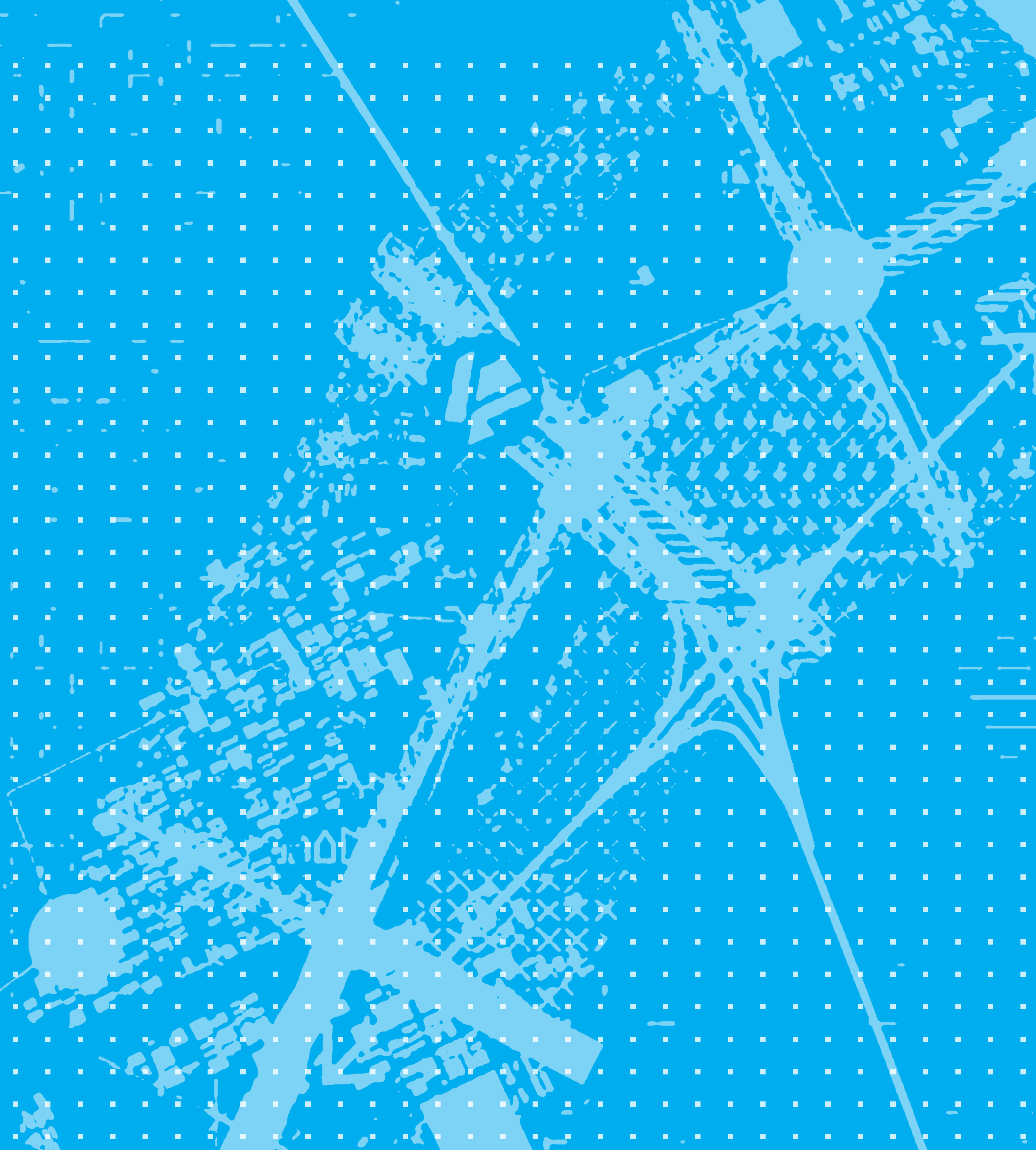
1. Levin, S.A., *The Problem of Pattern and Scale in Ecology: The Robert H. MacArthur Award Lecture.* Ecology, 1992. **73**(6): p. 1943-1967.
2. Hutchinson, G.E., *Homage to Santa Rosalia or Why Are There So Many Kinds of Animals?* The American Naturalist, 1959. **93**(870): p. 145-159.
3. Turing, A.M., *The chemical basis of morphogenesis.* Bulletin of Mathematical Biology, 1990. **52**(1–2): p. 153-197.

4. van de Koppel, J., et al., *Experimental Evidence for Spatial Self-Organization and Its Emergent Effects in Mussel Bed Ecosystems.* Science, 2008. **322**(5902): p. 739-742.

5. Couzin, I.D. and N.R. Franks, *Self-organized lane formation and optimized traffic flow in army ants.* Proceedings of the Royal Society of London. Series B: Biological Sciences, 2003. **270**(1511): p. 139-146.

6. Franks, N.R., et al., *The blind leading the blind in army ant raid patterns: Testing a model of selforganization (Hymenoptera: Formicidae).* Journal of Insect Behavior, 1991. **4**(5): p. 583-607.

7. Mittelbach, G., *Community Ecology.* Sinauer Associates, Inc. 2012.



Abstracts from the Association of Collegiate Schools of Architecture
100th Annual Meeting in Boston, MA

Address 1735 New York Avenue, NW Washington, DC 20006
Tel 202.785.2324
Fax 202.628.0448
Web www.acsa-arch.org

ACSA-ARCH.ORG

[En]Coding Architecture

THE BOOK

Edited by Liss C. Werner

[EN]CODING ARCHITECTURE 2013 WAS GENEROUSLY SUPPORTED BY...

Carnegie Mellon University
School of Architecture

Carnegie Mellon University
College of Fine Arts

The Frank-Ratchye
STUDIO
for Creative Inquiry

dFAB

C0DELAB

FB
A3
FG D/ A

TAUBMAN COLLEGE

Association for
Robots in Architecture

THIS PUBLICATION HAS BEEN FUNDED BY A GRANT FROM:

The Frank Ratchye Fund for Art @ the Frontier

SPECIAL THANKS TO...

Carnegie Mellon University School of Architecture
Carnegie Mellon University School of Music
Frank Ratchye Studio for Creative Inquiry
Dfab Lab
CoDe Lab

Joshua D. Bard
Jeremy Ficca
Madeline Gannon
Linda Hagar
Michael S. Jeffers
David Koltas
Steve R. Lee
Golan Levin
Dan Martin
Marge Myers
Rob Sutherland
Lena E. Tesone

All who helped and assisted with the conference
All participants and attendees of the conference
All contributors to this book

PREFACE

Liss C. Werner
Dessau International Architecture Graduate School
Carnegie Mellon University

The architect is no longer an organizer of matter and space, but a designer of systems with multi-layered components and complex relationships.
[EN]CODING ARCHITECTURE - THE BOOK was put together after a conference on the autonomy of architecture, code, fabrication, material morphology, robots, machinic desire and computation held at *Carnegie Mellon University*, School of Architecture in Pittsburgh, Pennsylvania in February 2013. The event focused on the ongoing paradigm shift in architecture and the role of the designer/architect in the age of code, beyond linear communication channels or a a clear differentiation of disciplines, which has dominated the profession of architecture since the second industrial revolution. The event brought together rising superstars, experienced researchers and designers to present experimental work, and thoughts, derived through computational thinking and digital making. Lectures by Sanford Kwinter, Neil Leach and Warren Neidich elevated the conference subject and furnished debates with new constructs.
The book presents an overview of what *[En] Coding in Architecture* may consist of, how it can be defined and which way a new language and new tools, namely the language and tools of computer sciences influence computational thinking for architecture and the built environment. *[EN]CODING ARCHITECTURE 2013* positions the field of architecture as an alloy of programming, digital tooling, art, and science. The book synthesizes new trajectories for the profession in a cybernetic context of tectonics, cultural philosophy, architectural theory and geopolitics. Despite focusing on computation, the conference specifically avoided to indulge in only one particular strand of the profession and discipline. Instead it aimed at triggering a conversation and debate between various of topics, ranging from material morphology via physical and cerebral interfaces to politics. Along with the paper presentations and panel discussions the conference also featured five workshops: two on industrial robots in architecture, two on scripting and one on the subject of ‘The Architect as Entrepreneur’. Furthermore the conference was accompanied by an exhibition featuring some of the projects contained in this book. A call for papers encouraged an international group of approximately 200 architects, architectural students and researchers to submit papers and/or projects to accompany the keynote lectures of the conference. Due to common ground, articles in this book partly overlap in the subject matter; the book, however, is structured in eight chapters: *INTRODUCTORY ESSAYS, CRITIQUE IN CODE, MATERIAL, ROBOTS, INTERFACE, BUILDING, POLITICS* and *VISIONS*. In that sense, the book spans from factual and theoretical understandings of architecture via matter and making, to critical observations of global phenomena in architectural development, culture and technology. The chapter *INTRODUCTORY ESSAYS* describes a general overview of the subject, including theory, philosophy and practice. *CRITIQUE IN CODE* emphasizes on how code can be understood, used, and translated as architectural vocabulary as well as how code triggers questions about architectural education and craft. The chapter pushes the boundaries of code from a spatial, non-linear, and dynamic coordinate system towards a tool for circular feedback, stigmergy, and self-organization. *MATERIAL* focuses on issues such as morphogenesis, biomimetics, a novel understanding of space and surface-articulation, and a cross-disciplinary research approach. *ROBOTS* presents an introduction into how industrial robots can be used in architecture, as form-finding tool, or as interface/learning devices between code and operation. *INTERFACE* is specifically concerned with activities between the architect as designer, the hard- and software involved, and the difference or similarities between atoms and bits. This chapter also touches upon locating current streams within cultural studies and cinematics. A number of projects are combined in the chapter *BUILDING*; these projects act as case studies, and are aimed to encourage research beyond the laboratory. *POLITICS,* and *VISIONS* present the two final chapters in *[EN]CODING ARCHITECTURE - THE BOOK*. They mirror on one hand an earnest and critical view towards spatial and urban design, integrating opportunities for code and computational design strategies, on the other feature utopian visions, equally politically charged.

Undeniably, there is a global desire to re-discuss architecture now.

Liss C. Werner

INTRODUCTORY ESSAYS

CRITIQUE IN CODE

MATERIAL

ROBOTS

INTERFACE

BUILDING

INTERIOR PROSTHETICS

Nicole Koltick, Drexel University

Interior Prosthetics resulted from a special topics digital fabrication seminar run in fall 2012, led by Professor Nicole Koltick at the Westphal College of Media Arts and Design at Drexel University. Students were challenged to develop a series of prosthetic design interventions to the newly renovated URBN Center.

Based on a narrative methodology, the seminar explored design speciation through developing and prototyping a variety of additive and subtractive design species. Moving beyond formal mimesis, we set out to induce a series of procedural operations, which could yield novel outcomes of design speciation. Students were particularly interested in the potential of synthetic relationships that might arise from interactions between varied species and their prosthetic interactions with their immediate environment, the building. Through a series of investigations into biological precedents that exhibit a highly discrete set of material, temporal and spatial relations, the *Interior Prosthetics* approximated some of these seemingly *messy and unorganized* adjacencies.

In *Philosophy and Simulation: The Emergence of Synthetic Reason*, M. DeLanda addresses mechanisms and relationships that exist at various

We were particularly interested in the potential of synthetic relationships that might arise from interactions between varied species and their prosthetic interaction with the building.

as when neurons manipulate concentrations of metallic ions, or a psychological entity interact with a chemical one

scales. In all of those systems he locates their presence, '[…]of a contingent accumulation of layers or strata that may differ in complexity but that coexist and interact with each other in no particular order: a biological entity may interact with a subatomic one, as when neurons manipulate concentrations of metallic ions, or a psychological entity interact with a chemical one, as when a subjective experience is modified by a drug'.[1]

the logic of speciation - the evolutionary process by which new biological species arise

The nested and heterogeneous nature of these relationships allowed for results of emergent nature. Therefore synthetic material relations were induced through the *logic of speciation*, the evolutionary process by which new biological species arise. In addition to analog procedures like experimental casting techniques, digital fabrication were explored in the generation of species. *Additive Speciation* was explored through cellular based modeling, 3D Printing and casting. *Subtractive Speciation* was explored through CNC milling and casting. *Hybrid Speciation* emerged through trajectories of interactions between additive and subtractive methods. In *The Ecological Thought*, T. Morton points out that, 'If there is anything monstrous in evolution, it's the uncertainty in the system at any and every point. Amazingly, the contamination of variation, speciation and so on is the reason why evolution works at all. Contamination is functional...It's like language. For meaning to happen, language must be noisy, messy, fuzzy, grainy, vague and slippery.'[2] This definition of contamination was pursued through experimental material approaches, where the uncertainty in outcome and effect provided an additional opportunity and dimension for novel synthetic discoveries. Materials such as clay, resin, rubber and felt provided a tactile dimension to the work. As *prosthetic interventions* these hybrid species then adapted to their given location. Forcing the species to contend with relations at multiple scales induced varying degrees of drift in the resultant systems. Even with the precise information and rules encoded within a given system, the evolutionary mechanisms inherent to biological systems will entail a certain amount of drift.[3] This drift may manifest as subtle or more pronounced shifts in behavior or appearance at one or multiple levels, and may affect the features, behavior or appearance of a given system. The

If there is anything monstrous in evolution, it's the uncertainty in the system at any and every point.

approach of the seminar was unique in its attempt to seed potential conditions that allow for drift and contamination to emerge simultaneously. Pursuit of evolving species in both genotypic and phenotypic expression, as well as the recombination of these across species would yield additional novel discoveries. The primary findings of this research indicate that the inducement of hybridity through material synthesis is a viable approach to design speciation, and lends itself to further study.

drift may manifest as subtle or more pronounced shifts in behavior or appearance at one or multiple levels

CITATIONS / REFERENCES / NOTES

1. Manuel DeLanda, *Philosophy and Simulation: The Emergence of Synthetic Reason* (Kindle), New York: Continuum, 2011, Intro chapter, par. 9.
2. Timothy Morton, *The Ecological Thought*, Cambridge: Harvard University Press, 2010, p.66.
3. Pablo Schyfter, 'Technological biology? Things and Kinds' in *Synthetic Biology, Biology Philosophy,* 2011, doi: 10.1007/s10539-011-9288-9, pp.27, 29-48.

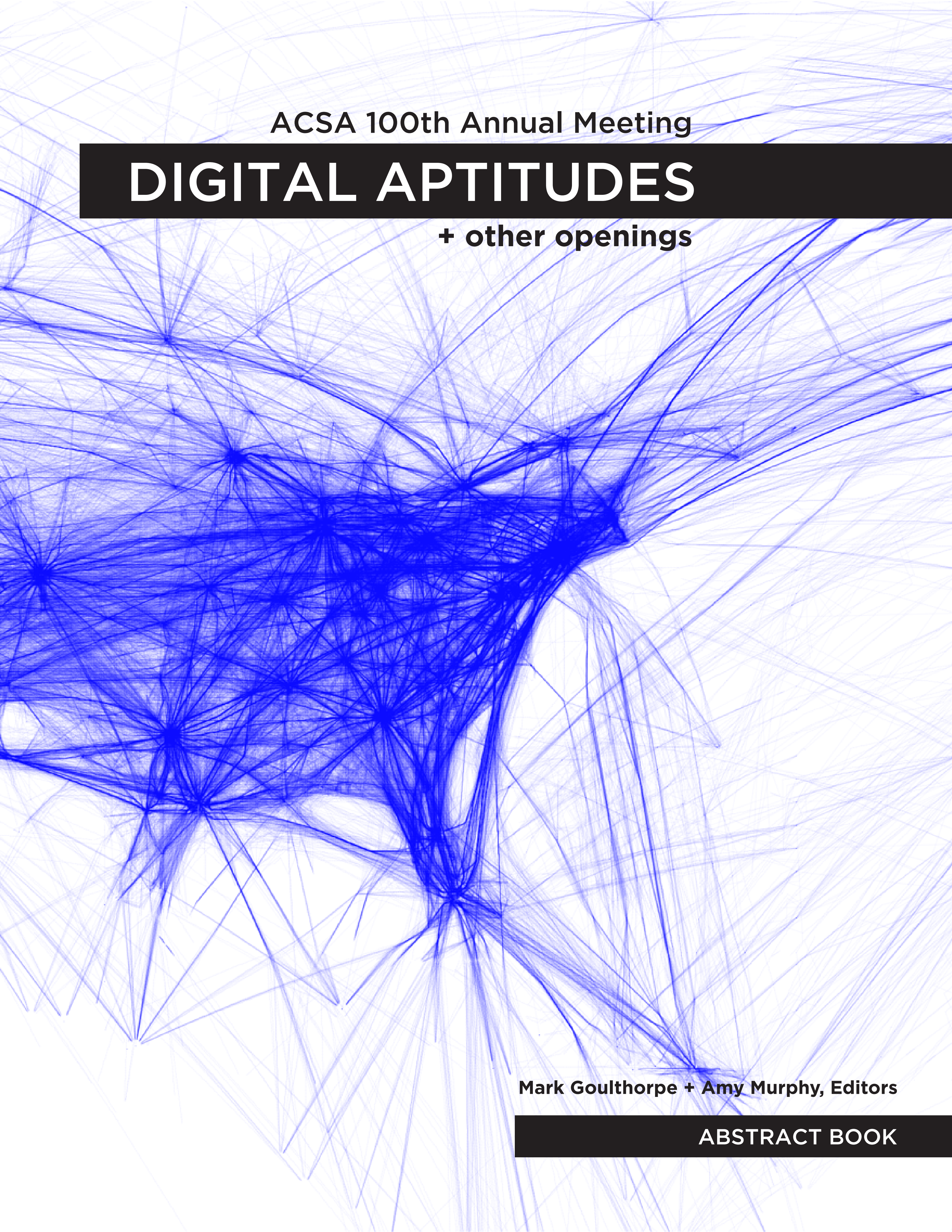
ILLUSTRATIONS

pp.96, 98-99: Special Topics Seminar: Interior Prosthetics, material prototype (silicone, resin) assembly by Kathryn Pellegrino.
p.99 bottom: Special Topics Seminar: Interior Prosthetics, research.

ACSA 100th Annual Meeting

DIGITAL APTITUDES

+ other openings



Mark Goulthorpe + Amy Murphy, Editors

ABSTRACT BOOK

FRIDAY, MARCH 2, 2012 - 2:00PM - 3:30PM

Beyond Digital: Speculations on Analog Convergence

Brian Lonsway, Syracuse University

From Digital Materials To Self-Assembly

Skylar Tibbits, Massachusetts Institute of Technology

A new paradigm is upon us, one that challenges our notions of assembly by looking to transfer digital and computational information from our design software and machine control through our physical methodologies of construction. The construction industry has traditionally been plagued by analogue processes inherited from the industrial revolution where raw materials are sent through machines and assembly sequences fighting tolerance, machine errors and efficiency. On the contrary, information can now flow through materials and embody adaptability and material computation, offering a new vision for construction where materials literally build themselves. This is a new paradigm for designing and making, one that offers the ability for self-assembling, self-repairing and replicating structures. This vision challenges our notions of the digital, converting analogue processes into digital information transfer by "computing-through-construction" and pointing towards new opportunities for manufacturing, construction and design tools.

Parallel Tracks: Digital | Analog Dialogue in Toy Development

Jennifer Akerman, University of Tennessee-Knoxville

Designers and fabricators have long understood their work to be related, but distinct. Boundaries, some intuited, others legally proscribed, dictate that designers establish the intent for a given outcome, while fabricators generate the actual work or product. That understanding is an action-based view, focusing on tasks performed by specific people or entities. We could shift our consideration towards the nature of work itself and state that there have traditionally been two fields, interrelated but distinct: design and craft. How are we to understand the changes to both of these fields necessitated by the ways emerging methods, practices, and technologies are merging the two? This essay will discuss the digital | analog convergence in design and fabrication as illustrated by examples from a line of toys developed through the collaboration of an architect and mechanical engineer. Our work considers questions of craft and fabrication, relying extensively on both digital and tangible techniques in continual iterative dialogue. Also at hand is a parallel consideration of the digital | analog convergence in the realm of toy design, considering toys as objects designed for interaction and play. Our continued engagement in the convergence of technology, material, and culture in the interest of design and fabrication is a catalyst for speculations of what may come next.

Émission

Jordan Geiger, SUNY at Buffalo

More than its physical matter, architecture's conditions - its determinants, performance, milieu, and multiple stakeholders - grow ever more ethereal. The "ether" condition can be named as such because of its entropic, expanding and hazy mixture of physical and computational and other characteristics; and possibly for a resulting delirium in its movement past any paradigm in which any of these parameters can lay dominant claim to its formation. Answering to an ever-expanding set of contemporary exigencies from market crashes and shifting climates to globalized sources of building materials and the evolving influence of ubiquitous computing, the built environment provokes speculation on its possible futures that must lie far outside of typological or even scalar parameters. It needs critical fictions as a means for planning tactically past choices of utopic or dystopic scenarios, embracing instead a messy tangle of new and future influences and a sober acceptance that analog convergence recasts architects more like steampunk novelists or design noir authors (to borrow here a term from Anthony Dunne). These influences resemble the categories found in a building code or current teaching curriculum, but in name only: cultural, technological, legal, material, to name a few. Upon further examination, the nature of each has already so fundamentally transformed as to demand speculation far past existing models of architect-consultant relationships or any mere new upskilling for young designers. We need new methods now to participate in speculating on the built environment's future.

A Materiality of Agency//Speculations on the Impact of Biological Computation on Materiality and Space

Nicole Koltick, Drexel University

Architects have traditionally viewed space as a static entity that is defined, shaped, and enhanced through the use of material objects that give form, structure and order to our daily existence. There have been clear boundaries between inside and outside, delineation between distinct building materials, the program and the project. But looking forward, is it possible that human interactions with objects and environments might be drastically re-envisioned, encompassing a more malleable and adaptive view of space and materiality? In this paper, I will explore how potential human interactions with space, objects and information may be transformed in the future through analyzing recent developments in biological computing, synthetic biology and object-oriented philosophy. To start, I propose an expanded definition of agency with respect to materials and objects. How can we begin to formulate conceptions of agency as they relate to objects or new categories such as object-beings1? Recent writings from object oriented philosophers may offer a way forward through a novel reframing of the conventional pattern of interactions between humanity, materials and environments. Object oriented ontology allows for a total reconsideration of the relationships between ourselves, object-beings, and object-object associations. Humans are highly complex "machines" operating within a dense network of dynamic experiences, yet currently our spatial organizations are highly static, rigid and inefficient. The capacity of materials, networks and objects to possess emergent capabilities and behaviors requires our acknowledgement of this agency, and new relationships with space will likely be defined not by static physical boundaries, but rather by a series of negotiations, signals and exchanges. Space may well take on a more active role that transcends utility, function and normative or fashion-driven aesthetics in favor of a shifting, responsive condition rich with varying emotions, perceptions, temporalities and interactions.

In complex systems, extremely sophisticated forms of higher-level order at the global scale can emerge from relatively simple, local interactions among individual agents. This ordering is a phenomenon seen across many systems and scales in biology, from the macroscopic to the cellular level. Engaging in the practice of design at these newly accessible scales might allow for a variety of information and intelligence to be configured into the materials and objects that we interact with. Towards these ends, biologically-inspired mechanisms of scaling, information reception and signaling can help us understand what makes a system resilient, complex and able to evolve. Such a shift towards a non-human centered understanding of systems and their interrelationships will become increasingly important as our environments and materiality expand their agency.

a materiality of agency// speculations on the impact of biological computation on materiality and space

NICOLE KOLTICK

Drexel University

Architects have traditionally viewed space as a static entity that is defined, shaped, and enhanced through the use of material objects that give form, structure and order to our daily existence. There have been clear boundaries between inside and outside, delineation between distinct building materials, the program and the project. But looking forward, is it possible that human interactions with objects and environments might be drastically re-envisioned, encompassing a more malleable and adaptive view of space and materiality? In this paper, I will explore how potential human interactions with space, objects and information may be transformed in the future through analyzing recent developments in biological computing, synthetic biology and object-oriented philosophy. To start, I propose an expanded definition of agency with respect to materials and objects. How can we begin to formulate conceptions of agency as they relate to objects or new categories such as *object-beings*[1]? Recent writings from object oriented philosophers may offer a way forward through a novel reframing of the conventional pattern of interactions between humanity, materials and environments. Object oriented ontology allows for a total reconsideration of the relationships between ourselves, object-beings, and object-object associations. Humans are highly complex "machines" operating within a dense network of dynamic experiences, yet currently our spatial organizations are highly static, rigid and inefficient. The capacity of materials, networks and objects to possess emergent capabilities and behaviors requires our acknowledgement of this agency, and new relationships with space will likely be defined not by static physical boundaries, but rather by a series of negotiations, signals and exchanges. Space may well take on a more active role that transcends utility, function and normative or fashion-driven aesthetics in favor of a shifting, responsive condition rich with varying emotions, perceptions, temporalities and interactions.

In complex systems, extremely sophisticated forms of higher-level order at the global scale can emerge from relatively simple, local interactions among individual agents. This ordering is a phenomenon seen across many systems and scales in biology, from the macroscopic to the cellular level. Engaging in the practice of design at these newly accessible scales might allow for a variety of information and intelligence to be configured into the materials and objects that we interact with. Towards these ends, biologically-inspired mechanisms of scaling, information reception and signaling can help us understand what makes a system resilient, complex and able to evolve. Such a shift towards a non-human centered understanding of systems and their interrelationships will become increasingly important as our environments and materiality expand their agency.

__On Signaling

Signaling is a fundamental mechanism in biology that operates at many different scales, typically at some cost to the individual. Put simply, signaling is any method of actively transmitting information from one entity to another. Signaling occurs in individual molecules and cells, among individual species and between species at the level of an ecosystem. These interactions may be fairly simple but can become highly complex depending on the density of the network and the specifics of the signaling pathways. The signals we may exchange and our relationship with other entities, objects and systems has not been adequately addressed in architectural design, and the signaling potential of new categories of objects including synthetic biological hybrids deserves further analysis.

A series of signals, exchanges and feedbacks operating at multiple scales presents a useful model for how we might re-imagine the ordering and adaptability of space. The emerging discipline of biological computing relies on various pre-existing biological mechanisms to process information, make connections and "learn." While much of this research is still in early phases, it seems imperative to begin speculating about its potential implications for design and architecture. Signaling in biology takes many beautiful and provocative forms, such as the synchronized bioluminescent flashing of fireflies, wherein the aesthetically impressive visual effect is merely a byproduct of an evolutionary-driven informational agenda to find a mate. Similarly, various camouflage strategies, such as that of the cuttlefish or certain species of octopus, demonstrate a variable and highly localized strategy of adaptation that is fluid and situational. These examples suggest novel ways in which we might begin to mediate our interactions with our external environment as well as with each other in a more adaptive and intuitive manner.

One intriguing development from the United Kingdom involves a series of slime mold robots. Scientists have used the slime mold *Physarum polycephalum* to create the first fully biological robot, a substance with an embedded intelligence. Professor Andy Adamatzky explains that, "the robots will have parallel inputs and outputs, a network of sensors and the number crunching power of super computers. The plasmobot will be controlled by spatial gradients of light, electro-magnetic fields and the characteristic of the substrate on which it is placed."[2] These biological robots are capable of processing and transmitting information, and therefore this biological substance can be manipulated to perform computational tasks depending on varying gradients of light and substrate. It can be difficult to assess the processes by which biological entities perform computation as they are somewhat different than digital computing. While in digital computers information is of a single bit, unchanged unless programmed and centralized, in biological computing the information is "often analog in nature and of different types (e.g., reflected in real-valued rates of interaction or concentrations of different substances), continually changing, decentralized (distributed over large areas and over large numbers of system components)…"[3]

The flexibility and built-in redundancy of distributed information processing systems breeds resilience. With a wide variety of connections and paths of information transfer, these systems are able to handle disruptions and anomalous occurrences. "In biology, information processing is massively parallel, stochastic, inexact, and on-going, with no clean notion of a mapping between "inputs" and "outputs."[4] The notion of a biological system with embedded intelligence is quite appealing, and it is easy to imagine systems functioning with similar principles embedded seamlessly into our materials, objects and environments. The ability of such systems and entities to adapt to shifting terrains, conditions and information in an evolutionary way would radically alter the way we conceive of materiality and the static nature of spatial definition.

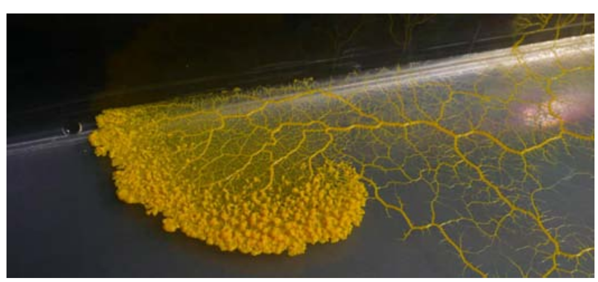


Figure 1: Slime Mold

_The Biological Hybrid

Future synthetic biological hybrids will operate at a very fine resolution, and our ability (or lack thereof) to control the composition, growth and evolution of material formations will necessitate a reorganization of the relationships between these material entities, information and ourselves. In reassessing our relationship with space, nature, objects, and our "dominance" over them, we can open up a more symbiotic relationship with space that envelops us. The artistic and ethical dimensions of these new relationships are explored in the *Tissue Culture and Art Project*, led by Oron Catts and Ionat Zurr. “The project focuses mostly on investigating human relationships with the different gradients of life through the construction/growth of a new class of object/being – that of the ‘semi-living’… Evocative objects, they are a tangible example that brings into question deep-rooted perceptions of life and identity, the concept of self, and the position of the human in regard to other living beings in the environment.”[5] What might this relationship to the “semi-living” entail? As synthetic biologies, biological hybrids and artificial intelligence systems become more prevalent it is more than likely that they will begin to evolve behaviors that we can not entirely imagine or envision. With this near inevitability approaching, it seems useful to contemplate how we might relate to, communicate, interact and exist with these new forms.

Rachel Armstrong examines the impact that these future emergent systems and categories of materials may have. “New emergent relationships and identities will exist at this intimate level that will rival the alleged uniqueness of animate matter and challenge our definitions of life.”[6] The definition of life referred to here is one tied to questions of agency, intentionality and imperative. What rights do these new categories of materiality hold? What is able to be controlled in these systems? The architects’ role in specifying materials and systems to accommodate human activity is no longer a straightforward task. The nature of self-organization, emergence and agency necessitate a rethinking of traditional ideas on control and “design” processes[7]. This will require a thorough re-examination of our relationship to these unseen objects, systems and desires.

The post-continental philosophy of Object Oriented Ontology and the related speculative realist movement provide an interesting framework to consider some of these new relationships. The speculative realists and Object Oriented Ontologists object to a correlationist view of philosophy that is primarily originating from the interplay between humans and the world. Object oriented ontologists assert that objects are not defined or exhausted by their relationships to other objects or humans. Graham Harman defines his position with two clear principles: “1. Individual entities of various different scales (not just tiny quarks and electrons) are the ultimate stuff of the cosmos. 2. These entities are never exhausted by any of their relations or even by their sum of all possible relations. Objects withdraw from relation”.[8] The object oriented classification of events expands traditional classifications of “objects”. Systems, stories, particles, animals, inert materials, organizations are all considered objects. This movement away from a human centered world view acknowledges a multitude of realities that exist simultaneously at all scales for all objects. It is important “…to underline the point that humans are beings among the swarm of differences and hold no special or privileged place with respect to these differences.”[9] Only by reexamining the status and consideration given to humans as a default can we recalibrate our relationships to systems, materials and environments.

--On permeability

When reconsidering our relationships to objects in the broadest sense it is helpful to consider barriers, membranes and connectivity. The interconnectedness of our inhabitations is not always readily apparent. The presence of walls, doors, opacity, transparency, thickness and the presence of visual and physical barriers in architecture help define the various functions of a space and how humans operate within. These distinctions and “zones” create a superficial construction of enclosure and exclusion. The reality is that there are a variety of phenomena, events and activities which permeate these physical constructions. Those living in close proximity to large scale factory farming operations have to contend with an enormous amount of olfactory intrusion and pollution. This is a wafting and seeping entity that windows and doors are unable to stop. The complexity of scent molecules and their subtle diffusion throughout the air is an example of a small scale interaction that permeates. Each specific scent is comprised of distinct molecules that are mixing with other molecules and then interacting with human receptors[10]. The complexity of scent alone is staggering. The way that our brain processes these sensory inputs and the fleeting and ephemeral condition of any one scent at any given time is informative. This flowing and constantly shifting organization of molecules and their interaction with other systems, materials and objects deserves attention.

Radiation and chemical pollutants are other examples of small scale particles that are able to penetrate our physical barriers. These examples are composed of things which cannot be necessarily seen but are felt, sensed or experienced in different ways. The effects on us both psychologically and physiologically are becoming increasingly legible and these effects happen at a very small level of disruption whether it is through cognitive signaling and disruptions or through cellular changes. Timothy Morton, another object oriented philosopher, has defined the term ”hyper-objects” to denote these larger or smaller events that are operating on a level that we are unable to directly observe or understand in a typical manner. Examples of hyper-objects include radioactive disasters and global warming. “As well as being about mind-bending timescales and spatial scales, hyper-objects do something still more disturbing to our conceptual frames of reference. Hyper-objects undermine normative ideas of what an “object” is in the first place. Let's consider the fact that hyper-objects disturb our habitual ideas of time and space by stretching them and by distributing effects across them.”[11] An awareness of the effects of these microscopic factors on our physical and mental experiences could be mitigated, informed or modified in certain ways through the use of small scale biological interventions both within us and around us. Other toxins in our environment waft through our spaces as well. Pesticides, chemicals and irritants such as mold spores and pollen are continually crossing our domestic and environmental thresholds. We make visible delineations in analog materials yet these constructions are permeable and fallible in a variety of ways. An architecture of permeability that contends with small scale matter and information could be much more robust moving forward as we contend with a volatile climate and a series of rapidly evolving social and cultural interactions.

Figure 2: Various protective gear at Chernobyl: Unknown Fields Division Research Group

Radioactive material is quite unsettling in that you cannot sense the presence of danger but it is nonetheless acting upon you. This summer I travelled to sites in Ukraine including the towns of Chernobyl and Pripyat and I was able to experience firsthand this strange landscape. I ate in the Chernobyl canteen and slept at the Chernobyl guest house. While everything appeared quite lush and verdant, the landscape is quite toxic. Levels of radioactivity ranged from slightly elevated to highly alarming. In discussing radioactivity there are two main categories of particles. The first category includes alpha and beta radiation. These radioactive particles are “sticky”. They are large enough to adhere to skin or mucous membranes and may be ingested or inhaled. However, these particles are not small enough to permeate skin or physical objects. The second type of radiation is from Gamma rays. “Gamma rays are high frequency photons. They pass easily through most materials including flesh. Gamma rays strip away electrons from atoms, disrupting cellular chemistry”[12]. Gamma rays can pass through people, buildings and other objects. So while our suits and masks protected us from alpha and beta particles, there is no adequate protection against high levels of gamma radiation. The time scale of these radioactive particles’ decay can stretch into tens of thousands of years. On a small scale, at the cellular level, as well as at a much larger scale, both geographically and temporally, the effects of this radiation can be seen. If we were to analyze larger networks and systems of migration and animal populations in the Exclusion Zone, there has been a re-organization ecologically in both flora and fauna. Some species have flourished due to the lack of natural predators. Wild boars are prevalent in the zone. Other species such as birds and insects have decreased in number[13]. Current human attempts to mitigate the damage in Chernobyl seem wholly inadequate. We were permitted to visit the Chernobyl Sarcophagus for only a few minutes, due to extremely high radiation readings. The sarcophagus is a concrete tomb that covers the destroyed nuclear reactor from the accident. This aging structure is rapidly deteriorating and a new enclosure is being built to replace it. After the explosion the first line of defense involved helicopters that dropped sand and then graphite into the exploded and burning area of the reactor. The nuclear fuel along with the graphite and sand formed a molten liquid and hardened into a hauntingly beautiful object called ‘The Elephants Foot’ inside the reactor. These materials did little to help extinguish the blaze and the concrete covering the reactor only provides minimal protection from the high levels of gamma radiation inside. The inadequacy of these inert materials to contend with something operating with this particular set of behaviors reveals the limits of our efforts to order and control space and experience through materiality. Radioactivity operates on a time scale and a spatial scale that differ by orders of magnitude from those of our sensory experience. Our ability to control, contain or remediate these effects is simply not adequate with existing technologies and protocols. Situations such as this may prove to be the ideal testing grounds for response strategies that incorporate biologically inspired mechanisms to contend with such widely divergent spatiotemporal scales.

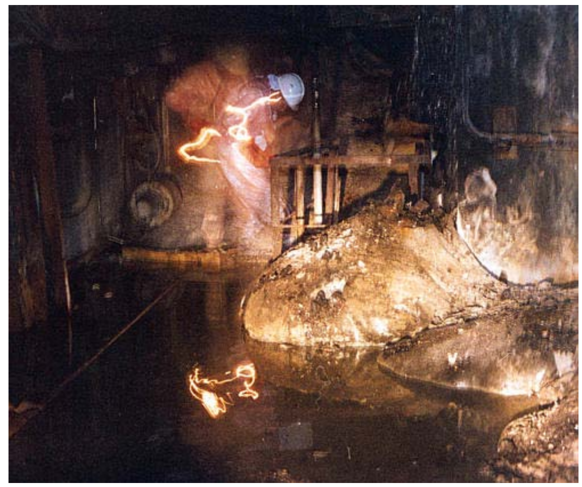


Figure 3:The Elephant’s Foot inside the Sarcophagus at Chernobyl Reactor 4

Biological computation and synthetic biological hybrids should incorporate evolutionary mechanisms if they are to be robust and adaptable. A truly “intelligent” permeable membrane operating with biological principles would require a material or biological agency on the part of the filtering system. As designers we have to consider how we may tweak or nudge some of these biological mechanisms. The potential for objects, networks and systems to digitally evolve will be possible through advances in our ability to model increasingly complex systems and interactions. In this way we could “speed” up the process of evolution and utilize optimal solutions that are determined digitally in a much shorter time span than biological evolution operates. Such a process would require the ability to hypothesize approximate parameters while preserving the agency of the materials and hybrids. Levi Bryant references Daniel Dennett’s concept of ‘design-spaces’ in relation to Darwin’s evolutionary theory:

> A design space can thus be thought as a sort of topological space of relations among objects that play a role in qualities an object comes to actualize. I speak of a topological space as opposed to a geometric space, for topology allows us to think relations as undergoing continuous variations, whereas geometric relations are fixed. Thus, as a topological space, a design space admits of many variable solutions to the problem posed by the design space, while nonetheless possessing constraints. A point of crucial importance, in this connection, is that design spaces change with changes in relations among objects and in objects. In short, design spaces are not fixed and immutable.[14]

Developing a set of parameters that loosely defines a possible range could offer a useful framework for how we might re-envision our role in organizing these new types of materials, systems and networks. Designers could begin to assemble conceptual topological 'design-spaces'. Such spaces would not have a fixed form but would instead allow for continuous variation and evolution rather than a predetermined outcome.

__On Filtering

An increasing awareness of the permeability of our relationships to spaces, environments, data and objects calls for a focus on filtering strategies. As humans navigating a hostile environment we are highly vulnerable to a wide variety of assaults. The concept of shelter as delineation between us and them, or us and "the outside," is a fragile and precarious one. Our current method of building is predicated on a static condition, one that gets periodic but very infrequent upgrades. Yet in a more volatile and complex society of both organic and inorganic entities in possession of varying degrees of agency, this idea of shelter will need to be radically reconfigured. In visualizing how we might begin to order these relationships and networks of interacting components the use of Venn diagrams could be quite operational. By grouping all sorts of objects into sets, this permeable condition would accommodate varying states of inclusion and exclusion. Objects can be categorized into (of), (and), (or) and (not). Reframing our interactions with other objects as a series of negotiations which are mediated through a distributed system of decision making, we might then be able to operate on a much smaller and finer-grained scale. I am using the term objects here in the broadest sense to include humans, information, spatial constructs, sets of objects, narratives, data, emotional states and other phenomena. Such a system would serve to redefine the boundaries between human activities as a more nuanced set of gates, membranes which can be made physical, visible as well as virtual or ineffable. These varying filters could operate as gatekeepers for both physical intrusions (pollutants, weather, etc.) and more intangible entrants including communications and information. In this way space, as we define it, becomes highly personal yet able to be highly communal, highly malleable and able to adapt to a variety of situations, socially, environmentally and spatially.

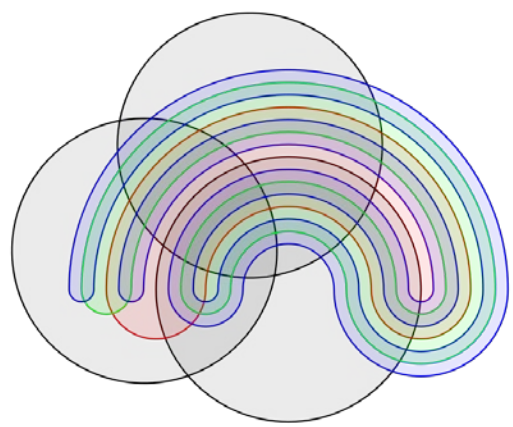


Figure 4: Venn Diagram with 6 Sets

To realize these sorts of organizations, biological and material computation will be necessary. The ability to control to a fine level of detail material formations and data transmission could radically transform how we inhabit the environment and how we interact within it. Massive sets of information and/or objects and materials may combine their efforts to coordinate larger scale endeavors. Just as at present we can lend our computers to large scale distributed computing efforts when we are not using them, a similar idea for our "space" can be imagined, one in which space and material is lent, reconfigured with others' spaces and objects to achieve larger tasks. Biological computing implies a scalability of systems operating within systems. The nature of these systems could comprise: natural/ cultural/ political/ geological/ astronomical. This would require a radical re-conceptualization of our place within these systems and our ability to interact through and within this arena. This is a conception of space that operates as a mediator between you and others, which embodies and regulates small scale, highly nuanced interactions. In this new, more permeable and malleable definition and construction of space one would be able to modulate connectivity and relationships in a much more nuanced way.

__On Re-Materiality

What does re-materialization mean? What does it mean to our field? Materiality needs to be radically re-conceptualized if we are to fully optimize the potential of biological computing into the fabric of our everyday lives. Currently there is a clear distinction between us, our environments and our technology. The idea of a rapidly dematerializing society could be seen as a threat to destabilize that which architecture has traditionally been author over. But just as a reactionary aversion to such developments would be futile, the malleability of material and space should not be seen merely as a pleasure machine or a device to delight. The idea to make legible additional layers of our experience in a tactile and experiential way is one possible benefit. The ability to understand more readily multiple time and material scales, and the interactions between us and our environment is another. It is possible to imagine new materials, new interactions between humans and objects and humans and data. Data could be made spatial and space could be made ephemeral.

With the ability to transform biological materials, it is possible to speculate on the types of experiences we may have with biological and non-biological computational materials. A recent development by Japan's RIKEN, involves the use of a new aqueous reagent that turns tissue transparent. This reagent has been used in mice embryos and it offers a provocative and aesthetically compelling vision of one way in which our understanding of materials and their inherent qualities and effects could be radically altered. The transparent mouse tissue still functions in a biologically similar way and the cellular signaling and performance is not affected[15].

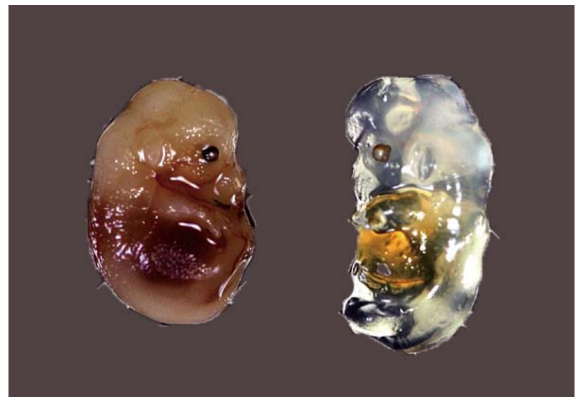


Figure 5: Two mouse embryos, one (right) incubated in Sca*l*eA2 solution.

Another intriguing development concerning materiality involves the creation of an inorganic cell. Professor Leroy Cronin has been working on developing a cell from non-organic materials. "This research is part of Cronin's larger project to show that inorganic compounds are able to self-replicate and evolve like biological cells do. The ultimate goal is to give these inorganic cells life-like properties so they can evolve and eventually be used in materials science."[16]. The inorganic cell has the ability of selective permeability in a limited capacity[17]. The implications of the effect this discovery may have on our future ability to specify, manipulate and control materials is quite intriguing. It is conceivable that in the near future we will have much greater control over both the particular makeup and inherent properties of a material as well as its embedded intelligence. We will have the ability to modify existing biological systems as well as program and create matter from inert material. Of course, the promise of programmable matter opens up many questions in regard to who is programming this matter and to what ends.

This paper has speculated on utilizing new insights into computation occurring in natural organisms in order to project how these might inform the ways we consider our relationship to materials, objects and environments. The next decade promises to provide an ever expanding list of new developments in science, technology and specifically biological computation. These developments have the potential to influence and dramatically redefine the very nature of our profession. The most promising developments in material and biological computation involve the ability for these systems to learn and evolve. However, if we are to utilize biological strategies of adaptation and evolution it will be necessary to accept entities and systems that are loosely controlled and more entropic. Our management and oversight of these systems will be far less prescriptive. Through enacting a series of ecologies, systems and networks that produce their own order and anomalies we may, however, begin to uncover crucial new insights into the nature of material agency. These developments in science and technology offer provocative new means to experience and mediate materials and objects while also raising serious philosophical questions in terms of sentience, agency and control. With these developments, our future holds a radically redefined relationship with material, space and intelligence systems.

Notes

1. Marcos Cruz, Synthetic Neoplasms. *AD Neoplasmatic Design*, 2008: 37.
2. Biological Computing: Robots Made of Mold, PSFK, accessed September 19, 2011, http://www.psfk.com/2009/09/biological-computing-robots-made-of-mold.html
3. Melanie Mitchell, “Ubiquity symposium: Biological Computation”, *Ubiquity* Volume 2011, Issue February, accessed September 19, 2011, doi:10.1145/1940721.1944826
4. Mitchell, “Ubiquity symposium: Biological Computation”.
5. Oron Catts and Ionat Zurr, Growing Semi-living Structures, Concepts and Practices for the Use of Tissue Technologies for Non-Medical Purposes, AD, *Neoplasmatic Design*, 2008: 32-3.
6. Rachel Armstrong, Artificial Evolution, a Hands-off Approach for Architects, *AD Neoplasmatic Design*, 2008: 84.
7. Steve Pike, Manipulation and control of Micro-Organic Matter in Architecture, *AD Neoplasmatic Design*, 2008: 22.
8. Graham Harman, “Brief SR/OOO Tutorial”, accessed November 24, 2011, http://doctorzamalek2.wordpress.com/2010/07/23/brief-srooo-tutorial/
9. Levi R. Bryant. “The Ontic Principle: Outline of an Object-Oriented Ontology”, *In The Speculative Turn: Continental Materialism and Realism*, ed. Levi Bryant, Nick Srnicek and Graham Harman, (re:Press, Melbourne, Australia, 2011), 267.
10. Leslie Vosshall, “World Science Festival: How Scent Works” by Maria Popova, accessed September 19, 2011, http://www.brainpickings.org/index.php/2011/09/07/scents-and-sensibilities-world-science-festival-how-smell-works/
11. Timothy Morton “Hyperobjects and the End of Common Sense”, accessed September 19, 2011, http://contemporarycondition.blogspot.com/2010/03/hyperobjects-and-end-of-common-sense.html
12. Steve Featherstone, “Life in the Zone”, *Harper’s*, June 2011: 47.
13. Featherstone,”Life in the Zone”, 44-48.
14. Bryant, “The Ontic Principle”, 272.
15. RIKEN press release: “New Chemical Agent Turns Mouse Brain Transparent”, accessed September 19,2011, http://www.riken.go.jp/engn/rworld/info/release/press/2011/110830_3/index.html
16. “Scottish Scientists are Trying to Create Inorganic Life” by Julie Beck, accessed September 19,2011, http://www.popsci.com/science/article/2011-09/scientists-aim-create-inorganic-life?utm_medium=referral&utm_source=pulsenews
17. Geoffrey J. T. Cooper, Philip J. Kitson, Ross Winter, Michele Zagnoni, De-Liang Long, and Leroy Cronin*,” Modular Redox-Active Inorganic Chemical Cells: iCHELLs**”,

Angewandte Chemie, Volume 123, Issue 44, accessed November 24, 2011, DOI : 10.1002/anie.201105068

Figures:

1. Image Credit: http://www.psfk.com/2009/09/biological-computing-robots-made-of-mold.html
2. Image Credit: author
3. Image Credit: http://www.jonmwang.com/blog/2011/04/13/the-battle-of-chernobyl-documentary/
4. Courtesy of: Wikipedia
5. Image Credit: http://www.riken.go.jp/engn/rworld/info/release/press/2011/110830_3/index.html

N. Koltick. *Entropic Ecologies*, VOLUME, Vol.31, no. 1, p.150-1, 2012.
Edited by: Arjen Oosterman
Contributing editors: Ole Bouman, Rem Koolhaas, Mark Wigley
Co-editors for this issue: Liam Young and Kate Davies, Feature editor: Jeffrey Inaba
ISBN:9 789 077 966 310

ENTROPIC ECOLOGIES: A PROSTHETIC APPROACH

Nicole Koltick

In vastly polluted areas, where species, due to exposure, have lost vital functions and abilities, how do we stop what would seem to be a slow downward spiral into obsolescence? Nicole Koltick explores the world of prosthetics and physical intervention in helping restore balance to violently imbalanced ecosystems. Can we 'pimp' our flora and fauna to save them from their own deficiencies?

A highly entropic ecology embodies a vast amount of potential. Might it be possible to seed an entropic ecology through the deployment of prosthetics in a variety of small-scale interventions? These seeds would yield diverse, unpredictable outcomes and provide additional opportunities for feedback, adaptation, and evolution within the system. The concept of entropy originates from the field of thermodynamics where it describes a measure of disorder or randomness in a given system. Entropy is related to the transfer and dissipation of energy in a system, and a corresponding increase in disorder. In closed systems it is a useful measure for evaluating a given set of exchanges. In an ecological context, when evaluating a complex system with many constituents operating at a broad array of spatial and temporal scales, the term entropy may be applied analogously.[1] The interplay between order and chaos is evident in cells and organisms as well as the systems they inhabit. This disorder is not chaos as portrayed in an apocalyptic vignette but rather is an indicator of the myriad potentialities in a given system. In closed systems order tends to reduce complexity. For example, the geometric configuration of a crystal embodies a set order and has no potential to embody another state without an application of an external force; therefore entropy and complexity decrease with the establishment of order in its spatial structure. However, in a living system with a variety of nonlinear feedbacks among interacting entities there exists both, "order and complexity or... actual and potential information."[2] Therefore an entropic ecology exhibits a higher tendency towards a number of potential outcomes rather than a fixed order. Too much order and a given ecology rapidly becomes a hegemonic monoculture with little ability for evolution or adaptation. Counter-intuitively, the entropic ecology should be our goal.

The prosthetic as a typology has traditionally not afforded an exact replacement of original function. Instead, the prosthetic impulse involves an honest appraisal of the present and a gesture of remediation, rather than replacement in whole. A prosthetic approach to ecologies, then, would require the admission that there is no ideal state to which we can return. Rather, we might explore a series of upgrades, nudges or tweaks to these systems. The prosthetic approach allows for a variety of small-scale efforts that through their radiating and unexpected consequences can yield varied, resilient remediation. The small-scale and highly divergent nature of prosthetic intervention dispels overly hierarchical or top-down approaches. The prosthetic seeks to assist, not insist. It does not dictate *a priori* outcomes or dogmatic usages, but offers a given organism or system some addition that can be incorporated into a larger network of operations and facilitate adaptation within a specific context or environment. There exists no large solution that will quickly or even slowly ameliorate these ecologies. The prosthetic is interested in localized, targeted assists that when incorporated into larger systems will increase diversity and potentials, and in turn provide opportunities for novel and adaptive solutions to evolve. The answer is not to do nothing, sit back and wait it out. Optimally, we need an increased sensitivity to the complexity and self-organizing principles at work in these systems. By encouraging diversity at all levels we may perhaps nudge these systems towards more resilient outcomes. In fact, it may be possible to 'seed' an ecology with a variety of species which can speed up the selection process. If a given ecology is 'seeded' beyond a certain threshold of diversity then the system may be able to optimize through evolutionary mechanisms the ideal combinations of processes and organisms to maximize performance.[3]

The prosthetic approach acknowledges that a given system or ecology embodies the potential for self-organization and that we may be able to encourage these tendencies with a series of ecological augmentations. There is no magic gift or solution to be proffered here; ecological prosthetics entail a series of finely tuned and localized micro-interventions, such as the introduction of a variety of bacteria, flora, or fauna along with social, behavioral, and technological tweaks. The prosthetic need not be confined to the realms of the natural or the biological. Although technology enacted on a large scale has contributed to many ecological problems, it is not the guilty party. Our deployment of technological solutions in unconsidered, shortsighted, and unskillful ways has been problematic. Ecological prosthetics should deploy all manner of interventions. Developments in genetic engineering and nano-materials suggest a multitude of future possibilities for prosthetic deployment in biological and synthetic realms. The prosthetic is localized. It does not attempt to fix every problem; instead it locates opportunities for augmentation and intervenes. It does not seek to overcompensate through guilt nor over-augment through a misguided sense of design. It recognizes the underlying mechanisms present in complex systems and works in targeted and precise ways. This is not to suggest that these interventions have a decided outcome. Indeed, by encouraging a varied and multivalent approach without an explicit top-down agenda the system itself is able to evolve and 'decide'. The prosthetic approach acknowledges that there is not one perfect prosthetic, but that there are in fact infinite combinations of elements that can produce resilient and diverse outcomes. The prosthetic approach is democratic and it is enhanced by heterogeneity in approach, opinion, deployment, and viewpoint.

It seems productive moving forward to expand the nature of what may be considered a prosthetic to a landscape, ecology, or system. Existing ecological prosthetics have taken the form of more typical landscape architecture or civil engineering projects involving wetland reconstruction[4] or targeted and strategic plantings. I am arguing for a more varied approach that takes into account specificities of spatio-temporal scale, and the complex interactions between individual agents. There are several categories which could offer rich opportunities for prosthetic augmentations: the behavioral, the micro-ecological, the technological, the social, and the aesthetic.

Behavioral prosthetics may apply to both human and non-human behaviors. In his book, *The Ecological Thought,* Timothy Morton offers a compelling new philosophical framework to evaluate our current attitudes toward ecology and natural systems. Some interventions he proposes include teaching drowning polar bears to use flotation devices, or feeding penguins until the seas contain enough fish.[5] While these suggestions are offered in a somewhat off-handed way, the underlying sentiment is that of a non-anthropocentric point of view that considers the desires and needs of non-human entities. In researching the permeating effects of radiologic fallout in the Chernobyl Exclusion Zone after my visit there, I came across a study indicating that male birds displaying bright orange colors are much less colorful and plentiful due to a lack of the available antioxidant GSH used in pheomelanin production which provides their color. These antioxidant molecules had been exhausted from the birds' continual long-term exposure to radioactive decay. Thus the birds did not have extra available antioxidants to allocate for pigment production of colored feathers.[6] These birds use their colorful feather displays in attracting female birds for mating, a prime example of sexual selection, an important mechanism of evolution found in many bird species. While mitigating the radiologic damage is a lofty goal, the prosthetic seeks a more modest solution. The mating behavior seems to be crucial to the birds' aesthetic and cultural behavior. In proposing a behavioral prosthetic I looked to other avian strategies in sexual selection behaviors. Bowerbirds, most prevalent in New Guinea, utilize a strategy to attract mates that does not involve their own color or personal characteristics. Instead these birds create bowers to impress females, highly specific and ordered creations incorporating both natural materials and man-made artifacts. A behavioral prosthetic might seek to teach the birds of Chernobyl a similar behavioral strategy. Whether through videos, demonstrations by robotic birds, or perhaps even genetic means, might it be possible to inject a new behavior into a species as a way to ameliorate a physiological deficiency?

This seeding process can take many disparate and novel forms. The use of bioengineered interventions and unconventional combinations of existing flora and fauna are possibilities. Also there seems to be potential for novel investigations of existing fields of study examined in new contexts. A given ecosystem can be viewed as a full scale real world lab in which various theories can be tested. The Chernobyl Exclusion Zone offers the potential to enact multiple ecological prosthetics on a large scale. This landscape could transition to an ecological incubation zone for the deployment of a wide variety of experiments in seeding a landscape with prosthetics. Can our interventionist approach be recombined and explored in more novel ways? The production of multiple narrative threads positing novel recombinations of interactions and behaviors is another way to approach the ecologically distressed. Perhaps these guilty landscapes may allow us the freedom to enact on their tarnished terrains a series of small prosthetic offerings.

1 Yuri M. Svirezhev, 'Thermodynamics and ecology' *Ecological Modeling* Volume 132, Issues 1–2, July 2000, pg.13.
2 Mathias Binswanger, 'From microscopic to macroscopic theories: entropic aspects of ecological and economic processes' *Ecological Economics* Volume 8, Issue 3, December 1993, 220-1.
3 William J. Mitsch and Sven E. Jørgensen, 'Ecological engineering: A field whose time has come' *Ecological Engineering*, Volume 20, Issue 5, October 2003, 363-377. At: http://www.sciencedirect.com/science/article/pii/S0925857403000600 (accessed February 12,2012).
4 David M. Blersch, 'Conceptual Basis for Ecological Prosthetics as a Subclass of Technoecosystem Engineering', presented at the Annual American Ecological Engineering Society Meeting, 2004. At: http://www.powershow.com/view/855Y2VhZ/Conceptual_Basis_for_Ecological_Prosthetics_flash_ppt_presentation#, (accessed February 12, 2011).
5 Timothy Morton, *The Ecological Thought* (Cambridge, Massachusetts: Harvard University Press, 2010), 128.
6 Lucas Laursen, 'When being Colorful Doesn't Pay' published May 4, 2011 At: www.nature.com, (accessed, 25 Feb 2012).