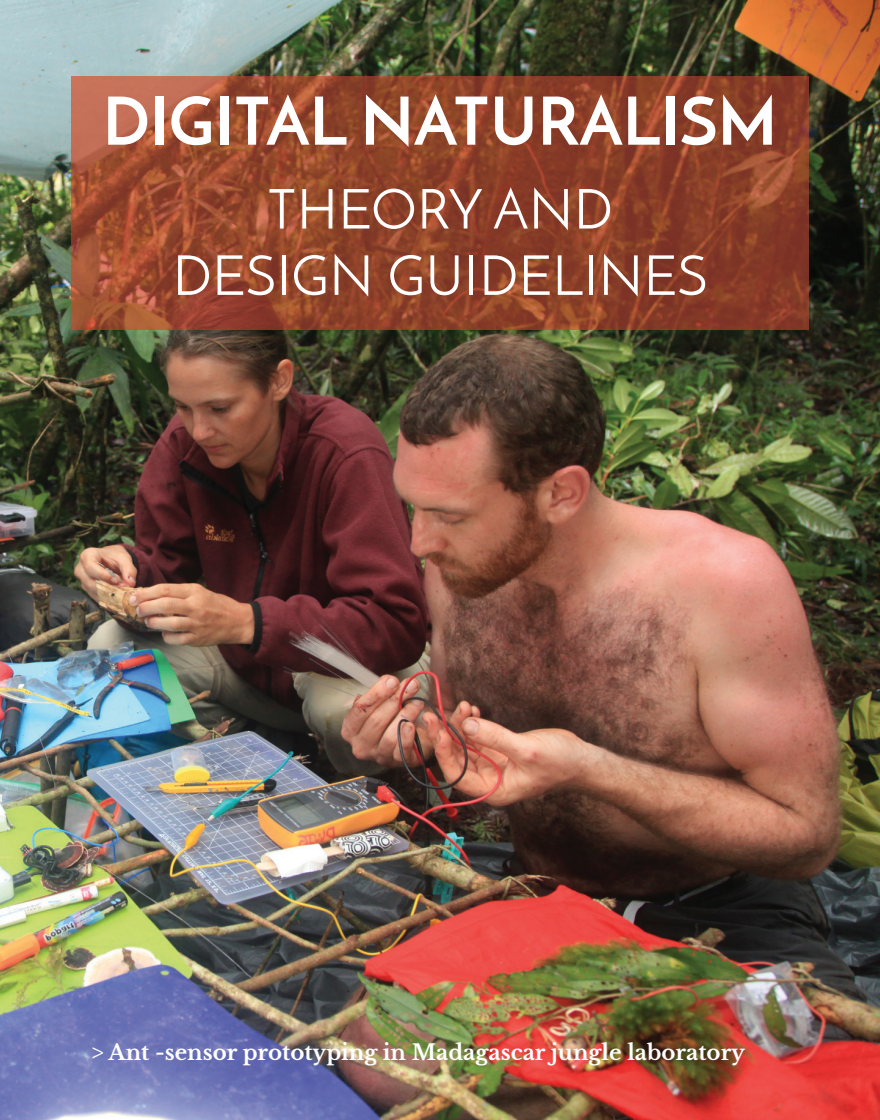
DIGITAL NATURALISM

THEORY AND DESIGN GUIDELINES



> Ant -sensor prototyping in Madagascar jungle laboratory

> Scientists, engineers, + artists building and living together in an outdoor studio. (Citico Creek Wilderness, USA)

DIGITAL NATURALISM

Digital Naturalism investigates the role that ***digital media*** can play for ***biological field work***.

It looks to uphold the naturalistic values of wilderness exploration, while investigating the new abilities offered by digital technology. Collaborations are growing between biologists, designers, engineers, and artists. This work provides a framework to facilitate all these participants in building and analyzing their own devices for exploring and sharing nature.

This booklet aims to quickly share many of the ideas that have developed over the past several years of this research. While the dissertation and other academic publications are freely available online (digitalnaturalism.org), this book provides a distilled, accessible entry point into this work.

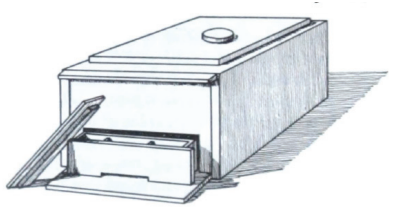
Both scientists and digital designers may benefit from the theory and its resulting design guidelines presented with illustrated examples. Hopefully more will be inspired to push digital media out of the lab and into the wild.

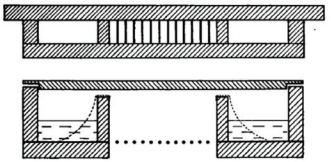
-Andrew Quitmeyer, PhD (November 2015)

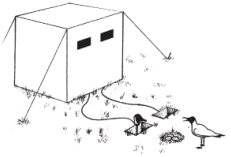
NATURALIST VALUES

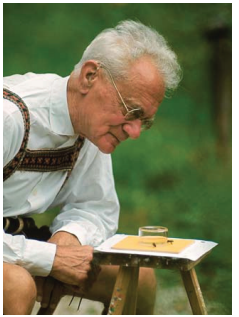
Ethologists (also referred to as Naturalists) study animal behaviors in natural environments. Working in the uncontrolled wilderness presents these scientists with unique challenges beyond traditional laboratory research. To fit the needs of their work, ethologists treasure a collection of qualities relating to their tools and practices.

First, ethologists have a rich history of developing their own techniques, practices, and tools customized for interacting with their specific research animals. Field biologists also support experiential assays of inquiry-based observation and open-ended interactions with their creatures over pure experimentation. In order to deal with the infinite complexity of working in the wild, naturalists tend to value insights from intuitive analysis. Tools and techniques that build tacit understandings of their work can strengthen such deductions.



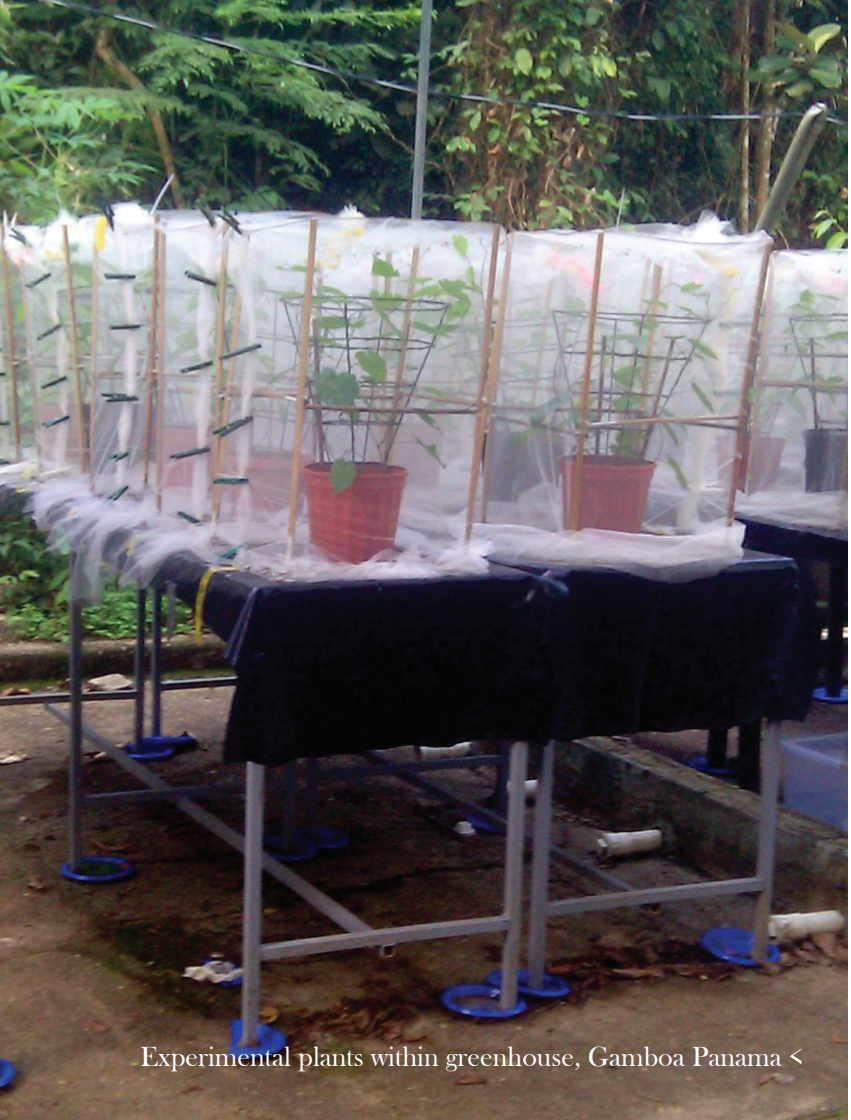






Custom crafted science tools developed and documented by foundational ethologists, Tinbergen and Frisch.

Contemporary naturalists continuing tradition of bespoke tool crafting (Klein's Robofrogs and Warkentin's Tadpole vibrators).



Experimental plants within greenhouse, Gamboa Panama <

In the naturalist's collection ...[plants are] reassembled, reunited, redistributed according to entirely new principles that depend on the researcher, on the discipline of botany,... and on the institution that shelters them, but they no longer grow as they did in the great forest.

The botanist learns new things, and she is transformed ... but the plants are transformed also. Knowledge derives from such movements, not from simple contemplation of the forest.

-Bruno Latour,
Pandora's Hope

"Computing has been constituted as a kind of imperialism; it aims to reinvent virtually every other site of practice in its own image."

-Phil Agre,
Critical Technical Practice

> Traditional ways of interacting with computers can bulldoze ethological traditions and force naturalists into the lab. (Images of computers and digital behavioral event recorders: Lehner's "Handbook of Ethological Methods")

COMPUTER INFLUENCES

The advent of new computer technology opens new possibilities for ethology, but they also risk erasing the values important to field biologists.

A blunt technological focus can begin to take over a scientific project and force the scientists to design their research around the tools rather than their original questions. Digital technology poses particularly high risk of domineering research due to both the new abilities it affords along with its traditionally stringent physical needs to operate.

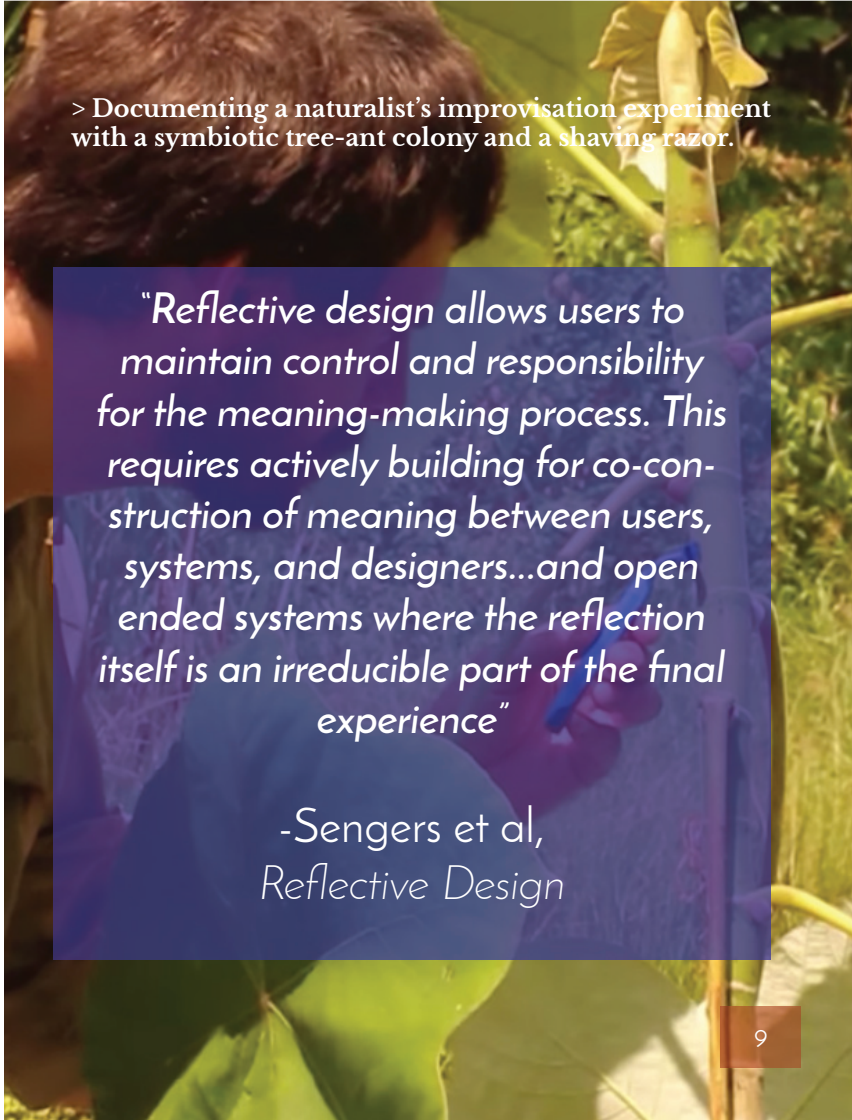
In order for computers to truly engage with the world, they will have to leave the safety of the womb-like laboratories in which they were conceived and confront the messy challenges outside. It is here, in nature's endless complication and discovery, that computers' design can work to fulfill the needs of the full planet.

QUALITATIVE ACTION RESEARCH

Computers may hold new powers for understanding the natural world, but ethologists' motivations should not be altered to fit the needs of the digital. Instead, computational tools should support the values developed in their field.

To maintain focus on the scientists' principles, this research uses participatory design approaches combined with hands-on, iterative practices (like Ratto's Critical Making and Sengers's Reflective design). It uses physical prototyping as an additional way to discover the needs of the users. We lived and worked with biologists, conducting workshops, performances, interactive art projects, and research documentation to discover aspects of digital design important to them.

Working with the participants to engage with the materials and actions constituting both the ecosystems and technologies can help avoid erroneous design assumptions to make more useful tools.



> **Documenting a naturalist's improvisation experiment with a symbiotic tree-ant colony and a shaving razor.**

"Reflective design allows users to maintain control and responsibility for the meaning-making process. This requires actively building for co-construction of meaning between users, systems, and designers...and open ended systems where the reflection itself is an irreducible part of the final experience"

-Sengers et al,
Reflective Design

Digital Naturalism's Design Framework

Technological Agency

Contextual Crafting

Behavioral Immersion

Open-endedness

GUIDELINES FOR DESIGN

The design framework is the main contribution of this work. It is a set of digital media design principles developed over years of shadowing the work of field biologists which aims to support their naturalistic values.

At its most basic, these guidelines urge designers and scientists to:

- make tools understandable and manipulable,
- build these tools within nature,
- viscerally engage human and non-human participants,
- and design improvisational tools that raise questions.

The first two concepts of agency and context guide ***how to make the tools***, and the second two concerning immersion and discovery describe the key ***functions of the instruments***.

> Soldering an “Ant-Mech” bristle-bot style robot deep in the rainforest for engaging with local insects. (Panama)

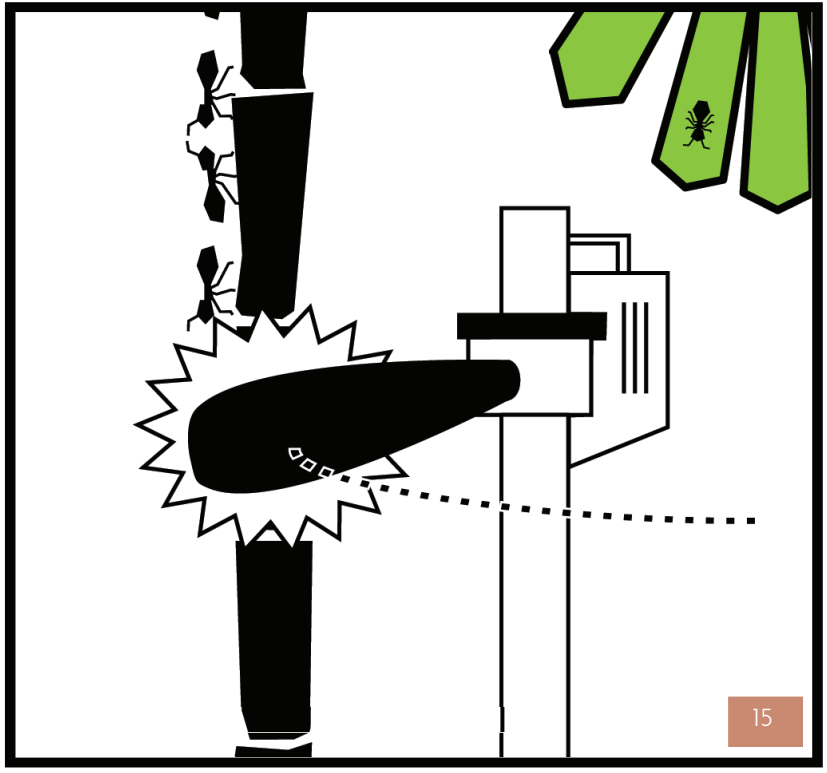
Technological Agency

Designing for **Technological Agency** means to create tools that are open, understandable, and manipulable.Giving naturalists agency over their instruments is essential to the integrity of their work. It ensures scientists' experiments are driven by their research questions and helps eliminate erroneus assumptions involved with their tech. This is especially important in digital tools, where functionality can be locked-away in machine code.

The ideal digital naturalist is a fully independent explorer of both biological and technological worlds. In collaborations, though, some techniques can help all parties have agency over their tools. Aim for simple, moldular tools that let one manipulate the code without reprogramming. Always encourage documentation and sharing of designs.

Techniques Technological Agency	
	Making Tools Oneself
	Simple, Modular tools
	Creating Manipulable Tools
	Encourage Design Documentation

> **Ant researcher, Marting, iteratively develops and programs his own digital tools for testing ant aggression.**



> Developing interactive toys (like a leech disco dance-floor) for exploring actions of local lifeforms (Madagascar)

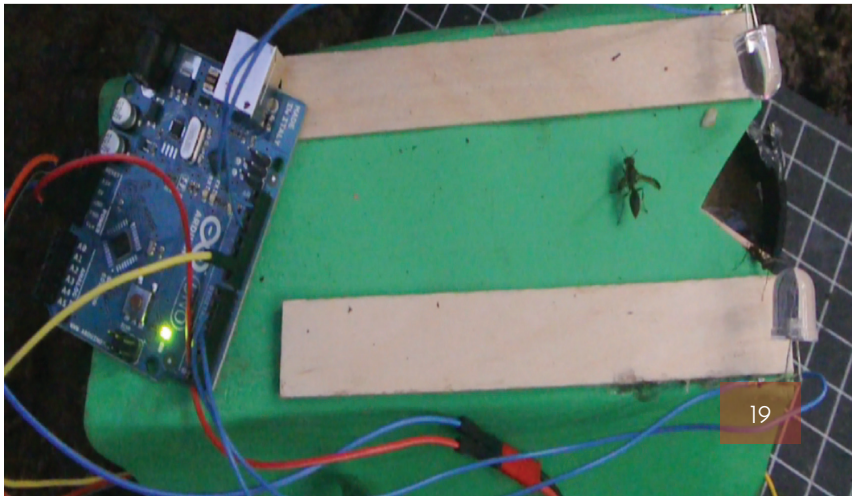
Contextual Crafting

Contextual Crafting encourages researchers to physically create devices as close to the target environment as possible. Ethologists study animals in the wild because their behaviors evolved to fit the idiosyncracies of the environment. Tools similarly incorporate assumptions about the environments in which they were made. This concept conserves a naturalist's precious time spent in the field, while enabling field-repairability and fostering inspirations in design from the nearby environment.

Building tools in the wild ensures their field-readiness and suitability for the research site and animals. Building in proximity to the field and incorporating natural materials fosters the idea of "making as exploring" which speeds iterations and inspires design insights from the field.

Techniques: Contextual Crafting	
	Shrink gap between Studio + Field Site
	Building in the wild
	Iterative Prototyping
	Incorporate Natural Materials

> Designing, building, testing and repairing digital tools in the rainforest promotes rapid iterations and insights. (Panama)



> Scene from interactive game played between fireflies and humans in firefly costumes at night in the rainforest (Panama)

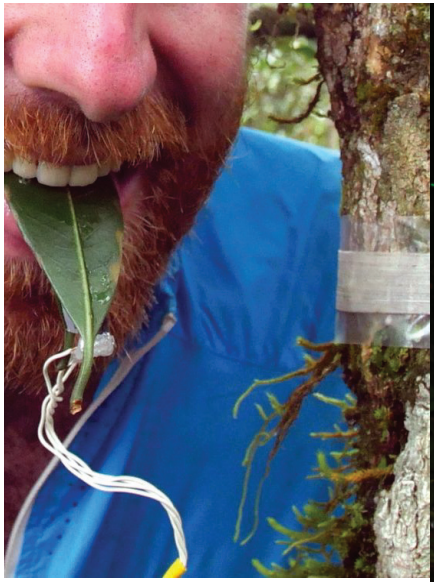
Behavioral Immersion

One of the functions of digital ethological tools should be to immerse the researchers in the behaviors of an organism or the environment. A scientist's early exploration is heavily dependent on immersing oneself in the overload of multifaceted stimuli of the environment and their animal's behavior. **Behavioral Immersion** augments ethologists' interpretive abilities by allowing them to deeply engage this data with their whole bodies.

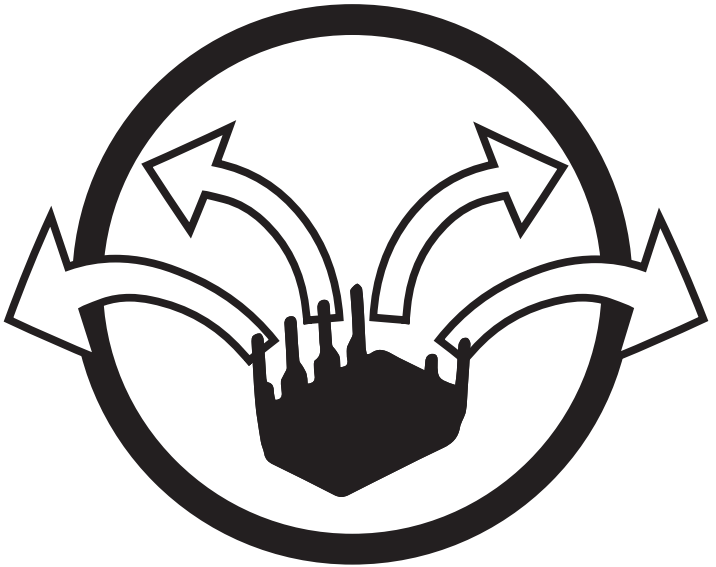
One can cultivate immersion by remapping one's own sensory modalities to the outputs of sensors studying animals or environments. Prolonged stimulation of body parts (like the tongue, or back) in coherent ways taps into the brain's plasticity, and develops engagement. Similarly, cybiotic interactions can be designed between computers and animals themselves.

Techniques Behavioral Immersion	
	Sensory Remapping
	Augmenting Environments
	Cybiotic Interaction

> **Projects which immerse humans in the worlds of the animals like Stereo Smelling, Ant traffic tongue displays, and firefly suit games in the forest (Panama + Madagascar).**



> Creating open-ended, improvisational tools with simple, extendable functions (like a capacitive touch leaf sensor), can be adapted for the environment and changed to suit new contexts. (Herbivory detector, Panama)



Open-endedness

A key task of scientific exploration is to increase chances of serendipitously stumbling across interesting new phenomena. Naturalists' tools should be designed for **Open-Endedness** and spur the curiosity and undirected exploration integral to their work.

Open-ended digital tools for scientific exploration can be thought to embody questions rather than only deliver answers. Tools with simple functions allow researchers to quickly re-arrange devices and poke and probe in new ways. Making adaptable, improvisational tools spurs curiosity by encouraging the interactor to create novel combinations of behavioral stimuli. Having tools that are only partially built further encourages such open-ended questioning and discovery.

Techniques: Open-Endedness	
	Simple Tools
	Improvisational Tools
	Unfinished Tools

> Turning plants into reactive surfaces (Appalachia, USA)

"The animals always do something different than you would think. It's about figuring out what are the bits you can build, and what are the bits you need to leave open until you can get them together with the frogs and see what works with the frog behavior?"

"What you make and what you leave open, I think that is a very important question."

-Karen Warkentin,
Discussing open-endedness in tools

> Malagasy research crew climbing through thick forest to a research site on top a mountain (Madagascar).

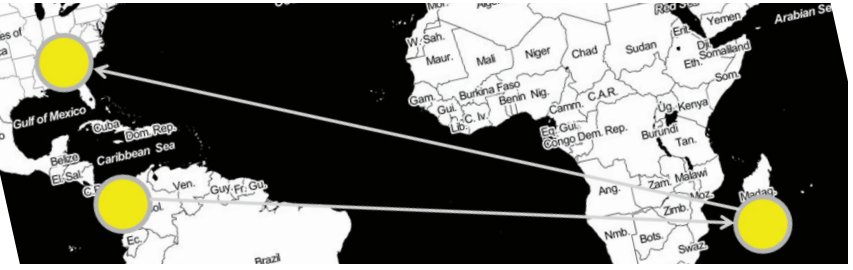
HIKING HACKS

A secondary contribution of this research is the **Hiking Hack** as a model for conducting Ratto's Critical Making – style workshops with diverse groups of participants located entirely in the wilderness.

The Hiking Hacks were originally created to test the concepts in the Digital Naturalism design framework. In doing so, however, they also proved to be a successful model for conducting workshops that support naturalist's principles with digital technology.

Moving the electronics workshops into the wild is the key, distinguishing component of a Hiking Hack. Like biological field courses, participants venture out to a specific site in the wilderness and attempt to use the tools they can carry to conduct their research, while exploring the techniques and ideas of others.

The ***Hike In*** has participants are most heavily weighed down, and covering the most ground per day. Participants relax and exploring the worlds of nature and the digital technology during ***Base Camp***. The ***Hike Out*** has participants mobile once again, but with lighter loads and opportune for reflection.



Panama 2014

Madagascar 2015

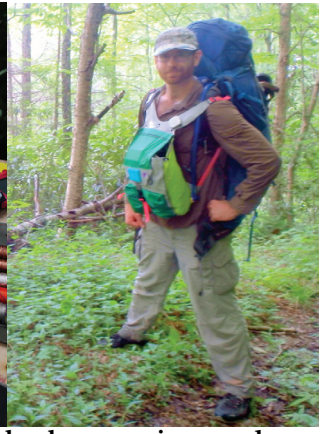
US 2015

EXPEDITIONS

Three official "Hiking Hack" expeditions have already been held in the forests of Panama, Madagascar, and the US. However this concept has been unofficially tested and explored in many other environments around the world. A key benefit of building in harsh conditions is that it opens electronics prototyping possibilities everywhere. Parks, trains, hotel rooms, and urban streets can also become sites of digital-physical exploration.

WEARABLE STUDIO

The Hiking Hacks have inspired us to explore an additional realm of design: the wearable, portable studio. Creating specialized gear to transport, organize, and facilitate electronics crafting in wilderness situations lets scientists stay close to the site where they explore their subjects.



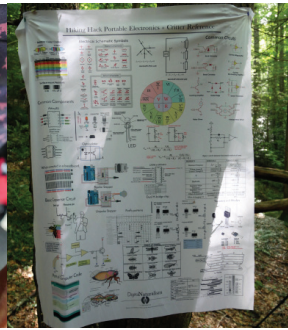
> Modular worksurfaces and daypacks that turn into tool organizers are essential to a Wearable Studio in Hiking Hacks.

EXTENDING THE BODY

Your own body might be the only structure you can fully rely on when hacking in the wild. Thus designing wearable devices and tool organization systems becomes an important part of being about to build within nature.

Access to technical information can be helped with temporary tatoos and printed cloth reference sheets. Mobile power via fire, water, and sun are also important areas of development.

MOBILE INFORMATION



PORTABLE POWER

FUTURE WORK

While still in its infancy, Digital Naturalism has succeeded in finding a validated, functional framework for designing digital technology in a way that aims to serve ethological practice. The preliminary research also reveals many fruitful new avenues of exploration. We will lead many more Hiking Hacks and design research for engaging with different biomes and differ cultures around the world.

This research is a small push in the broader struggle of using digital media to escape an anthropocentric worldview. Designing devices that promote enjoyment and engagement with non-humans can not only strengthen the design of digital media, but also foster greater empathy and appreciation for the natural world.

> Sharing Marting's research in the form of public, interactive performances with robotic ant puppets.

> Testing designs using stiff rainforest mushrooms as prototyping surfaces for electronics (Madagascar).

"We propose a new category of [computational] gifts for...focusing attention back on Modern Nature and how to build with it, nurture it, and form an intimate relationship with it."

-Silver and Rosenbaum,
Gifts for Intertwining with Modern Nature

> Post-performance reflection with real ants and participant experiences.

"Often I have been frustrated with the journal articles that come out of the research because only the finished results are given. All the excitement of the process has been squeezed out so that the results will conform to certain expected standards...

My hope is to capture... the sounds and sights, the endless chores and happy accidents, the obsessions, the wonder of it all."

-Bernd Heinrich,
In a Patch of Fireweed

This work was made possible by the contributions of time and knowledge by many dozens of people. Full acknowledgements in dissertation at digitalnaturalism.org

DigitalNaturalism

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www.digitalnaturalism.org