

# Breakdown, Obsolescence and Reuse: HCI and the Art of Repair

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## ABSTRACT

This paper describes an integrated program of theoretical, ethnographic, and building work meant to explore post-humanist alternatives to questions around HCI creativity and design. We review recent theories in the humanities, social sciences, and HCI that argue for different ways of framing the relationship between human agents and the object world around them. We then describe a program of ethnographic work with artists who feature found and broken technologies as central methods and topics of work. Finally, we describe an installation and self-study project of our own, “Scale,” that extends these lines of analysis through collaborative acts of building with broken and discarded technologies. We argue that such integrated programs of work offer one useful model for leveraging the theoretical, ethnographic and material dimensions of HCI work; and that the distinct “propensities” of found and broken objects can challenge and extend HCI notions of creativity and design itself.

## Author Keywords

Repair; art; agency; ethnography; design

## ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## General Terms

Human Factors; Design; Measurement.

## INTRODUCTION

In June 2012, controversy broke out around the design of the new MacBook Pro laptop computer, a functionally and aesthetically elegant machine that was also, as Kyle Wiens of iFixit.org reported in Wired Magazine[33], “the least repairable laptop we’ve ever taken apart.” In contrast to earlier generations of Apple’s Pro series (but continuing a trend from the MacBook Air and Apple’s consumer electronics lines) the construction of the new MacBook Pro was remarkably closed in nature: the new retina display was fused to the glass, the RAM was

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CHI 2014, April 26 - May 01 2014, Toronto, ON, Canada  
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ACM978-1-4503-2473-1/14/04 \$15.00. <http://dx.doi.org/10.1145/2556288.2557332>

soldered to the logic board, and the battery was glued to the case. This made the new machine largely unrepairable (except by returning the machine to Apple itself). It also undermined Apple’s environmental claim that the new design incorporated highly recyclable aluminum and glass, as current electronics recycling facilities have no way of cost effectively separating aluminum fused to glass in this way. Shortly thereafter, over the lull of the July 4<sup>th</sup> weekend, Apple announced its decision to withdraw 39 of its products from Electronic Product Environmental Assessment Tool (EPEAT), an industry self-monitoring initiative backed by the U.S. EPA, on the grounds that the company’s “design direction was no longer consistent with EPEAT requirements.” (One week later, bowing to customer and media pressure, Apple restored its membership.)

Nine months later, in March 2013, a new exhibit, “The Art of Recology,” opened at the San Francisco Airport. The exhibition was the outcome of the artist-in-residence program organized by the San Francisco Solid Waste Transfer and Recycle Center under the auspices of the “Recology” project, promoting recycling and reuse of discarded materials as well as new ways of thinking about art and sustainability. Since its inception in 1990, this art residency program has provided access to discarded materials at the 47-acre facility to more than 100 professional artists and 20 student artists have created diverse types of reuse-art works. The March 2013 exhibition included more than 100 artworks by 45 artists, all built around recycled materials ranging from styrofoam and plastic bags to mechanical parts taken from typewriters and vacuum cleaners.

What can these two stories tell us about the nature of technology reuse and repurposing and its relation to larger HCI concerns around creativity, innovation, and design? Per recent work in sustainable HCI and green computing[2,5,8] they call attention to the often-neglected links between design, aesthetics and consumption that extend beyond points of technological purchase and adoption. They tell us important things about power and control, both around the devices we own (but can’t fix?) and around the disposition of computing’s material flows, both ‘upstream’ and ‘downstream’ from moments of technology design and adoption. And they suggest the

insufficiency of design, at least as the sole or dominant lens through which questions of human-computer interaction are to be assessed.

From this perspective (what we've explored elsewhere as "broken world thinking"[15,16]) artifacts get designed, purchased, and adopted, but they also get fixed, discarded, and (sometimes) reused. Values get built into technology, but they still take work to maintain – and additional, sometimes alternative values may be introduced through ongoing acts of repurposing and reuse that humans routinely perform vis-à-vis the world of objects around them. Objects themselves participate in this process, and as rather more than the dumb and inert things we sometimes presume them to be.

This paper explores the problematic of technological breakdown, obsolescence and reuse, and how this might lead us to think differently about a range of issues core to the field of HCI – responsibility and sustainability, but also the nature and location of creativity and design. Theoretically, we build from work in HCI, the interpretive social sciences, and the philosophy of technology that explores the possibilities of a richer and more complex relationship between humans and the object world than typically acknowledged under either functionalist approaches to technology design or human-centered traditions of ethics or social science. Under this 'post-humanist' approach and related strains of work in HCI[3,6] what we've historically called the 'human' or 'social' appears not as a pure or separate world of inter-human values and relations operating without the intercession and mediation of things (including technology). Rather, both individually and collectively, to be human is to be embedded, constituted and completed in a world of things, as a fundamental aspect and building block of our natures. Humans are made human by addition, not subtraction: completed rather than compromised through sustained and care-ful engagements with a world of things.

The paper that follows develops these arguments through an integrated program of theoretical, ethnographic and building work. We start by reviewing recent "post-humanist" theory in the humanities, social sciences, and HCI that argues for different and broader ways of framing the relationship between humans and the objects around them. We then turn to a series of ethnographic interviews and observations with a particular class of creative designers whose activities we believe hold lessons for the CHI design community: namely, new media and interactive artists who work with found and broken technologies as a central method and topic of work. Finally, we describe an installation and self-study project of our own, "Scale", that attempts to bring together and extend these two lines of analysis through collaborative acts of building with broken and discarded technologies. We conclude by arguing that the distinct "propensities" of

found and broken objects may challenge and extend our notions of creativity and design itself: from a position of conceptual mastery and authority towards a flatter and more distributed model in which the artist/designer operates as participant and co-creator in a mixed world of people and things.

## THEORETICAL DEVELOPMENT

Recent work in the humanities and social sciences has begun to rethink what some have come to regard as a category error in the constitution of the modern social sciences: namely the existence of a social world separate and separable from the world of things. Growing from strands of work in environmental ethics and animal studies [1,10] science and technology studies [20,21] and the philosophy of technology [11,12], such post-humanist approaches assert three basic claims: first, that humans aren't alone in the ethical universe, but rather participate (in more and less responsible ways) with a world of animate and inanimate things; second, that much of what we regard as essentially human is constituted in this encounter; and third, that there exist autonomous realms of value and meaning beyond our capacity or interest to engage. For Latour, "things" – objects, buildings, other organisms, etc. – constitute the "missing masses" of modern social theory, the not-so-mysterious dark matter that accounts for the otherwise inexplicable patterns and durabilities of recognizably "social" entities: organizations, nation-states, markets, etc. Work in environmental and bioethics has replaced the line dividing humans from other biological forms with a series of constitutive interconnections, pointing to ways in which human nature and experience is paralleled, transected and constituted through interaction with entities ranging from dogs, to insects, to parasites[1,10,30]. Philosophers of technology like Graham Harman[11,12] have reevaluated the ontological status of objects in the material world, pointing to ways in which such objects 'withdraw' from the world of human understanding, even as they proliferate and form into new and surprising combinations. This necessitates what Quentin Meillassoux[24] has termed a 'flat ontology' built around forms of ontological diversity and combination denied under more human-centered orderings of the world.

These claims stand out more clearly when we consider their more intuitively familiar opposite: that the world *does* sort naturally by categories (or 'kinds'), in which humans occupy a distinct and privileged place; or that our practical and ethical world can be reliably divided into "subjects" and "objects", each with radically different rules and responsibilities of being. The force of such humanist separations are revealed by the disorientation we experience when such ontological lines are challenged or elided (for example in classic science fiction which plays with the sanctity of the human/non-human divide: the computer that thinks, the robot that feels). We also see it in our responses to the interjection of technological

practice and calculation into spheres of activity traditionally conceived as lying closest to the heart of human exceptionalism: love, sorrow, mortality, etc. Such developments are, literally, unsettling.

This work has begun to permeate approaches to human-computer relations in important and sometimes disorienting ways. In the 2006 re-issue of her 1987 classic *Plans and Situated Action*, Lucy Suchman[31] switches from the language of human-machine communication (implying some fixity of the entities on either side of the hyphen) to the more supple and open-ended language of *(re)configuration*, suggesting the possibility of a more fuzzy and interchangeable set of relationships. Recent work by Ian Bogost[4] argues in favor of a new “object-oriented ontology” that places humans and objects (insects, trees, graphical user interfaces, etc.) on a shared and more equitable ontological plane. Such an ontology would make no in-principle division between entities traditionally classed as ‘human’ and ‘object,’ nor assert a priori reasons for ranking one above the other. And it would recognize the possibility of elision or movement *between* categories – including across the particular ontological frontier traditionally defined as human.

At the same time, post-humanism tries to account for the ontological diversity and autonomy of things *in themselves*, providing strategies or heuristics for understanding that don’t automatically fall back into the instrumental languages of use or function. For if humans are caught up and constituted in their interactions with a rich and multifaceted world of things, each of these things are also constituted in interaction *with each other*, and according to rules or processes not solely defined by their positioning in human frames of value or meaning. But this poses deep challenges of understanding at the margins of our relationship to technology. If indeed objects ‘withdraw’ from human-centered modes of understanding and valuation, are there ways of approaching objects that can help us to think and see beyond their immediately ‘human-facing’ elements and dimensions?

As a matter of philosophical reflection, Bogost recommends the challenging idea of *metaphorism*: roughly, that we find and grasp relations across the essential diversity of things by understanding the partial connections that, like metaphor, establish both similarity and difference between objects without reducing one to the other (the tree as seen by the human, or the human the tree), and without recourse to an overarching system of value or meaning (e.g., function). In this fractal and emergent world, the task of ontology becomes descriptive: the giving of names to relations and combinations we have only partial hand in forming, or none at all. Michael Lynch[23] has labeled this practice “ontography,” and offers it as a “deflationary” alternative to the ordering and rule-giving pretensions of ontology.

But as Bogost also argues, the conceptual and philosophical approach sketched above may tip and restrict our approach to the object world in important ways, leading us away from rather than towards the ‘withdrawing’ nature of the things around us. Fortunately, we do more with the objects around us than talk about them. We also build them, use them, love them, fix them, and generally interact with them across a host of contexts in which the material difference of things is inevitably (and sometimes frustratingly!) engaged. Such practical interactions provide additional points of engagement through which the depth and dimensionality of objects can emerge – literally, different ways of knowing the object world around us. This has led to recent work in the humanities and social sciences that tries to build new ways of engaging objects into the process of critical reflection itself. Bogost[4] for example advocates “carpentry,” a term meant to include forms of hands-on building and construction as a supplement or alternative to analytic reflection. Ratto[26] recommends the process of “critical making.”

This broad sensibility has begun to enter HCI and other design literatures. HCI has long recognized the distinct qualities or “affordances” that artifacts may bring to contexts of design and action[9,25], and the art or skill of reading those qualities as a feature and principle of good design practice[29]. More recent work has sought to extend and radicalize this position, pointing to forms of material agency resident in the world around us. Tholander et. al.[32] for example, have called out the emergent and performative role of materials, emphasizing the ways in which material objects “talk back” to designers, the emergent and distributed character of agency, and its status as “not an attribute of things but ‘on-going reconfiguration of the world’” [p 2507]. Robles and Wiberg[27] have explored relations between physical and digital elements of the Swedish Icehotel, charting how basic material properties like texture may shape and unite the physical and digital dimensions of interactive design and experience.

Others have spelled out the implications of material agency for long-standing HCI concerns ranging from creativity and participation to the politics of design. Jacucci and Wagner[17] have argued for the connection between material objects and processes of collective creativity, emphasizing both the range of materialities at play in creative work (here, architectural design) and the persuasive, performative, and experiential roles such materialities may assume. Lowgren and Stolterman[22] have documented the ways in which artists deploy and leverage creative potentials embedded in the world around them, bounding and constraining their design process through the properties, possibilities, and limits of extant material forms. Pelle Ehn[7] has recast the nature of design as a form of cultural-material practice, charting rights and responsibilities that may extend and renovate

the principles of participatory design. And in their study of craft and material restoration in the world of bookbinding, Rosner and Taylor[28] have explored the restoration of existing material forms as sites of inspiration for an alternative design practice.

Within this world of creative material engagement, as explored in separate work[15,16], acts of maintenance, repurposing and repair constitute important and undervalued moments. ‘Broken’ things push back on human action and possibility in ways that ex-nihilo conceptions of creativity and design may miss. And activities of repurposing and repair may call out forms of long-run relationships between humans and objects that tend to disappear under the up-front design orientations of the HCI field.

The sections that follow explore moments of technological breakdown, reuse, and repurposing as important and neglected sites of human engagement with technology, with implications in turn for core HCI concerns around creativity and design. We begin by mapping these theoretical concerns against the experience of artists engaged in practices of technological repair and repurposing, before turning to an installation and self-study of our own built around the same rough principles. Our decision to work with artists and broken objects rather than a more conventional set of HCI designers and materials, stems from two basic beliefs. The first is our sense that artists struggle with and expose questions of creativity and its relationship to the material world in unusually rich and forceful ways, and that these experiences can shed light in turn on HCI’s own necessary struggles around these questions. The second is our sense that work with broken and discarded objects may bring to the fore possibilities in our individual and collective relationships with technology that are often obscured in the case of the new and functioning objects we more traditionally consider in HCI.

#### **LEARNING FROM WATCHING: REPAIR, REUSE, AND DESIGN**

In this section we report findings from an ethnographic interview study conducted between July 2012 and August 2013 with 17 artists who engage processes of technological breakdown and reuse as central methods or topics in their work. This included circuit-bending musicians, makers and hackers, and kinetic and found-object artists, identified by our prior knowledge of their work, recommendations from friends and other artists, and through public showings and listings of their work, in galleries or online. Interviews followed a semi-structured format organized around questions of motivation, process, and materials, and the artists’ own background, experience, and ambitions for their work. Most lasted between one and two hours, and were conducted via telephone or in person. Wherever possible, interviews were combined with studio visits and/or observations of

public exhibitions. In one case, our ethnographic interactions morphed into a longer series of interactions that eventually gave rise to the collaborative installation project described further below. Interview and observational data were transcribed, reviewed, and coded by both members of the study team according to grounded theory principles. The following sections pull out elements of the fieldwork data connecting most directly to the questions of creativity, design, and materiality explored in this analysis.



**Figure 1. Study participants (clockwise from top left): Richard Birkett, Paulo Goldstein, Tazoo Park and Nemo Gould**

#### *Finding and Collecting*

All of the artists in our study described the process of finding and collecting broken or discarded materials as an important and sometimes surprising moment in their larger creative process. In some cases, artists reported turning from other more conventional materials to discarded or repurposed items because they were simply free or cheap. In some cases these economic motivations remain, and artists continue to rely on discarded or obsolete objects from the street, garbage, or donation from friends as a financial necessity. Some of the artists we spoke with augmented or replaced these methods with a more targeted approach, often turning to eBay or local antique malls to source materials. This was particularly true for artists who sought objects with distinctive aesthetics or functions that were central to their design intentions. Nemo Gould, for example, is an Oakland-based artist who creates interactive kinetic sculptures that incorporate movement, light, and sound. He told us that he particularly likes working with mid-century electronics and military equipment because the “story” that those objects speak harmonizes well with the Steampunk-like aesthetic he seeks to create. He explains that artifacts from this period embed an ethos that placed high value on visions and explorations of future possibilities:

*Part of what I like about the period that I collect from like the 40s and 60s is, we had a space race. We had a cold war, and a lot of ideals that aren’t really at the forefront of the culture anymore. The*

*government was very much behind science and exploration, at least as far as military purposes went, and it trickled down to everybody else. There was just really high value put on exploration and speculating about the future.*

Other artists we spoke with professed to be more open or eclectic in their choice of materials, preferring *not* to settle on a particular style or period, but rather allowing the composition of found objects serendipitously encountered to shape their ideas and vision for the work. In some cases, artists described an environmental rationale to their work, liking that using repurposed materials might call attention to issues of waste, consumption and sustainability that they cared about. But in every instance this was given as a secondary motivation, and not the primary cause or reason for their choice of objects.

#### *Playing and Exploring*

Many of the artists we interviewed reported an interest in technological function, breakdown and repair that dates from an early age. Many describe childhoods spent disassembling and reassembling artifacts ranging from ‘G.I.Joe’ toys, to VHSs and radios, which were described variously as “enjoyable” and “inspirational” tasks. All reported that such curiosities and orientations towards the “secret” inner landscape of things remained a central motivation and pleasure in their work..

Richard Birkett, for example, an Otego, NY-based artist who builds elaborate ‘Fantasy Clocks’ out of a range of broken and discarded technologies, told us that taking apart artifacts has always been (and remains) both an enjoyable and inspirational hobby; “the more things I have taken apart, the more I get inspired to what I have been doing now.” Birkett says he approaches each artifact as an autonomous actor with a distinct language that interacts with and inspires his work. He describes the joy and mystery that accompanies the process of exploring the internal functions of lost and broken objects. On the day we visit his studio, he is working on an old mechanical typewriter, an object class that appears periodically in his work. Objects like the typewriter, Birkett explains, hold natures and realities all their own: “you can almost say that it’s whole different language inside the typewriter, that you as an artist can translate.” The “language” that old technology generates is fascinating for him precisely because it reveals different connections (current and potential) between objects, functionality and the world.

Taezoo Park is a New York City-based artist who creates interactive installations (the “Digital Being” series) out of old and broken technologies found thrown away on the street. Park explains that he likes to think about technological artifacts as “humanized agents” with forms of “intelligence” and “soul” assembled from the “junk” of commands and microprocessors that humans might not be

able to fully understand. He imagines these forms of soul and intelligence continuing to grow and evolve after technologies have been thrown away, constituting a form of identity different to the one perceived and experienced by humans. To explore these, Park carefully observes and interacts with the objects for a long time before trying to do anything with them. In the below passage, he describes his interactions with a Sony surveillance monitor he has recently found and brought back to his apartment:

*Since I found him, I have been observing him for a long time, and I found that this guy doesn’t make any sound - because there is no speaker with him, and something like...he keep blinking and..I just felt that he has some characteristic that shy people have. I felt like he is doing something in the corner. So I thought he is kind of shy....*

#### *Assembling and Configuring*

Although some of the artists we studied occasionally made use of the linear idea-sketch-prototype-build model of design learned from their art school days – a process which overlaps strongly with forms of design education we see practiced in HCI – most have adopted a more organic and improvisational approach in which processes of discovery and material engagement precede the existence of any conceptual plan or idea. Nemo Gould, for example, likens his design process to doing a complicated jigsaw puzzle in which individual artifacts serve as inspirations and starting points for the assembly of the whole.

*If you look at the jigsaw puzzle, you learn pretty quickly that you want to dig through the confusion of the mixed parts and look for the corner. Right? The element that has enough suspicion that you know it goes on one side or the other. You sort of narrow down your options, so you won’t be overwhelmed with possibilities..*

Andrew Smith, a Utah-based artist who builds large-scale kinetic structures out of discarded industrial and farm equipment, describes his design process as “organic in the way it happens,” so that the final outcome is not created but grows through discovery of the physical world:

*it’s just so organic in the way it happens. It just grows. It just happens as it goes. There’s no set process as to how...I don’t know. It’s really kind of interesting...I never would have even come close to discovering or finding out in pen and paper or even with a CAD system or anything. You don’t notice it until you’re in the physical world creating it, and then you discover something and you’re like, “Holy cow! If I do this, then it does that. That does this effect. Wow! That was really cool!”*

In this improvisational and emergent process, the artists consider not only design and aesthetic aspects like color, shape, or texture, but also take into account the context,

function or what one artist described as the “aura” of things, taking the rich and layered histories of found objects and “re-mixing” them, sometimes through combination or juxtaposition with other kinds of materials. Such processes of re-mixing require forms of imagination and creativeness that reflect and establish each artist’s distinctive aesthetic and vision. In this way, processes of design and creativity are described as both combinatorial (produced through acts of assembly rather than *ex nihilo* conception or creation) and deeply indebted to the material worlds from which they originate..

Richard Birkett, for example, often uses non-technological components in his clock series, such as old pictures or music boxes, arousing wonder and curiosity by the strange juxtaposition of objects, people, and memory. If such combinations produce endless possibilities in the final design of the clock, they also provide, as Birkett describes, an endless source of imagination and creativity:

*The whole construction process is like “this will make a nice clock” and I have all sorts of typewriters arms coming down to decide it. You know, there are just so many possibilities. My wife used to say, “What happens if you run out of ideas?” And I say “it’s not going to happen, I just can’t see that. My problem is that I have more ideas than I can deal with...”*

The above discussion foregrounds processes of creative assembly, repurposing and juxtaposition that were central to the creative work and sensibilities of all the artists we studied. But most also connected this work to prior material encounters that were no less distinctive. Almost all of our interviewees described, in one form or another, the distinctive energies and freedoms that moments of technological breakdown, error, and frustration unleashed. Paulo Goldstein is a London-based industrial designer and found object artist responsible for the “Repair Is Beautiful” series, featuring elaborate and visibly restored industrial and everyday objects. He describes his design process and overall aesthetic as being organized around “frustration”:

*So at the start, you control the tool and you control the wood. And you control the environment because you took this wood from the forest. And so you are in full control of everything. But completely opposite to that is this everyday world that we are in—you are not even in control of your own finances because you cannot control that. And so all this frustration comes, well, through this whole reality. During the repair process by projecting my frustration into the broken object and by creating this metaphor of a broken system with a broken object, by combining both of them and repairing just using elements of this broken system, I am controlling roughly how I am going*

*to push the string. It’s like a very hands-on kind of repair, touching the material and controlling it.*

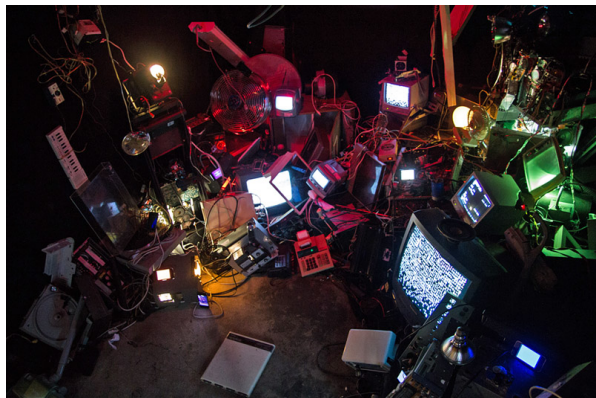
The artists reviewed above demonstrated a range of relationships to the found and broken objects they engaged through their work. While all demonstrated a deep and generative curiosity and engagement with the world of objects they engaged, the precise form and import of this engagement varied. In a minority of cases, found objects were deployed after the manner of a resource or raw material whose distinctive natures or features were selected or repurposed according to a preconceived notion of aesthetics or design. Far more often however, the relationship ran deeper and longer, with the peculiarity and distinctiveness of materials persisting all the way through processes of collecting, discovery, and assembly. In such cases, objects retained a live and formative influence on ongoing design, shaping the artists own creative process and imagination in a more collaborative way. In some instances (for example, Tazoo Park’s ‘Digital Being’ and Paulo Goldstein’s ‘Repair Is Beautiful’ series – the “strangeness” or resistance of objects was retained all the way through to the end, becoming a theme or topic of the work itself.

#### **LEARNING FROM BUILDING: THE ART OF ‘SCALE’**

Following on these findings and building on theoretical principles laid out above, we resolved to test and develop these ethnographic insights through the significantly different medium of building: a program of work that would eventually produce “Scale,” a multimedia art installation created during summer 2013 and exhibited during September 2013 at the World Maker Faire in New York. Developed by the paper authors in collaboration with New York City-based digital artist Tazoo Park (through a relationship established during the ethnographic portions of our study), Scale gathers and recombines broken, discarded and other found technologies to explore a number of topics simultaneously: neglected moments of breakdown, obsolescence and reuse in human-technology relations; potentialities for action retained by technologies beyond points of original design and function; and the aesthetic experience of wonder, joy, and beauty that engagement with broken and discarded artifacts can bring. As the installation description explains,

*These things lives all around us – the toaster that toasts on one side, the abandoned reel-to-reel player left over when humans move on to new and different devices. Bereft of context and function and left to rust in attics, basements, and landfills, they provide the forgotten technological backdrop to our lives. But they also remain alive, filled with mysteries and secret languages, neglected talents and strange beauties. How are we to relate to this secret society of things? What values and qualities can we find in them (and in ourselves)? And what*

*might that teach us about fear and wonder, imagination and care, in the mixed world of humans and objects?*



**Figure 2. Scale**

The first iteration of Scale (see Figure 2) was produced over an intensive ten-day period in August 2013, during which the collaborating team worked (sometimes around the clock) through project conception, functional and visual design, and material construction. This was accompanied by an extensive process of documentation and reflection, captured through a rich combination of cameras (still, video, and time lapse) and audio recorders set up throughout the studio. Each collaborator also recorded daily video logs of 10-30 minutes, and key decision points were marked by semi-formalized two- and three-way interviews among members of the project team. This produced more than 1300 still pictures, 10 hours of formally recorded interviews and group discussions, and several dozen hours of video recording the design and development process. (A part of this record would later be incorporated into the installation itself, in the form of time-lapse videos of the construction process that appear alongside the finished project.) This audio and video record was reviewed, partially transcribed, and analyzed through an open and iterative coding scheme organized around themes of reuse, design, and material agency developed in the theoretical and ethnographic portions of our study. This documentary record forms the basis of the discussion that follows.

In our initial stages of conceptualization and design, the project was open-ended and improvisational, bounded only by a pair of ground rules mutually agreed to in advance: first, that we would work primarily with broken and obsolete technologies that could be sourced easily or inexpensively from our local environment; and second, that we would adopt a “flat” collaborative model, in which each team member would work across all aspects of the project rather than falling into specializations based on pre-existing strengths and experiences (designer, engineer, theorist, etc.). The eventual shape and function of the installation emerged from sustained and collaborative interactions between members of the design

team and the artifacts collected and engaged, with occasional critique and feedback from friends and acquaintances who dropped by our studio. Our process of design and construction proceeded in three basic phases.

#### *Finding and Collecting*

Over the first two days of the collaboration, we collected more than 80 broken or discarded objects from local streets, second-hand stores, yard sales and occasional personal donations. Objects collected included (among many others): a reel-to-reel film projector; a darkroom photo enlarger; a clock radio; old computer and television monitors of various shapes and sizes; an office printer; a variety of old theater lights; an electric fan; a calculator; manual and electric typewriters; and a broken toaster.

Our object selection was guided by a collaborative decision process that weighed factors ranging from price and condition to aesthetic or functional interest. In some instances, objects were collected with immediate potential uses in mind; in many others, objects simply struck us as curious or noteworthy, and they went back to the studio to be figured out later. During collection, we documented all available information around the objects (era of origin, price, model number, etc.); this basic project inventory was later incorporated as a wall display within the installation itself. The first item we encountered was a broken bathroom scale discovered in a local recycling shop. The installation (and the title) followed from there.

As revealed by later coding and review, much of our design process at this stage was driven by our basically serendipitous encounters with found and broken objects, and our varying reactions, individual and collective, to the objects encountered. In some cases, we immediately converged on shared senses of interest and curiosity; in others, a member of the project team ‘saw’ something in an object that others did not, and our discussions then turned to sharing and explaining the individual reactions evoked. Through such processes we gradually converged on a joint aesthetic that would unite the collection process.

Other discussions in this period centered on the nature and range of ‘broken-ness’ encountered. Some of the objects were broken in an immediately functional sense: parts were missing or had stopped working, electronics had failed, etc. Others were broken by virtue of context: objects which still ‘worked’ in their original sense, but whose placement in the world had disappeared, often through losses of medium and infrastructure that rendered them effectively (though not functionally) useless.

#### *Playing and Exploring*

Once back in the studio, we began the process of exploring the items collected. Using tools ranging from hammers, screwdrivers and suction cups to drills and rotary cutters, we opened objects up, exploring inner workings and logics, and otherwise digging into the “guts” of the objects collected. In some cases, repairs were made

and original functions restored (though artifacts were sometimes altered to make these inner workings more visible, for example through cracked or broken casings). In others, internal function or aesthetics suggested different uses and possibilities, and objects were altered or repurposed towards radically different ends. Still other objects struck us as beautiful and complete in present form, and we left them substantially alone.

This stage of the project also involved intense one-to-one interactions between members of the design team and specific objects. As with collection, this became a place where distinctive aesthetic and design sensibilities were engaged, and particular design imaginations were unleashed. One member of the team might find a particular object or kind of mechanism beautiful, striking, or suggestive, while another might pass it by with indifference (although there was much indeed that we immediately and intuitively agreed on). These varying sensibilities drove our individual selection of objects and through this our overall division of labor. Such individualized processes were once again punctuated by discussions in which we tried (not always successfully) to convey our varying senses of interest and curiosity around specific artifacts. Though we imposed no strict rule of agreement, artifacts which inspired the most widespread sense of interest and curiosity within the team (sometimes after explanation by the team member most taken with them) tended to emerge as featured pieces within the assembled installation that followed, and often drove or located the interpretation or placement of objects that followed. In this way, the stage of playing and exploring described separately here flowed seamlessly into the process of assembling and configuring which followed.

#### *Assembling and Configuring*

Four days into the collaboration we began transitioning from a focus on individual objects to wider conceptions and imaginings of the whole. This process was not simply about placing artifacts according to some obvious or pre-ordained order or plan. Instead, it depended on the improvisational mixing and matching of objects that, in combination and through juxtaposition, produced aesthetic or functional connections and effects that we decided we liked. In this way, the possibilities of meaning uncovered in earlier moments of individual play and exploration remained live, enhanced and transformed by their placement or situation within the whole. This process was both cumulative and collaborative, and driven substantially by the materials at hand. For example, one member built up a certain part of the installation with a collection of old and analogue technologies, including an old film projector and photo enlarger. Once assembled, another artist suggested adding both digital and analog clocks hanging on the top to create a juxtaposition of time and nostalgia in hopes of creating the feeling of forgotten items under the strain of time.

The phase of assembling and configuring also involved the production of basic functional connections, through which objects widely separated in time, nature, and function could be made to interact. This included the supply of basic power to artifacts throughout the installation; changeable lighting through the strategic insertion of programmable LED lights; the ‘programming’ of the various screens and displays that appear (mostly with randomly-generated number and text strings and/or responding to changes in the ambient environment); and wiring for a variety of interactive effects linking one object to another (produced for the most part through Arduino code and processors). Here again, the shape of the received (albeit now modified) objects shaped the design space, suggesting possibilities but also posing sharp and sometimes insurmountable limits.

As our project unfolded, we witnessed and experienced many of the same pleasures and difficulties described earlier by the artists in our ethnographic study. Our encounters with broken, found and repurposed objects turned out to be rich and generative, shaping and reshaping our own gathering and conception of what the installation could and might be. In this way, our sense of design developed incrementally and collaboratively, in conjunction with each other but just as centrally with the collection of object we encountered. Like our artists, we too became enthralled by the puzzle-like nature of the objects we encountered, a sense of mystery and discovery that often sustained us through long nights of building. Opening up many of these objects looked and felt less like “opening the black box” in its cold and analytic sense, and more like opening a present, with all the mystery, excitement and pleasure the analogy implies. In rare cases, objects became less interesting to us upon disassembly, with compelling external properties giving way to dull and unimaginative inner workings. More often however our experience ran in the other direction, with plain and faceless exteriors pulled back to reveal ingenious, elegant, and aesthetically beautiful inner landscapes. Such experiences of wonder, beauty and discovery – often ignored or downplayed under more instrumental traditions of HCI work – constitute central values and pleasures, both in practices of design and creativity, and in human relationships to the non-human world more generally.

#### **DISCUSSION AND CONCLUSION**

The story sketched above represents a small and distinct sub-world within the wider problematic of breakdown, obsolescence and repair that we argue deserves deeper consideration among the panoply of HCI concerns. The artists engaged here approach the work of repair and creative repurposing under radically different constraints than those attending the work of the amateur repair movements in North America and livelihood repair communities in the global South that we have also, in other contexts, studied[14,15,16]. Nor is the above meant to fetishize or romanticize the automatic virtues of



creative material engagement itself, not least as other movements in this space (making, hacking, etc.) are subject to complex processes of institutionalization, branding and appropriation.

Nevertheless, the program of theoretical, ethnographic and building work sketched above has wider implications for HCI scholarship, including around questions of design and creativity central to the field. One of these concerns the relationship between creativity and function. As work with found, broken and obsolete objects makes clear, there are ‘lives’ to our technologies beyond the contexts and functions for which they were originally designed. Processes of creative breakdown and reuse can unleash these, suggesting alternate universes of possibility in our relationship with extant technologies. A typewriter is always a typewriter while a typewriter; once broken, as our artists show, it can be just about anything. In this way, function can constrain and obscure, locking objects into a world of necessary dependencies that limits the kinds of relations we may imagine with them (though rarely as completely as designers may imagine or perhaps hope). This is mostly to the good – technologies are *designed* to function and we want them to. But it also sets limits to practice and imagination that designers would do well to bear in mind, and that acts of creative breakdown, repair, and repurposing may liberate.

Moments of reuse and creative repurposing may also call attention to the fundamental *incompleteness* of human relationships to technology, again with implications for creativity and design. In our work with artists and again in our own installation project, we encountered frequent echoes of the kind of technological “strangeness” described by Bogost. Part of the pleasure of material interactions in this context may lie in the puzzle-like nature of the process, including the frustrations and surprises that such encounters routinely throw up. These forms of surprise and resistance can feed in turn into processes of creativity and design – and *did*, among the artists we studied and in our own installation work. This in turn suggests a much more distributed model of creativity and design than typically supported or assumed by HCI scholarship. If, per Hutchins[13], cognition lives in the world and not solely in the brain, so too does imagination and creativity, structured and completed in a world of material encounter. From this perspective, creativity and design loses the *ex nihilo* and untrammelled quality sometimes ascribed to it under more “heroic” notions of genius and discovery. Rather, we’re creative in conjunction with the things around us (and they with us) borrowing as much from their limits as their possibilities. We think and imagine in concert with things, not just through them or about them. Creativity is something we do *in* and *with* the world, not just to it.

In all these ways, languages of post-humanism and material agency, and the specific contexts of

technological breakdown, repair and repurposing have important things to offer questions of creativity and design in HCI today. But there is also something deeply unsettling and weird about the proposal that things “act” in the world, or have “agency” akin to that typically accorded to humans. If “affordance” seems too weak and constrained a word for the kinds of things that things can do in the world, “agency” seems too strong, granting objects qualities and attributes that they may not in fact possess (and we may not want them to have).

Without rehashing this long and complicated debate, we’d like to conclude by proposing that part of the difficulty may lie in our languages of action and agency themselves – and that new approaches to such questions may help extend and reorient the way we think about and practice design. Our starting point comes from French historian Francois Jullien[18,19], who over a series of books in the past twenty years has unfolded a different philosophy of action built around what he identifies as “the propensity of things,” a kind of intuition or principle that runs across the fields of classical Chinese strategy, politics, aesthetics and history. From this perspective,

reality – every kind of reality – may be perceived as a particular deployment or arrangement of things to be relied on and worked to one’s advantage. Art, or wisdom... consequently lies in strategically exploiting the propensity emanating from that particular configuration of reality, to the maximum extent possible (15)

In this way of thinking, capacities or potentialities for action – a force Jullien describes as “efficacy” – are not embedded in the mind, hand, or eye of the human strategist or creator, but are distributed across the landscape of “things” themselves, a term here indicating both the nature and disposition of discrete objects and their arrangement or organization into larger “configurations”. Such propensities are more than inert and passive resources to be drawn on and activated through human intervention (as the ultimately functional language of “affordances” would suggest). Instead, they form live and active partners to human action in the world, adding weight, shape and direction to some lines of action while subtracting it from others. And they do so without acquiring or needing any of the attributes of intention or subject-hood that western-centered conceptions of agency seem to invoke.

Propensity, efficacy, configuration: such languages may help us out of the impasse left by the ways in which our dominant philosophical traditions have tended to frame the problem of action in the world. But they may also help us think differently about the problem of design itself. From this perspective, the role of design and designer may be less about building “new” things in the world, and more about inflecting and remixing the human and object

worlds that exist, bringing old forces into new combinations. As work with broken and repurposed materials makes clear, such work may involve forms of communication with material objects and forces with idiosyncrasies, challenges, and inclinations all their own. Propensities let us approach core HCI questions around design and creativity in a world of things without falling into old problems of intention, agency or determinism that efforts to account for the non-human can sometimes face. Better exploration of these questions may require new forms of research that cross the lines of theoretic, analytic, and material engagement.

#### ACKNOWLEDGMENTS

Research for this paper was supported by funding provided under the Intel Science and Technology Center for Social Computing.

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